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SLOW PBX DEVELOPMENT

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DEVELOPMENT DIVISION

OCTOBER - DECEMBER 1971

Normal Process Development
Endeavor No. 203

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ATOMIC ENERGY COMMISSION
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DISCLAIMER

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The purpose of this project is to develop a very high quality pressable explosive with a detonation velocity of about 5 mm/μsec or less.

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Acct. No. 22-2-44-01-203

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ABSTRACT

A total of nine batches of pressable baratol and pressable Composition B-3 were made and analyzed. One pressing was made for P/040 fabrication and test fire.

The first P/040 plane wave lenses designed were fabricated and fired, yielding a center-leading average of 0.17 μsec asimultaneity. The interface contour was redesigned and two lenses were fabricated and fired, resulting in center-lagging asimultaneity of 0.098 μsec and 0.074 μsec.

DISCUSSION

HE FORMULATIONS

Four pressable 60/40 RDX/TNT Composition B-3 batches, four 76/24 BN/TNT baratol batches, and one 80/20 BN/TNT baratol batch were formulated and analyzed, the results of which are summarized in Tables I and II.

With the previously reported pressings available, it was only necessary to press two Composition B-3 billets from Batch No. 1302-401C-01 of Table I to provide the components for the six P/040's fabricated and fired during this reporting period. The two billets, Piece No.'s 99307E2401 and 99307E2402, were made from powder preheated to 155 F, then pressed isostatically, at 20,000 psi for 10 minutes. The finished density for both billets was 1.724 g/cc.

P/040 TEST FIRE RESULTS

The lenses were assembled by machining the interface coutour on the baratol and Composition B-3 components which were than glued together. After gluing, the outside dimensions were machined with the detonator locating hole designed to accept an SE-1 adaptor. In final assembly the SE-1 adaptor was modified to allow direct contact between the SE-1 detonator and lens without a booster pellet.

Table III summarizes all of the six lenses fired during this period. Lens No's. 3 and 4 of the P/040 Mod I were the first assembled but because of excessive washing during machining of the baratol and a small crack in one Composition B-3 component, lens No.'s 1 and 2 were used as the basis for the redesigned P/040 Mod. I-A lenses. Lenses 3 and 4 were fired primarily to determine what detrimental effects, if any, the defects noted might have on lens performance. There was apparently little effect, as may be seen from Table III. As shown in Fig. 1 the center of the P/040 Mod. I's were leading by approximately 0.170 μsec but the output was basically symmetrical about the center indicating generally good quality. Modifying the P/040 Mod. I contour equation to the P/040 Mod. I-A resulted in an overcorrection with the center-lagging by about 0.086 μsec; the output was still basically symmetrical about the center as shown in Fig. 1.

Table I. Pressable Composition B-3 Compositional Analysis

60/40 RDX/TNT

Batch No.	Wt. % RDX ± 95% Confidence Interval (4 Determinations/Sample)					
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Average
1302-401C-01 (15 lbs)	60.2 ± 0.2	60.1 ± 0.3	60.2 ± 0.5	59.79 ± 0.08	60.4 ± 0.4	60.1 ± 0.3
1347-401C-01 (59 lbs)	60.1 ± 1.0	60.4 ± 0.2	60.3 ± 0.1	60.27 ± 0.08		60.3 ± 0.1
1348-401C-01 (57 lbs)	60.9 ± 0.2	61.0 ± 0.4	61.1 ± 0.3	60.9 ± 0.2		61.0 ± 0.2
1350-401C-01 (53 lbs)	60.4 ± 0.2	60.3 ± 0.1	60.5 ± 0.2	60.34 ± 0.08		60.40 ± 0.07

Table II. Pressable Baratol Compositional Analysis

76/24 BN/TNT, Except Batch 1351 was 80/20

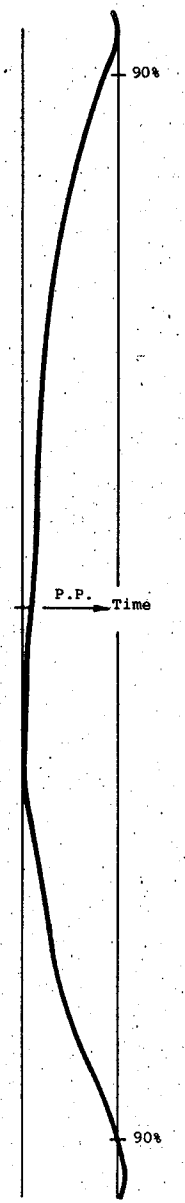
Batch No.	Wt. % $Ba(NO_3)_2$ ± 95% Confidence Interval (4 Determinations/Sample)				
	Sample 1	Sample 2	Sample 3	Sample 4	Average
1314-402B-01 (96 lbs)	76.6 ± 0.1	76.4 ± 0.3	76.8 ± 0.4	76.4 ± 0.3	76.5 ± 0.1
1328-402B-01 (58 lbs)	76.0 ± 0.07	75.9 ± 0.3	75.9 ± 0.1	76.0 ± 0.1	75.92 ± 0.08
1334-402B-01 (58 lbs)	76.2 ± 0.3	76.1 ± 0.2	76.31 ± 0.05	76.2 ± 0.1	76.23 ± 0.07
1335-402B-01 (57 lbs)	76.03 ± 0.07	76.0 ± 0.4	75.96 ± 0.07	75.97 ± 0.06	75.99 ± 0.05
1351-402B-01 (15 lbs)	80.4 ± 0.3	80.5 ± 0.2	80.0 ± 0.2	80.24 ± 0.06	80.3 ± 0.2

Table III. P/040 Plane Wave Lens Test Fire Results

P/040 Mod/Ser.	Batch No.	Piece No.	Comp. B-3 Density* (g/cc)	Transit Time (μsec)	Trace Spread** (μsec)	Remarks
I/1	1302-401C-01	99307E2402	1.724	Lost	0.173	
I/2		99307E2402-01	1.724	7.78	0.167	
I/3	1159-401C-01	24264E2402-01	1.726	7.83	0.175	Hair Line Crack in CB-3, Washed Baratol Contour & Face
I/4	1158-401C-01	24264E2401-01	1.722	7.63	0.188	Washed Baratol Face
I-A/1	1302-401C-01	99307E2401-01	1.721	7.95	0.074	
I-A/2		99307E2401	1.724	8.05	0.098	Hair Line Crack in CB-3

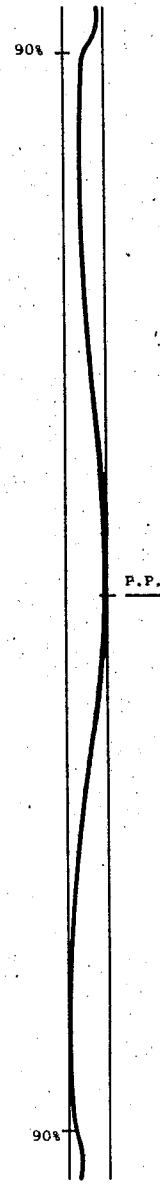
The baratol component of these lenses came from a 60-pound billet, Batch No. 1060-402B-01, Piece No. 99253E4601 with a density of 2.584 g/cc.

**The Mod. I lens traces lead at the polar point and the Mod. I-A lenses lagging.*



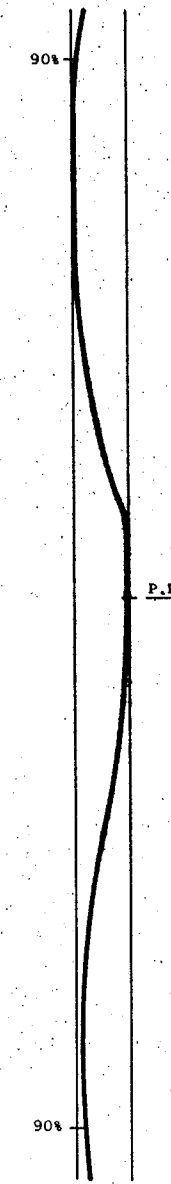
P/040 Mod I/2

T.T. (Polar Point Transit Time in μsec)	7.78
So(Range - μsec)	0.17
S(Slope - μsec)	0.023



P/040 Mod I-A/1

T. T. (Polar Point Transit Time in μsec)	7.95
So(Range - μsec)	0.074
S(Slope - μsec)	0.026



P/040 Mod I-A/2

T. T. (Polar Point Transit Time in μsec)	8.04
So(Range - μsec)	0.098
S(Slope - μsec)	0.003

Fig. 1. P/040 Test Fire Results (Time Scale: 0.5-inch = 0.1 μsec)

P/040 REDESIGN (P/040 MOD. I-A)

Prior to any lens test fire, the P/040 Mod. I interface contour was derived neglecting the effect of the interface on the detonation velocities of the slow and fast components in the region of the interface. The original P/040 Mod. I had a calculated transit time of 8.097 μsec whereas the measured transit time from test fire results was 7.78 μsec or a difference of 0.317 μsec indicating a faster breakout than calculated. These results might be due to the greater shock sensitivity of pressed explosives (vs. cast) or to uncertainty in detonation velocity. Or one can assume a transition zone in the baratol near the interface, initially overdriven by the Composition B-3 (head-on with respect to the interface at the center and more tangential nearer the edges).

To describe the transition zone, a zone of unknown thickness within the baratol was assumed in which the detonation velocity was decaying exponentially over a time period equal to the difference between the calculated and measured transit times:

$$V = V_o e^{-kt} \qquad (1)$$

Applying the boundary conditions V = 7.9 mm/μsec at t = o and V = 4.6 mm/μsec at t = 0.317 μsec to equation (1) yields

$$V = 7.9e^{-1.706t} \qquad (2)$$

Integrating (2) for X and applying the boundary condition X = 0 at t = 0 yields

$$X = \frac{7.9}{1.706}\left(1-e^{-1.706t}\right) \qquad (3)$$

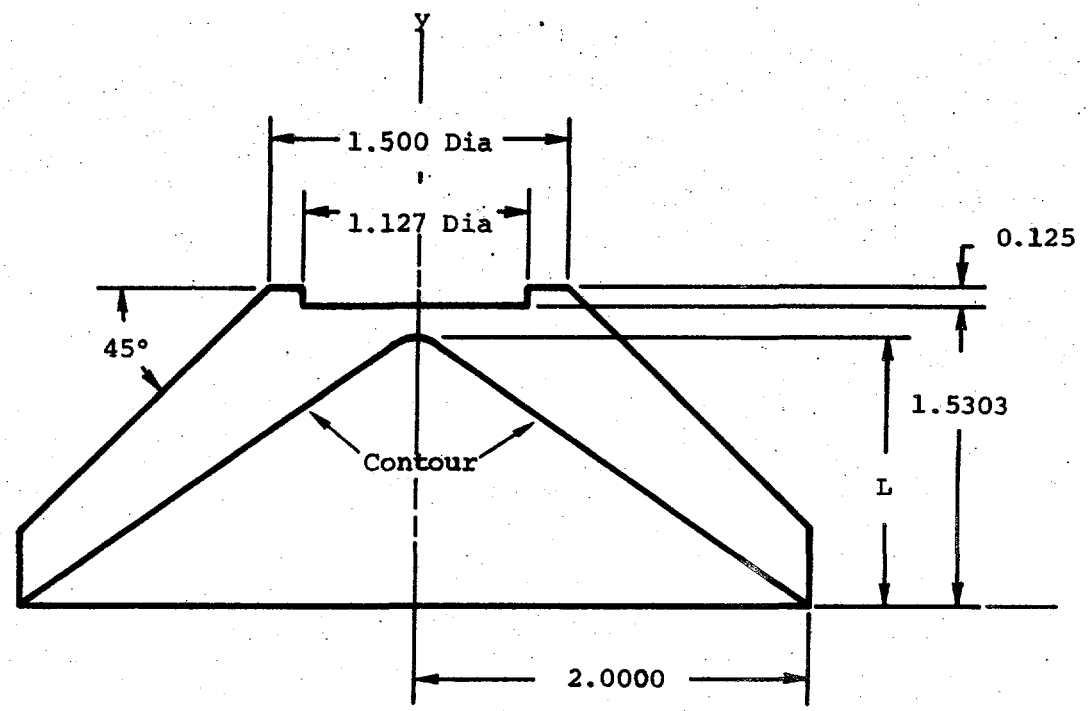
Solving (3) for X at t = 0.317 μsec yields X = 0.0762 inch as the length of the transition zone along the central axis of the P/040 lens. Correction to the lens contour therefore required decreasing the Composition B-3 and increasing the baratol by 0.0762 inch along the lens axis.

An equation of the same general form as in the Mod. I was used for the redesigned P/040 Mod. I-A:

$$X^2 = AY^2 + BY + C \qquad (4)$$

With two points known, the new peak of the contour along the central axis and the same contour extreme at the lens edge, only one intermediate point needed to be specified. Since the overdrive by Composition B-3 on baratol might decrease with distance from the lens axis due to increasing tangency to the baratol contour as the distance from the axis increased, it was assumed that the decrease in transition zone thickness at a point on the contour was directly proportional to the distance of the point from the lens axis relative to the radius of the lens; i.e., transition zone thickness at one inch from a P/040 lens axis was assumed to be 1/2 of zone thickness at the lens axis. This defined a third point required for derivation of a contour, resulting in the following equation:

$$X^2 = 1.757839Y^2 - 5.307010Y + 4.0 \qquad (5)$$



P/040 Mod I

L = 1.3772

Contour Equation: $X^2 = 1.949446Y^2 - 5.589221Y + 4.0$

P/040 Mod I-A

L = 1.4534

Contour Equation: $X^2 = 1.757839Y^2 - 5.307010Y + 4.0$

Fig. 2. P/040 Design (Dimensions in Inches)

The two lenses, P/040 Mod. I derived previously and P/040 Mod. I-A based on the test fire results of P/040 Mod. I, are shown in Fig. 2 for comparison purposes. As previously discussed, the P/040 Mod. I-A test fire results were within the usually desirably maximum asimultaniety but they did indicate an overcorrection had been made, and the asimultaniety is not considered satisfactory.

FUTURE WORK; COMMENTS; CONCLUSIONS

Further improving of the 4-inch lens contour will be done.

In addition, plans have begun to extend these efforts into fabrication of an 8 inch lens using 60/40 Composition B-3 and 76/24 baratol. Also, to increase the difference between the fast and slow component detonation velocities (and thereby decrease size, and pressure differences), efforts have begun, via the 80/20 baratol formulation, to decrease the slow component detonation velocity which will then be combined with PBX 9404 as the fast component.