One method of reporting explosive output is in terms of TNT equivalent under specific conditions. For example, in these measurements, the maximum output for a sample was found to produce a TNT equivalent of 27%. For this sample, the explosive output (air blast wave) of 1 gram was found to be equivalent to that expected to be produced by 0.27 gram of TNT. The average results from the series of test mixtures are graphed in Figure 4 and demonstrated in Figure 5.

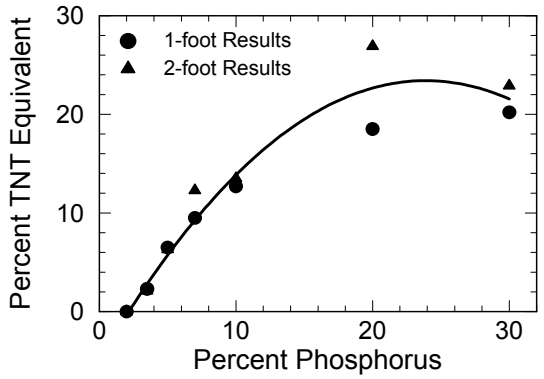

Figure 4. A graph of the TNT equivalent as a function of red phosphorus content. Air blasts were measured at 1 and 2 feet from 1 gram, unconfined test samples.

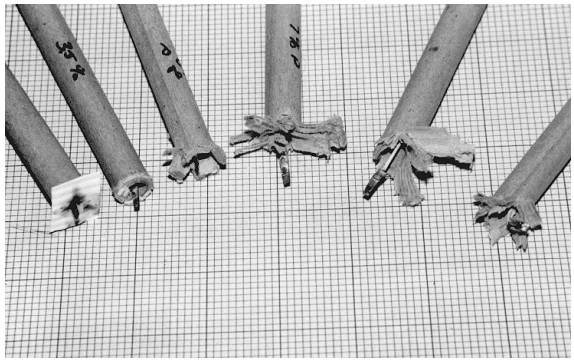

Figure 5. Representative examples of damage to the test sample holders for 2, 3.5, 5, 7, 10, and 20% red phosphorus mixtures, shown from left to right.

Note that in the case of 10 and 20% red phosphorus test mixtures, nearly one inch of the end of the support tube was blown off by just one gram (0.04 ounce) of material. For an unconfined pyrotechnic in such a small quantity this is impressive. (Considering the extreme sensitivity of these mixtures, this is just plain scary.) Note also that even small percentages of red phosphorus produce explosive results and would certainly be disproportionately more explosive in larger amounts.

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References

1) R. R. Rollins, "Potassium Chlorate/Red Phosphorus Mixtures", *Proc. of 7th Symposium on Explosives and Pyrotechnics*, Franklin Institute (1971).

2) D. Haarmann, "Tell the Wiz, Armstrong's Mixture", *American Fireworks News*, No. 54 (1986) p 4.

3) D. Haarmann, "Tell the Wiz, Armstrong's Mixture", *American Fireworks News*, No. 51 (1985) p 3.

4) T. L. Davis, *The Chemistry of Powder and Explosives*, Angriff Press (1941) p 105.