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Title: PBX 9502 air-gap tests

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PBX 9502 air-gap tests

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Summary

A small number of simple air-gap tests were performed on 1-inch diameter PBX 9502 cylinders to determine an approximate threshold for detonation failure. The primary diagnostics were streak imaging and dent measurements in a steel witness plate. Relight was found to occur, with negligible excess transit time, for air gaps up to 1 mm. Relight did not occur with a 3-mm air gap.

Experiments

Pressed cylinders of PBX 9502, of diameter 1.5 inches and length 1 inch, were initiated by an RP-80 EBW and 1-inch x 1-inch cylinder of PBX 9501. The detonation between the PBX 9502 pellets was interrupted by an air gap of varying thickness. The progress of the detonation was viewed from the side using an Optronis SC-10 streak camera, and the output acceptor PBX 9502 charge was placed on a steel witness block to allow comparison of shock outputs.

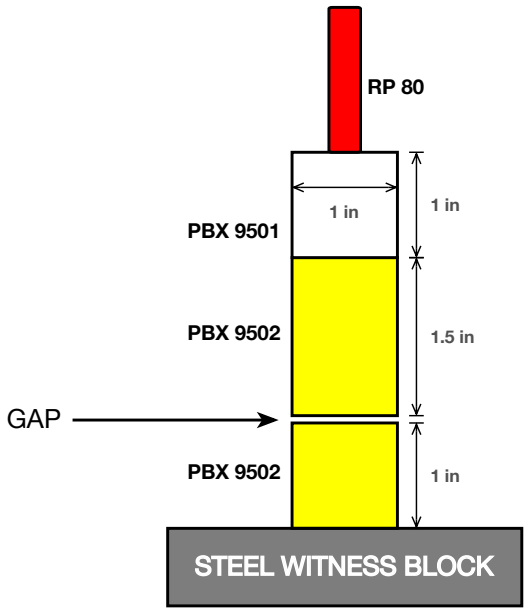


Figure 1. Schematic view of the test arrangement

In this arrangement, an approximately spherical detonation front progresses from the end of the detonator through the PBX 9501 pellet, intersecting the wall of the pellet and producing a variable, observed phase velocity at the wall. The detonation front is still divergent when it lights the first PBX 9502 pellet, which is slightly overdriven. The streak camera is arranged with its slit central and axial to the stack, and the phase velocity down the entire stack is estimated from the resulting streak images. The streak camera was configured with a total write time of 20 μs. The scaling factors are shown in figure 2, with the streak images, in which time progresses left to right and the detonation progresses upwards in space. Note that this view is inverted relative to the schematic of the test arrangement in figure 1.

Results

Table 1 summarizes the results. The listed VOD is estimated in the first PBX 9502 pellet, and should only be regarded as approximate. The predicted detonation velocity for 1-inch diameter PBX 9502 is 7.6 – 7.7 mm μs^{-1} [1].

Shot 1 was a calibration test with no air gap and two 1 inch PBX 9502 pellets. Shot 2 is included in the record since it produced valid dent-depth data, but a problem with the camera software resulted in the streak image being overwritten by shot 3.

Inspection of the streak images clearly shows that propagation across the air gap, with little or no delay, occurs for gaps up to and including 1 mm, while the 3-mm gap leads to rapid detonation failure in the second PBX 9502 pellet. Those results are also supported by the observed dent depths.

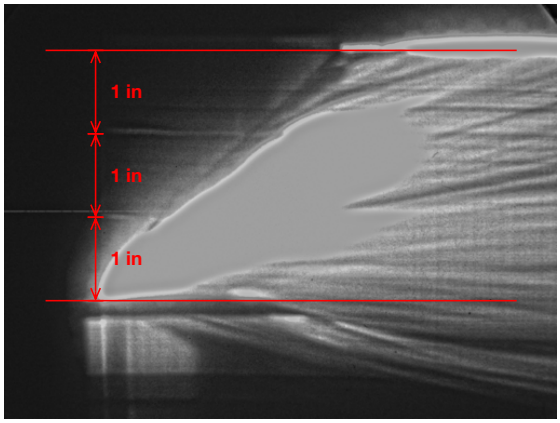
Shot #	Gap (mm)	PBX 9502 VOD (mm μs^{-1})	Dent depth (mm)	Outcome
1	0	7.6	5.0	Propagated
2	0.5	N/A*	5.1	Propagated‡
3	1	7.5	5.2	Propagated
4	0.5	7.5	5.0	Propagated
5	3	7.5	3.2	Failed

* streak image not saved ‡ based on dent depth only

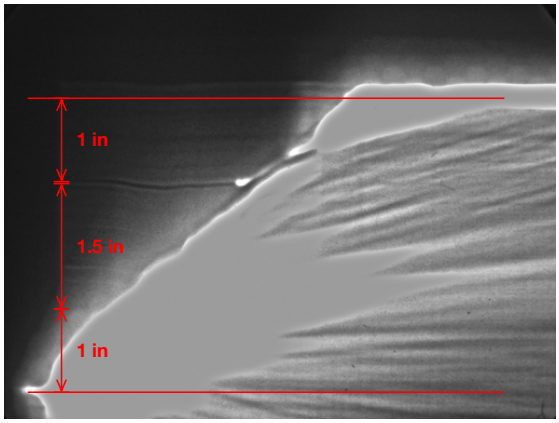
Table 1. Summary of results

Discussion

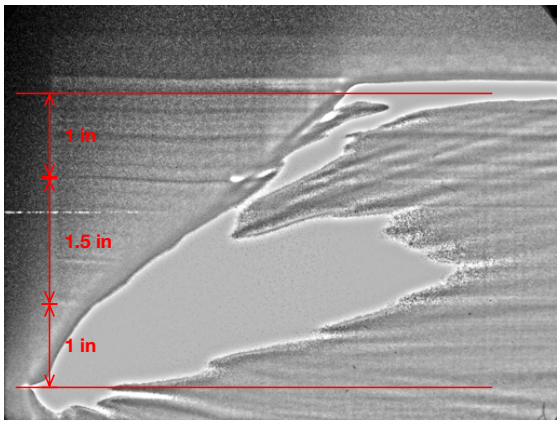
While these results are limited in number and do not represent high-precision tests, they are quite conclusive in placing the onset of detonation failure somewhere between 1 mm and 3 mm air gap. This is consistent with a previous study at LLNL by Lauderbach et al. [2] that looked at air gap effects on detonation in LX-17.



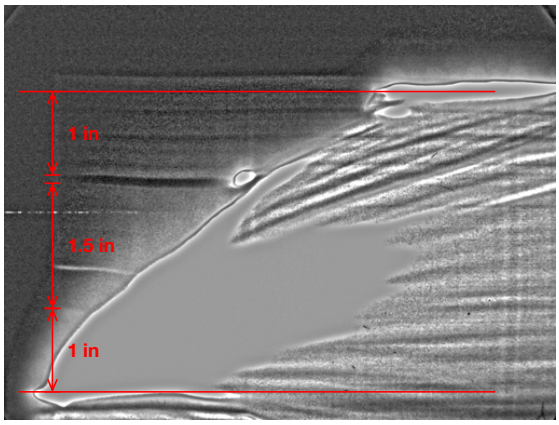
Shot 1: no gap



Shot 3: 1 mm gap



Shot 4: 0.5 mm gap



Shot 5: 3 mm gap

Optronis SC-10 streak camera
Regular sweep, 1μs/mm
1400 x 1052 image
70.2 px/μs
8.34 px/mm

Figure 2. Streak images and calibration data

References

1. Gibbs, T.R. & Popolato, A. (Ed), "*LASL Explosive Property Data*" *University of California, Berkeley* (1980).

2. Lauderbach, L. M., Souers, P. C., Garcia, F., Vitello, P., & Vandersall, K. S. (2009, December). CHARACTERIZING DETONATING LX-17 CHARGES CROSSING A TRANSVERSE AIR GAP WITH EXPERIMENTS AND MODELING. In *AIP Conference Proceedings* (Vol. 1195, No. 1, pp. 384-387). AIP.