TATB PERFORMANCE AND SENSITIVITY

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DEVELOPMENT DIVISION

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ABSTRACT

Gap sensitivity tests continued on RX-03-BB. Results on materials which had been thermally cycled were consistent with density changes induced by the cycling.

Two wedge tests were conducted with dry machined pure TATB at 1.84 g/cm^3 . Sensitivity was essentially equivalent to RX-03-BB at 1.81 g/cm^3 .

Several cylinder tests were conducted with RX-03-BB and pure TATB. Results are discussed.

DISCUSSION

GAP TESTS

Parts made from TATB and its formulations are known to exhibit dimensional growth when subjected to thermal treatment. As part of an investigation of the phenomenon, gap test parts were fabricated from RX-03-BB Blend 2 and sent to LLL for study. After treatment the parts were returned to Pantex for gap testing. Three groups were evaluated: a control maintained at ambient conditions during the study period; a group which was heated to 100°C and held for 2 months; and a thermally-cycled group. The thermal cycling consisted of a 24-hour period at -50°C followed by a 24-hour period at 93°C and then a return to -50°C . This was continued for 12 cycles.

The control group was pressed to and maintained a density of 1.898 g/cm^3 . The density of the heated group decreased to 1.888 g/cm^3 whereas the density of the thermally cycled group decreased to 1.862 g/cm^3 .

Assuming that this blend of RX-03-BB was essentially like others which had already been tested (the control group has not yet been returned to Pantex for testing) it was possible to estimate what the gap test results should have been if density were the only factor affecting the shock sensitivity. When such estimates are made, test results which agree within 0.25 mm are not considered to be significantly different from the estimate. Such was the case with both the heated and the thermally cycled groups, thus leading to the conclusion that density change was probably the only mechanism by which the treatments affected the shock sensitivity. However, the fact that the heated group fell 0.15 mm below the estimate while the thermally cycled group was 0.2 mm above might indicate that some other weak mechanism was also present. Testing of the control group might help clarify this point.

Routine testing of RX-03-BB continued with Blends 10 and 11. Blend 10 results were as expected. Blend 11, which was made with Cordova TATB containing unknown impurities, proved to be slightly more sensitive than the other LLL blends.

See Table I for gap test results.

Table I. Gap Test Results

HE	Density (g/cm ³)	G ₅₀ (mm of Brass)	
		Predicted	Observed
RX-03-BB Blend 2 ^a	1.888	2.6	2.35
RX-03-BB Blend 2 ^b	1.862	4.6	~ 4.7
RX-03-BB Blend 10	1.902 ± 0.001	1.8	1.80
RX-03-BB Blend 11	1.899 ± 0.001	2.0	2.41

^aHeated to 100 C and held for two months

^bCycled 12 times from ambient to -50 C (for 24 hours) to 93 C (for 24 hours) and back to ambient

Table II. Wedge Test Results for Pure TATB

$\rho_0 = 1.842 \text{ g/cm}^3$
 Observed Detonation Velocity ~ 7.54 km/s
 Predicted Detonation Velocity = 7.60 km/s

Transmitted Pressure (GPa)	Distance to Detonation (mm)	Time to Detonation (μ s)	Excess Transit Time (μ s)
9.0	6.9	1.40	0.49
11.8	3.8	0.72	0.22

WEDGE TESTS

Attempts to conduct wedge tests with pure TATB have been underway for quite a while, but discovery that the parts readily absorbed water required that a new set of wedges be fabricated. Dry machining was required and the new parts only recently became available. Determination of density by the usual dry-wet weighing procedure was not feasible, so the quoted density was obtained by the dry-wet procedure on the "cleaned-up" billet from which the parts were subsequently machined. (Tests had shown that the dry-wet procedure yielded insignificant errors so long as the pieces were large enough.)

A two shot series was conducted and the results, which appear in Table II, show that pure TATB at 1.84 g/cm^3 is essentially identical in wedge test sensitivity to RX-03-BB at 1.81 g/cm^3 . It is interesting to note the curves generated with TATB gap test data indicate that the gap sensitivities should also be identical.

CYLINDER TESTS

Cylinder tests (50.8 mm diameter) were conducted with Blends 10 and 11 of RX-03-BB. The primary purpose was to determine if Blend 11 displayed a low energy output. This material was formulated with Cordova TATB, some of which contained solvent extractable impurities which have not been identified. It was feared that these impurities might degrade the energy of the formulation. Data from a test on Blend 4 are included for comparison. The expansions for Blends 4 and 10 were nearly identical. The divergence of velocities beyond 24 mm appears to be a result of mathematical modeling rather than a true difference. It is felt that the late values for Blend 10 are fairly representative for both shots. The lower velocities for Blend 4 in the 8 - 14 mm range do appear to be real. See Table III for results (scaled to a 25.4 mm diameter configuration).

The results in Table III indicate that the impurities in Blend 11 did not degrade its energy. Out to about 20 mm expansion, the behavior of Blends 10 and 11 were essentially identical. The apparent more rapid expansion of Blend 11 beyond 20 mm is rather strange and might simply be due to experimental error. There is no reason to believe there were any impurities that would cause a delayed energy release.

Cylinder tests were also conducted with a Pantex lot of pure TATB and with a batch of Cordova TATB known to contain 5% of (unidentified) solvent extractable impurities. The Pantex lot was fired in both 25.4 mm and 50.8 mm diameters, with anticipation that the smaller diameter would prove to be adequate for pure TATB.

The results for the two different diameters led to no clear conclusions. The detonation velocity in the smaller diameter was clearly lower than the value expected at the test density. This diameter effect was naturally

Table III. Cylinder Test Results for RX-03-BB^a

R-R ₀ (mm)	Blend 4 $\rho = 1.896 \text{ g/cm}^3$		Blend 10 $\rho = 1.901 \text{ g/cm}^3$		Blend 11 $\rho = 1.903 \text{ g/cm}^3$	
	T	V	T	V	T	V
	(μs)	(mm/ μs)	(μs)	(mm/ μs)	(μs)	(mm/ μs)
4	4.01	1.230	3.97	1.230	3.97	1.235
6	5.58	1.305	5.55	1.306	5.54	1.309
8	7.09	1.350	7.05	1.355	7.04	1.354
10	8.55	1.379	8.51	1.387	8.50	1.385
12	9.99	1.401	9.94	1.409	9.93	1.407
14	11.41	1.419	11.35	1.425	11.34	1.424
16	12.81	1.434	12.75	1.437	12.74	1.439
18	14.20	1.447	14.13	1.448	14.12	1.452
20	15.58	1.458	15.51	1.459	15.49	1.465
22	16.94	1.467	16.87	1.468	16.85	1.476
24	18.30	1.475	18.23	1.478	18.20	1.487
26	19.66	1.481	19.58	1.486	19.54	1.497
28	21.00	1.486	20.92	1.494	20.88	1.505
30	22.35	1.492	22.26	1.501	22.20	1.513

^aScaled to 25.4 mm diameter

expected to cause slower expansion of the cylinder, but beyond 16 mm (scaled) the expansion histories were virtually identical. The data indicate that the larger diameter shot expanded more rapidly at very early times but that between 8 and 14 mm the smaller shot exhibited the higher velocities. This behavior does not fit normal scaling effects. As a consequence, there will presently be no change in the policy of using the 50.8 mm diameter for all TATB cylinder tests.

Based on density alone, the Cordova TATB should have exhibited expansion energies about 1% smaller than those for the Pantex lot. The actual differences range from about 1.5 to 2% indicating the Cordova TATB to be no more than 1% energy deficient. Since 1% in energy is about the accuracy limit in cylinder tests, it is not possible to state positively that the extractable impurities in the Cordova batch degraded its energy. However, the possibility of a slight degradation exists. Table IV lists the cylinder test results for pure TATB.

CONCLUSIONS

The cylinder test results indicate that the most impure Cordova batch might suffer a slight energy loss due to impurities, but that the blended lot used in RX-03-BB Blend 11 shows no loss in either energy or detonation velocity.

The gap test indicates that Blend 11 was slightly more shock sensitive than normal.

There is also evidence that the use of reprocessed machining waste to formulate RX-03-BB causes no change in energy but may result in higher detonation velocity (see Blend 10 in Table V).

Table IV. Cylinder Test Results for TATB^a

$R-R_0$ (mm)	Lot 6071-16-01 D = 25.4 mm $\rho = 1.854 \text{ g/cm}^3$		Lot 6071-16-01 D = 50.8 mm $\rho = 1.854 \text{ g/cm}^3$		Cordova 034-002 D = 50.8 mm $\rho = 1.839 \text{ g/cm}^3$	
	T	V	T	V	T	V
	(μs)	(mm/ μs)	(μs)	(mm/ μs)	(μs)	(mm/ μs)
4	3.98	1.232	3.95	1.244	3.96	1.229
6	5.55	1.317	5.51	1.313	5.54	1.302
8	7.04	1.372	7.00	1.361	7.05	1.352
10	8.47	1.408	8.45	1.396	8.51	1.386
12	9.88	1.432	9.87	1.423	9.94	1.411
14	11.27	1.449	11.27	1.443	11.34	1.430
16	12.64	1.462	12.64	1.460	12.74	1.445
18	14.01	1.472	14.01	1.473	14.11	1.458
20	15.36	1.481	15.36	1.484	15.48	1.469
22	16.71	1.490	16.70	1.494	16.84	1.479
24	18.04	1.499	18.04	1.502	18.18	1.489
26	19.37	1.508	19.37	1.509	19.52	1.497
28	20.70	1.516	20.69	1.516	20.86	1.505
30	22.01	1.524	22.01	1.521	22.18	1.511

^aScaled to 25.4 mm diameter

Table V. Detonation Velocities from Cylinder Tests

<u>HE</u>	<u>Density</u> <u>(g/cm³)</u>	<u>Velocity</u> <u>(km/s)</u>
RX-03-BB Blend 4	1.896	7.58
RX-03-BB Blend 10	1.901	7.65
RX-03-BB Blend 11	1.903	7.60
TATB Lot 6071-16-01 (50.8 mm)	1.854	7.66
TATB Lot 6071-16-01 (25.4 mm)	1.854	7.60
TATB Cordova Lot 034-002	1.839	7.65