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Recommended Lift Charge Amounts

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One of the most frequently asked questions is "How much lift powder do I need for my shell?". Unfortunately, the answer is not an easy one. The first reason is a lack of consensus regarding the optimum height to which various sized shells should be propelled. Of course, it is a requirement that burning components must not fall to the ground, but that is where the consensus ends. For a 3-inch shell, is 250 feet high enough or is 450 feet required? The second reason is that after deciding on the proper height, there are still a large number of other variables that determine the needed weight of lift powder. Among the variables are:

- Shell Type (cylindrical or spherical),
- Shell Weight,
- Shell Size (diameter),
- Shell Length (for canister shells),
- Lift Powder Grain Size,
- Lift Powder Quality (if it is not a commercial grade),
- Mortar Length,
- Loading Space (volume between bottom of mortar and shell), and
- Shell Clearance in Mortar.

Our typical response is to refer the questioner to what others have reported and to recommend the use of these suggestions as a starting point from which further adjustments can be made as found to be necessary during testing.

Basically, there are two ways in which authors have reported their recommendations regarding shell lift. One is the weight of lift per weight of shell. The other is weight of lift per shell size.

Lift vs. Shell Weight

As regards the weight of lift per weight of shell, there are at least three recommendations. The Westech[1] literature advises 1/5 ounce of black rifle powder for every ounce of shell weight, with the caution that actual weight must be determined by experimentation [Authors' note: Caution is advised because this is higher than the other recommendations by a factor of at least 3]. Fulcanelli[2] also provides a rule of thumb — 1 ounce of 2FA for each pound of shell weight up to ten pounds, then 1/2 ounce for each pound over ten pounds. Fulcanelli also notes that with very large shells, such factors as the fit of the shell in the mortar, the mortar length, and the length of the shell, assume more importance than for smaller shells. A *PGI Bulletin* Question and Answer article[3] presented a

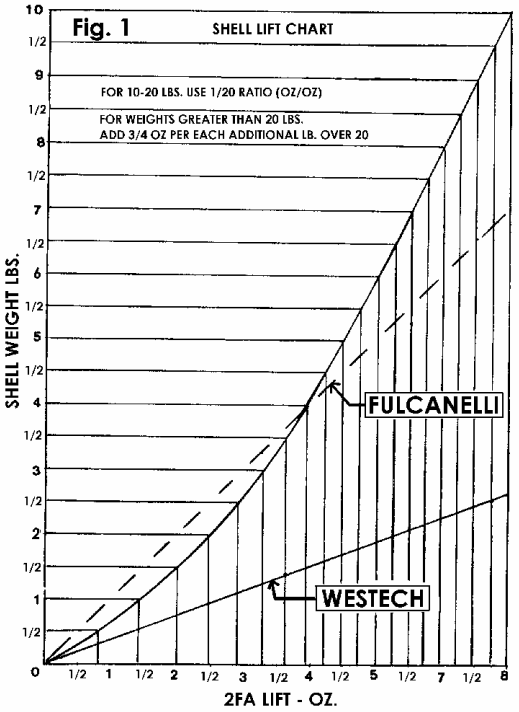

Figure 1. Shell lift chart.

Table 1. Recommended Lift for Spherical Shells.

Shell Size (in)	Shimizu (2Fg–3Fg)[a] (oz)	Shimizu Shell Weight (lb)	Lancaster (Cannon Powder) (oz)	Bleser (2Fg) (oz)	Tenge (2FA) (oz)	Weingart (Unknown Powder) (oz)
2	—	—	—	0.3	—	—
3	—	—	—	0.6	0.75	—
4	—	—	2	0.9	1.5	1.5
5	1.3–1.6	.9–1.4	—	1.6	2.5	—
6	2.6–3.0	2.5–3.3	—	2.8	3.5	3.5
7	3.9–4.6	4.4–5.7	—	—	—	—
8	—	—	9		6	—
8.5	6.0–6.7	7	—	—	—	—
10	8.5–9.9	7.7–11.7	—	—	—	14
12	15.9–17.6	18.3–20.3	—	—	—	—
24	145.5–172.	132.–149.	—	—	—	—

(a) This does not mean 2 Fg or 3 Fg but rather Shimizu reports using Black Powder with a wide particle size range, which encompasses the particle sizes of both 2 Fg and 3 Fg.

chart of shell weight in pounds versus 2 FA lift in ounces. Figure 1 is a reproduction of that chart with added lines for Fulcanelli and Westech weight ratios. Of these, the authors feel that the graph from the *PGI Bulletin* probably represents the best starting point.

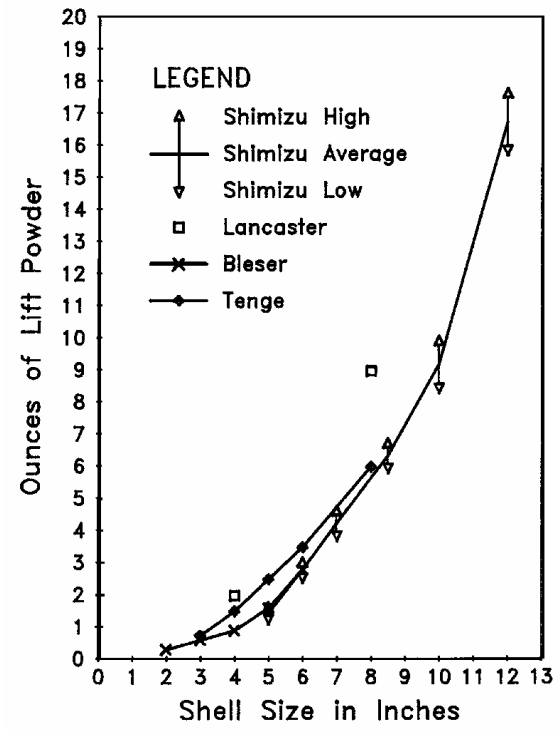

Figure 2. Spherical shell lift chart.

Lift vs. Shell Size — Spherical

With regard to weight of lift vs. spherical shell size, Table 1 presents the recommendations of Shimizu,[4] Lancaster,[5] Bleser,[6] Tenge,[7] and Weingart.[8] Only Shimizu provided shell weight data. These same data are presented graphically in Figure 2.

Lift vs. Shell Size — Cylindrical

Cylindrical or canister shells are more difficult to deal with because: the shell length can vary greatly; the contents of the shell can be high density (stars with Black Powder burst), low density (flash powder), or anywhere between; and the shells can be single or multi-break. Nonetheless Tables 2 and 3 provide suggestions for one- and two-break cylindrical shell lifts from Tenge, Fulcanelli, and Freeman.[9] The data are presented graphically in Figures 3 and 4. All references suggest using 2FA powder.

Freeman also offers a chart of estimated shell weights and lift amounts for multi-break 4-inch shells. See Table 4.

For long multi-break shells Freeman notes that the mortar lengths should be at least half again the shell length. For example, a shell 32 inches long should be fired from a mortar at least 48 inches long.

Table 2. Recommended Lift for 1-Break Cylindrical Shells.

Shell Size (in.)	Tenge 1-break (oz.)	Fulcanelli 1-break (oz.)	Freeman 1-break (oz.)
3	1	1	.9
4	2	2	1.5
5	3	3–3.5	2.8
6	4	4–5	4.2
8	6	6–12	–

Because of all the many factors mentioned in the introduction, you should only use these tables as starting guidelines; you **MUST** experiment to determine the correct amount of lift for your particular shells.

Table 3. Recommended Lift for 2-Break Cylindrical Shells.

Shell Size (in.)	Tenge 2-break (oz.)[b]	Fulcanelli 2-break (oz.)	Freeman 2-break (oz.)
3	1.5	1.25–1.5	1.4
4	2	2.5	2.2
5	4	4.0–5.0	4.2
6	4–5.5	4.5–6	6

(b) Specifically color and report, or larger single break component shells.

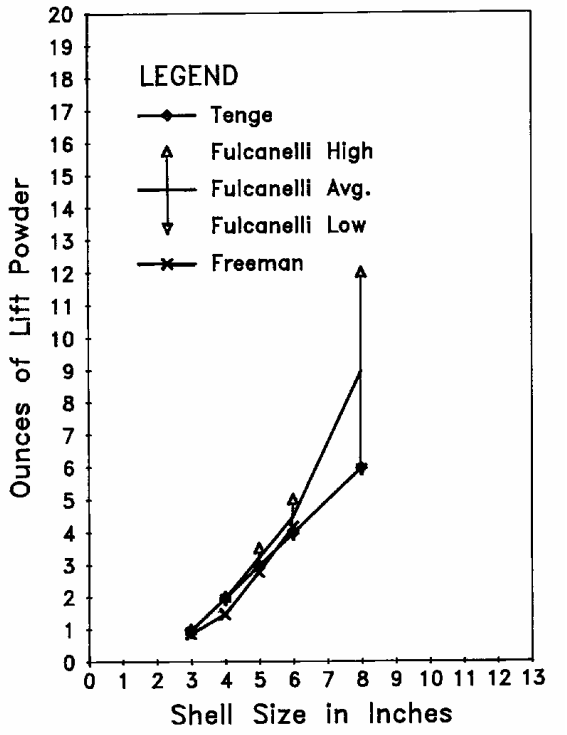

Figure 3. Lift weights for cylindrical 1-break shells.

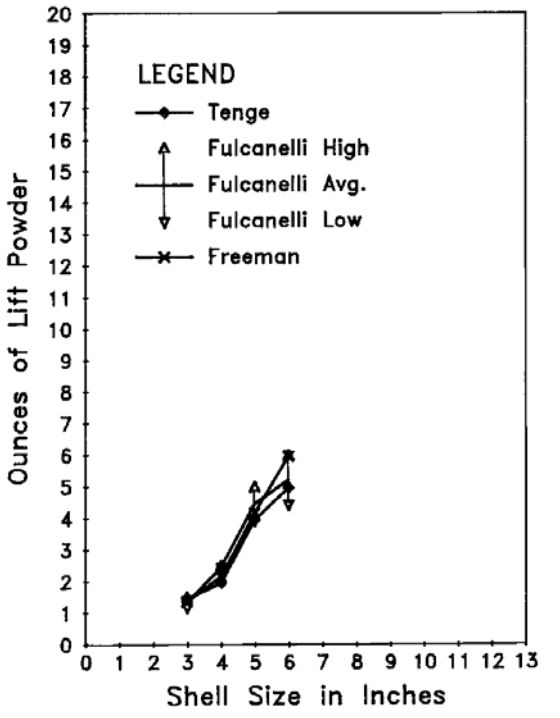

Figure 4. Lift weights for cylindrical 2-break shells.

Table 4. Weight Ratio for Multi-Break 4-Inch Shell.

Number of Breaks	Estimate of Shell Wt. in lb.	Recommended Lift in oz.
1	1.2	1.5
2	2.4	2.2
3	3.6	2.8
4	4.8	3.4
5	6.0	4.0
7	8.4	5.0
8	9.6	5.5

References

1) Westech, *Basic Aerial Shells*, Westech Corporation, 1970.

2) A. Fulcanelli, "Traditional Cylinder Shell Construction, Part I", *Pyrotechnica IX*, Pyrotechnica Publications (1984).

3) Unknown, "Questions and Answers", *Pyrotechnics Guild International Bulletin*, No. 22 (1981).

4) T. Shimizu, *Fireworks The Art, Science and Technique*, Pyrotechnica Publications, 1981.

5) R. Lancaster, *Fireworks Principles and Practices*, Chemical Publishing, 1972.

6) D. Bleser, *Round Stars and Shells*, American Fireworks News, 1988.

7) C. Tenge, "Lifting Shells with Black Powder", *Pyrotechnics Guild International Bulletin*, No. 34 (1983).

8) G. W. Weingart, *Pyrotechnics*, Chemical Publishing Co., 1947.

9) W. H. Freeman, "Some Thoughts on Shell Lifting", *Pyrotechnics Guild International Bulletin*, No. 50 (1986).