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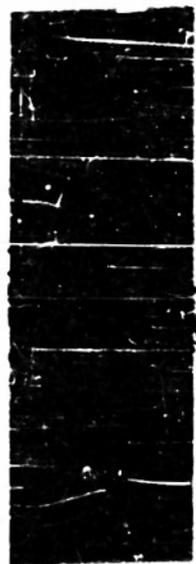
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NAVORD REPORT 2647



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IMPACT SENSITIVITY OF PRIMARY EXPLOSIVES

1 November 1952



**U. S. NAVAL ORDNANCE LABORATORY**  
**WHITE OAK, MARYLAND**

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IMPACT SENSITIVITY OF PRIMARY EXPLOSIVES

Prepared by:  
George Svadaba

Approved by:

*Russell McMill*  
Chief, Explosives Properties Division

ABSTRACT: The relative sensitivities of various primary explosives have been determined using 0.5, 1.0, and 2.5 kg weights. The sensitivities of several high explosives are included for comparison. The Bruceton Explosives Research Laboratory drop-weight impact machine was used with type 12 tools to determine the relative sensitivities. This relative order of sensitivities was the same within the realm of experimental error, regardless of the weight used. The use of the lighter weights for differentiating the sensitivities of primary explosives is indicated. Smaller differences in sensitivities are apparent and the method is more discriminating because the 50% heights are spread over a longer scale.

Explosives Research Department  
U.S. NAVAL ORDNANCE LABORATORY  
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The work reported was done in order to orient the impact sensitivities of primary explosives using varied weights. The work was part of Task Assignment NOL-Ra2c-18-1-52. The results support the conclusion that more satisfactory measurements of the sensitivities of primary explosives can be made with a light weight rather than with the heavier weight used for testing high explosives.

EDWARD L. WOODYARD  
Captain, USN  
Commander

*J. E. Arlard*  
J. E. ARLARD  
By direction

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## IMPACT SENSITIVITY OF PRIMARY EXPLOSIVES

### Introduction

The extended use of the drop-weight impact machine to include primary explosives was introduced in references (a) and (b). The tests recorded here have been conducted for the purpose of differentiating between the various primary explosives and providing a reference for comparison of the sensitivities of new primary explosives.

### Apparatus and Procedure

#### Impact Machine

The EOL facilities for impact testing of explosives consist of two machines, one of which was obtained from the Explosives Research Laboratory, Bruceton, Pennsylvania. The second, a duplicate was built at the Naval Ordnance Laboratory. These are described in detail in references (c) and (d). In the tests included in this report, the 1/2 and 1 kg weights were used in addition to the 2-1/2 kg weight.

#### Basic Test Procedure and Data Reduction

The basic unit test employed in this work has been made by the 50 trial A.M.P. "up and down" method. The results have been analyzed by the method of reference (e). The nomenclature and significance of symbols employed in this report are uniform with those of references (a) through (e), and are as follows:

- $m$  - 50% explosion height on the normalized (logarithmic) scale
- $h$  - 50% explosion height in centimeters
- $\sigma$  - estimated standard deviation of the parent population
- $\sigma_m$  - estimated standard error of  $m$
- $\sigma_\sigma$  - estimated standard error of  $\sigma$

#### Sample Preparation and Loading

All materials in this report have been tested as received.

The samples of explosives tested were loaded into the machine for test on a weight basis. A small set of scoops were used to deliver a uniform sample of  $3\frac{1}{2} \pm 1$  mg.

#### Evaluation of Individual Trials

For all sensitivity tests reported here, the decision that the results of a given trial was an explosion or non-explosion was made by the electronic

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noise indicator described in detail in Enclosure (A) of reference (c). In the testing of primary explosives, there is no doubt whether any trial was an explosion or non-explosion because of the intense sound of the detonation that occurs.

Investigation and Results

The sensitivities of the following primary and high explosives were determined in order to learn whether smaller differences in sensitivities could be detected by using lighter weights. Several high explosives were included for comparison.

Diazodinitrophenol, DNMP  
Lead 2,4-dinitroresorcinate (normal)  
Lead azide (dextrinated)  
Lead azide (polyvinyl alcohol)  
Basic lead styphnate (Western Cartridge Co.)  
Normal lead styphnate (Western Cartridge Co.)  
Mercury fulminate  
Nitromannite  
Silver azide (Western Cartridge Co.)  
Silver azide (Hercules Powder Co.)  
Tetracene  
BMX  
PETH  
RDX  
Tetryl

We have mentioned the particular lots of the explosives tested because of the variation in sensitivity between different lots of the same explosive.

The detailed results calculated by the procedure of reference (e) are presented in Tables 1 through 3. Due to several changes in lots of primary explosives during the course of these experiments, and the known small variation in sensitivities of the different lots, the data offered in this report are presented for information only pending further testing.

An analysis and comparison of the results obtained indicated that the kinetic energy of the three weights on impact are nearly equal at the respective 50% points. Therefore, the apparent sensitivity is not a function of the velocity of the weight and sensitivities might be reported in kilogram-centimeter units rather than in centimeters. This practice will not be adopted pending completion of additional experiments.

Acknowledgment

Mrs. Sarah F. Duck and Mr. George W. Reynolds, Physical Science Aides, operated the impact machines during the course of these experiments. Their patience and attention to detail contributed much to the success of the work.

*George Svadeba*  
GEORGE SVADEBA

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Table 1

Tests on Primary Explosives Using a 0.5 Kg. Weight

Explosive	h	m	$\sigma$	$\sigma_m$	$\sigma_\sigma$
Lead azide, X-114 (polyvinyl alcohol)	9 cm	0.96	0.15	0.03	0.05
Silver azide, X-117*	16 cm	1.20	0.21	0.04	0.07
Silver azide, X-116**	17 cm	1.24	0.18	0.04	0.06
Lead azide, Lot 64	20 cm	1.29	0.12	0.02	0.04
Diazodinitrophenol, X-54	25 cm	1.40	0.06	0.01	0.01
Mercury fulminate, X-81	30 cm	1.48	0.14	0.03	0.04
Tetracene	32 cm	1.51	0.24	0.05	0.09
Lead styphnate (normal)	37 cm	1.57	0.05	0.01	0.01
Nitromannite, X-104	37 cm	1.57	0.11	0.02	0.03
2,4-Lead dinitroresorcinate (normal)	63 cm	1.80	0.47	0.14	0.40
Lead styphnate (basic)	96 cm	1.98	0.36	0.05	0.10
PEIN, X-71	39 cm	1.59	0.08	0.02	0.02
HMX, X-156	86 cm	1.94	0.11	0.02	0.03
RDX, X-153	97 cm	1.99	0.14	0.03	0.04
Tetryl, X-102	192 cm	2.26	0.15	0.03	0.05
TNT, X-111 (as received)	no explosions at 320 cm				

\*Hercules Powder Company

\*\*Western Cartridge Company

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Table 2

Tests on Primary Explosives Using a 1 Kg. Weight

Explosive	h	m	$\sigma$	$\sigma_m$	$\sigma_s$
Lead azide, X-114 (polyvinyl alcohol)	3 cm	0.50	0.10	0.02	0.03
Silver azide, X-117	6 cm	0.79	0.15	0.03	0.05
Silver azide, X-116	8 cm	0.89	0.21	0.04	0.07
Lead azide, Lot 64	8 cm	0.92	0.18	0.04	0.06
Tetracene	11 cm	1.05	0.19	0.04	0.06
Diazodinitrophenol, X-54	12 cm	1.07	0.14	0.03	0.04
Nitromannite, X-104	14 cm	1.15	0.08	0.02	0.02
Lead styphnate (normal)	15 cm	1.18	0.13	0.02	0.04
Mercury fulminate, X-81	16 cm	1.21	0.13	0.03	0.04
2,4-Lead dinitroresorcinate (normal)	22 cm	1.35	0.31	0.06	0.13
Lead styphnate (basic)	44 cm	1.65	0.21	0.06	0.10
PEIN, X-71	21 cm	1.32	0.13	0.03	0.04
HMX, X-156	37 cm	1.58	0.07	0.01	0.02
RDX, X-153	47 cm	1.67	0.13	0.03	0.04
Tetryl, X-102	106 cm	2.03	0.14	0.03	0.04
TNT, X-111 (as received)	no explosions at 320 cm				

Table 3

Tests on Primary Explosives Using a 2.5 Kg. Weight

Explosive	h	m	$\sigma$	$\sigma_m$	$\sigma_\sigma$
Lead azide, X-114 (polyvinyl alcohol)	2 cm	0.28	0.15	0.03	0.05
Silver azide, X-117	4 cm	0.55	0.17	0.03	0.06
Silver azide, X-116	4 cm	0.56	0.16	0.03	0.05
Lead azide, Lot 64	4 cm	0.61	0.12	0.03	0.04
Tetrazene	6 cm	0.76	0.12	0.02	0.04
Diazodinitrophenol, X-54	6 cm	0.76	0.05	0.01	0.01
Nitromannite, X-104	8 cm	0.88	0.16	0.03	0.05
Lead styphnate (normal)	9 cm	0.96	0.20	0.04	0.07
2,4-Lead dinitroresorcinate (normal)	9 cm	0.96	0.15	0.04	0.07
Mercury fulminate, X-81	10 cm	0.99	0.18	0.04	0.06
Lead styphnate (basic)	12 cm	1.08	0.12	0.02	0.03
PETN, X-71	11 cm	1.04	0.09	0.02	0.02
HMX, X-156	19 cm	1.28	0.10	0.02	0.03
RDX, X-153	22 cm	1.34	0.07	0.02	0.02
Tetryl, X-102	33 cm	1.51	0.28	0.08	0.17
TNT, X-111 (as received)	164 cm	2.22	0.31	0.06	0.13

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References

- (a) NavOrd Report 1589, Impact Sensitivity Determinations of Explosive Compounds Tested During the Period from 1 January 1950 to 1 November 1950, 1 November 1950
- (b) NavOrd Report 2111, Impact Sensitivity of Primary Explosives, 1 June 1951
- (c) OSRD Report No. 5744, Physical Testing of Explosives, PART II
- (d) NOLM 10003, Studies of the ERL Type 12 Drop Weight Impact Machine at NOL, 25 January 1949
- (e) A.M.P. Report No. 101, 1R, Statistical Analysis for a New Procedure in Sensitivity Experiments.