

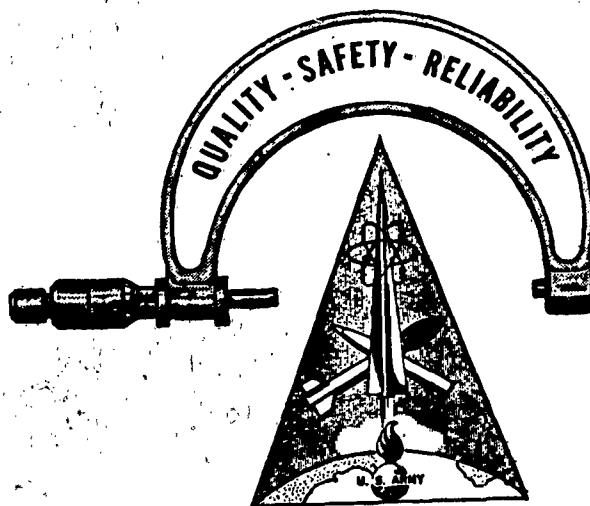
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QUALITY ASSURANCE DIRECTORATE
PICATINNY ARSENAL
DOVER, NEW JERSEY

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Report No. 317733

Evaluation
of Propellant, M-6

Lots

BAJ - 37536

BAJ - 37537

By

H. Gultz

24 April 1963

QUALITY ASSURANCE DIVISION

PICATINNY ARSENAL

DOVER, N. J.

ACKNOWLEDGMENT

Acknowledgment is made of the cooperation of the Analytical Chemical Section and Ballistics Research Unit of the Propellants Research Group, Explosives and Propellants Laboratory in conducting the tests indicated in this report.

Mr. K. Russel of the Process Engineering Laboratory, Ammunition Group is thanked for his aid as a consultant.

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OBJECT

1. To determine if suspect propellants meet the General Requirements indicated in Specification JAN-P-309 (except for Ash Content and Hygroscopicity),
2. To determine the nature of the yellow coloration of the suspect grains.
3. To determine the cause of disformation of grains.
4. To determine if the reported condition co-exists in complete rounds of ammunition items containing subject propellants (of similar vintage).

Introduction:

In February 1963, this Arsenal was contacted by the Army Procurement and Supply Agency to conduct an investigation on samples of M-6 Propellant (Lots BAJ-37536 and BAJ-37537) having the following history:

Salvage Powder, Propellant M-6, was being generated from a 90MM Renovation at Black Hills Army Depot. This propellant was manufactured in 1953 at Badger Ordnance Works. The salvaged powder was being sold to a private corporation for use as an explosive in an "open pit" mining operation. The propellant was being used to sensitize a water, ammonium nitrate slurry to the degree that the combination would detonate. The corporation reported that the following was being experienced:

1. "The sensitizing action of the propellant has decreased fairly uniformly with time until at the present, a two fold increase in the percentage of the 90MM M-6 powder in the slurry explosive produces only marginal sensitizing action."
2. " the deteriorated condition of some of the 90MM grains. These grains which are normally dark green cylinders are puffed up to nearly twice the diameter at the mid axial plane and are yellow at that circumference.
3. "The yellow color is proportional to the degree of deformation."

4. "The deterioration may be associated with the decreasing sensitivity to detonation."

This Arsenal was interested in this problem because lots of Propellant, M-6 of similar vintage are currently loaded in different rounds of ammunition being used by the U. S. Army.

A sample of the suspect propellant (BAJ-37536) which was supplied by the Army Procurement and Supply Agency was used for this laboratory evaluation program.

CONCLUSIONS:

1. Except for grain dimensions, the submitted sample of Propellant, M-6 (BAJ-37536) passes the General Requirements indicated in Specification JAN-P-309.

2. The results of the Closed Bomb Tests indicate that a small number of the expanded grains can be tolerated without seriously affecting the ballistics of the gun.

3. It appears that the distortion observed in the grains was caused by volatile constituents which were either present as the result of the manufacturing process or resulted from a physical-chemical deterioration.

RECOMMENDATIONS:

The following actions are recommended:

1. Investigate the possibility that a change was made in the manufacturing procedure for this propellant (i.e. mixing, drying, etc.)

2. Analyze the results of the most recent Surveillance Firing Tests of Propellant M-6 of similar vintage.

3. Obtain samples of complete rounds containing these propellants from their various storage locations in order that they may be disassembled and the propellant examined for abnormalities.

ACTIONS TAKEN:

1. The Army Procurement and Supply Agency by teletype was requested to furnish Complete Round Numbers which contain propellant lot BAJ-37536 and BAJ-37537.

2. This Arsenal is investigating the possibility that a change was made in the manufacturing procedure for these propellant lots (i.e. mixing, drying, etc.).

DISCUSSION:

The submitted sample of propellant was removed from its containers and spread out in a large tray. Visual examination of the grains showed that some were distorted and discolored. The distorted grains were puffed up to nearly twice the diameter at the mid axial plane. Some of these grains were also cracked and others were punctured. Photographs of these grains are in the Appendix.

The sample of propellant was subjected to the tests described below:

1. Microscopic Examination of Grains:

The grains were viewed under a microscope. The examination indicated that the distortion was caused by volatile constituents which were either present as the result of the manufacturing process or resulted from decomposition. During the process of formation and/or volatilization of these gases, the solid matrix of the grain was splintered and distorted. The distorted sections are much lighter in color, therefore apparently deficient in diphenylamine.

2. Chemical Analysis of the Propellant:

The sample of propellant was tested in accordance with the procedures described in Specification JAN-P-309 (Rev 1) and Picatinny Arsenal General Laboratory Report No. 58-HI-648. The propellant sample was subdivided into two groups for this analysis (normal appearing grains and distorted grains). The results of this analysis (See Table 1) shows that both of these sub-samples pass the General Requirements given in Specification JAN-P-309, also, chemically they are approximately equal. The differences which do appear are that the degradation product (2-Nitrodiphenylamine) in the distorted grain is greater than in the normal appearing grain, and that the Total Volatiles in distorted grain are less than normal grain. This is indicative that a greater degree of chemical-physical degradation is occurring in the distorted grains.

3. The Closed Bomb results are given in Table 2. The sample used in this test contained about 5-7% distorted grains. The results obtained from this test show that there is a slight difference between the reference sample as compared to the test sample. The greatest difference occurs when burning first starts (5000 psi) which is due to the cracks present in some of the sample grains. Nevertheless, the results of these tests indicate that a small number of these expanded grains can be tolerated without seriously affecting the ballistics of the gun.

Ordinarily, consideration is not given to the sensitivity characteristics of developed propellants. Consequently, this investigation made no special attempt to study this characteristic. It is assumed that the sensitivity of the propellant should not have changed since the chemical composition has changed only slightly.

REFERENCES:

1. Specification JAN-P-309 (Rev 1)
2. Picatinny Arsenal's General Laboratory Report No. 58-HI-648
3. Letter dtd 20 March 1963 from Ammunition Procurement and Supply Agency to Picatinny Arsenal, Subject: Propellant, M-6.
4. Letter dtd 5 March 1963 from Black Hills Army Depot to Army Procurement and Supply Agency, Subject: Powder, Propellant, M-6.

APPENDIX

TABLE I

CHEMICAL ANALYSIS-PROPELLANT, M-6 (BAJ 37536)

	<u>At time of Manufacture ^c</u>	<u>Normal</u>	<u>Distorted</u>
<u>a</u>			
Composition:			
Nitrocellulose, %	86.0	86.21	86.68
Dinitrotoluene, %	10.1	10.02	9.74
Dibutylphthalate, %	3.9	<u>3.77</u>	<u>3.58</u>
		100.00	100.00
Diphenylamine (added), %	0.92	0.95	0.93
Potassium Sulfate (added), %	0.94	0.98	0.86
Total Volatiles, %	1.13	1.38	0.88
Total Moisture, %	0.72	0.28	<u>b</u>
<u>134.5° C. Heat Test</u>			
Salmon Pink, minutes	75	75	75
Explosion, minutes	300 +	300 +	300 +
<u>Available Stabilizer</u>			
Diphenylamine, %		0.73	0.69
2-Nitrodiphenylamine, %		0.06	0.24
N-Nitrosodiphenylamine, %		<u>0.10</u>	<u>0.12</u>
Total		0.89	1.05

^a Calculated on a Diphenylamine, Potassium Sulfate and Total Volatiles - free basis.
^b Not enough distorted grains to permit a determination of total moisture.
^c Information from Lot Description Sheets - Results of analysis at time of manufacture.

Methods: JAN-P-309 (Rev 1)

Picatinny Arsenal G.L.R. No. 58HI-648

TABLE II

<u>Comparison Propellant</u>	<u>Test Propellant</u>	<u>Temp ° F</u>	<u>Relative Quickness, % at Pressure, psi</u>				<u>Relative Force, % at Max. P.</u>
			<u>5000</u>	<u>10,000</u>	<u>15,000</u>	<u>20,000</u>	
BAJ-37535-53	BAJ-37536-53	+70	100.0	100.0	100.0	100.0	100.0
		+70	105.7	105.1	104.2	102.2	101.0
		-40	100.0	100.0	100.0	100.0	100.0
BAJ-37535-53	BAJ-37536-53	-40	108.6	103.7	103.3	101.7	99.4
		+70	100.0	100.0	100.0	100.0	100.0
BAJ-37536-53	BAJ-37536-53	-40	95.4	93.9	92.9	89.8	97.7





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