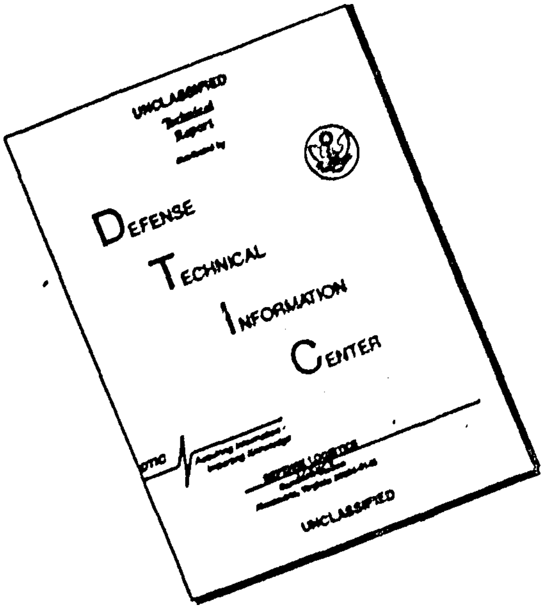
UNCLASSIFIED

AD NUMBER
AD222729
CLASSIFICATION CHANGES
TO: UNCLASSIFIED
FROM: CONFIDENTIAL
AUTHORITY
31 Mar 1957, DoDD 5200.9, per document marking

THIS PAGE IS UNCLASSIFIED

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

NAVY DEPARTMENT
BUREAU OF ORDNANCE
WASHINGTON, D.C.

6 April 1945

From: The Chief of the Bureau of Ordnance.
To: The Coordinator of Research and Development.

Subject: Explosives Research Memorandum No. 10.

Enclosure: (A) Explosives Research Memorandum No. 10.
(herewith) (Copies 26,27,28,29,30)

1. Five (5) copies of Explosives Research Memorandum No. 10 entitled, "Table of Military High Explosives" by Dr. P. C. Keenan and Miss D. Pipes, are forwarded herewith as enclosure (A) for information.

G. F. HUSSEY, JR.

Stephen Brunauer

Stephen Brunauer
By Direction

as listed above — qq. no. c/ved for SPOT M

Copy to:
BuShips (Copy No. 20)
Gerlach, Cdr. C. H., USN, BuShips (374) (Copy No. 21)
BuAer (Copy No. 22)
Operational Research Group, Com'nCh, Room 4311 (Copies 23,24,25)
OinC, NOL, Navy Yard, Washington, D. C. (Copies 31,32)
Experimental Ammunition Unit, NOL, Navy Yard, Washington, D. C. (Copy 33)
David Taylor Model Basin (Copies 34,35)
Roop, Capt. W.P., USN, Taylor Model Basin, BuShips (Copy 36)
Ormondroyd, Cdr. F., USN, Taylor Model Basin (Copy 37)
Naval Mine Depot, Yorktown, Va. (Copies 38,39)
Naval Mine Warfare Test Station, Solomons, Md. (Copies 40,41)
O.I.L., Naval Powder Factory, Indian Head, Md. (Copy 42)
Farnum, Dr. W. W., Naval Powder Factory, Indian Head, Md. (Copy 43)
Kray, Mr. R. H., Naval Powder Factory, Indian Head, Md. (Copy 44)
Naval Proving Ground, Dahlgren, Va. (Copy 45)
Naval Torpedo Station, Newport, R. I. (Copy 46)
Joint Army-Navy Ammunition Storage Board (Copy 47)
CO, Naval Ammunition Depot, Crane, Md. (Copy 48)
CO, Naval Ammunition Depot, McAlester, Okla. (Copy 49)
CO, Naval Ammunition Depot, Hawthorne, Nev. (Copy 50)
CO, Naval Ammunition Depot, Hastings, Neb. (Copy 51)
CO, Naval Ammunition Depot, Hingham, Mass. (Copy 52)

CONFIDENTIAL

(Re2c)

CO, Naval Ammunition Depot, St. Juliens Creek, Va. (Copy 53)
CO, Naval Ammunition Depot, Mare Island, Calif. (Copy 54)
CO, Naval Ammunition Depot, Navy No. 66, FPO, San Francisco, Calif. (Copy 5
USNA Post graduate School, Annapolis, Md. (Copy 56)
CO, Naval Mine Warfare School, Yorktown, Va. (Copy 57)
CO, Naval Ordnance Test Station, Inyokern, Calif. (Copy 58)
ChOrd, War Dept., Washington, D. C., Attn: Safety and Security Branch
Technical Unit (Copy No. 59)
ChOrd, War Dept., Washington, D. C., Attn: SPOTH & Pyro. Section (Copy 60)
ChOrd, War Dept., Washington, D. C., Attn: Col. G. C. Tibbits (Copy 61)
ChOrd, War Dept., Washington, D. C., Attn: Dr. L. R. Littleton (Copy 62)
ChOrd, War Dept., Washington, D. C., Attn: Mr. J. Levy (Copy 63)
ChOrd, Field Director of Ammunition Plants, St. Louis 8, Mo. (Copy 64)
Hale, Dr. G. C., Picatinny Arsenal, Dover, N. J.
Ballistic Research Lab., Aberdeen Proving Ground, Md. (Copies 66,67)
Kent, Mr. R. H., Ballistic Research Lab., Aberdeen Proving Ground, Md.
(Copy 68)
Clark, Capt. J. C., Ballistic Research Lab., Aberdeen Proving Ground, Md.
(Copy 69)
Roberts, Col. C.H.M., Office of ChOrd, Tech. Div., War Dept., Washington,
D. C. (Copy 70)
British Admiralty Delegation, 1025 Vermond Ave., Washington, D. C.
(Copies 71,72,73,74,75)
British Commonwealth Scientific Office, Dupont Circle Bldg., Dupont Circle,
Washington, D. C. (Copies 76,77,78, 79)
Wright, Dr. G. F., University of Toronto, Toronto, Ontario (Copy 80)
Herzberg, Dr. G., University of Saskatchewan, Saskatoon, Saskatchewan
(Copy 81)
U. S. Naval Attache, Technical Section, London, England (Copies 82,83,84,
85,86)
Taylor, Dr. G. I., Cambridge University, Cambridge, England (Copy 87)
Armament Research Dept., Woolwich, England (Copy 88)
National Physics Lab., Engineering Section, Teddington, England (Copy 89)
Libessart, Col. P., British Ministry of Home Security, Oxford Research
Station, Oxford, England (Copy 90)
MacColl, Mr. J. W., Ordnance Board, c/o Director of Scientific Research,
Fanum House, Leicester Square, London, England (Copy 91)
Robertson, Sir Robert, Shaped Charges Subpanel, University of Swansea,
Swansea, Wales, British (Copy 92)
Todd, Dr. J., c/o Director of Scientific Research, Admiralty, Fanum House,
Leicester Square, London, England (Copy 93)
Poole, Dr. J. H., Director of Explosives Research Lab., c/o National
Research Committee, Ottawa, Canada (Copy 9
OSRD Liaison Office, 1530 P St., N. W., Washington, D. C. (Copies 95,96)
Wilson, Dr. E. B. Jr., Chief, Div. 2, NDRC, 2101 Constitution Ave., Wash.
D.C. (Copy 97)
Cross, Dr. P. C., Director, Underwater Explosives Research Lab., Woods Hole,
Mass. (Copy 98)

CONFIDENTIAL

CONFIDENTIAL

(Re2c)

Connor, Dr. R., Chief, Div. 8, NDRC, Dumbarton Oaks, 3101 R St., N. W., Washington, D. C. (Copies 100,101)

MacDougall, Dr. D. P., Div. 8, NDRC, 4800 Forbes St., Pittsburgh, Pa. (Copy 102)

Cairns, Dr. R. W., Div. 8, NDRC, Hercules Experimental Station, Wilmington, Delaware (Copy 103)

Lawson, Dr. W. E., Div. 8, NDRC, duPont deNemours & Co., Inc., Wilmington, Delaware (Copy 104)

Kirkwood, Dr. J. G., Div. 8, NDRC, Cornell University, Ithaca, N. Y. (Copy 105)

Bureau of Explosives, 30 Vesey Street, New York, N. Y. (Copy 106)

Lawrence, Dr. R. W., Hercules Experiment Station, Wilmington 99, Delaware (Copy 107)

CO, Naval Ammunition Depot, Fort Mifflin, Philadelphia 12, Penna. (Copy 108)

CONFIDENTIAL

EXPLOSIVES RESEARCH MEMORANDUM NO. 10
(First Revision)

TABLE OF MILITARY HIGH EXPLOSIVES

NAVY DEPARTMENT
BUREAU OF ORDNANCE
WASHINGTON, D.C.

COPY NO. 61 MARCH 1945 CONFIDENTIAL

NAVY DEPARTMENT
BUREAU OF ORDNANCE
WASHINGTON, D.C.

Rear Admiral G. F. Hussey, Jr., USN
Chief of the Bureau of Ordnance

Captain C. L. Tyler, USN
Director, Research and Development

Commander J. A. E. Hindman, USN
Ammunition and Explosives

Lt. Comdr. Stephen Brunauer, USNR
High Explosives

Research Group on Theory of Explosives

Explosives Research Memorandum No. 10
(First Revision)

TABLE OF MILITARY HIGH EXPLOSIVES

P.C. Keenan and D. Pipes

MARCH 1945 CONFIDENTIAL

TABLE OF MILITARY HIGH EXPLOSIVES

1. The table has been prepared in answer to the demand for a summary of the properties of the more important high explosives which are in use by the Navy or with which naval personnel may come into contact. The data have been drawn from a wide variety of sources which differ greatly in reliability and completeness, and in combining this material the measurements have been weighted according to their accuracy insofar as this has been possible. The values in the table, however, are to be considered not as final results but rather as a set of the best estimates which can be made at the time of publication. Since the appearance of the original edition the table has been completely revised, and extended to include additional explosives which are coming into general use. It is planned to issue further revisions as more data become available to fill in the gaps which remain in some of the columns.

2. The properties of solid explosives are given in the first ~~five~~ 5 parts of the table; those for liquid explosives are listed in Part 6. Some of the columns require short explanations, and these are given in the paragraphs which follow.

3. VACUUM STABILITY. The stability of an explosive is usually expressed in terms of the rate at which gas is given off when the explosive is kept under low pressure at a constant temperature. This quantity is a measure of the rate of decomposition of the explosive compounds. Unless otherwise noted the values given in the table are the volumes of gas evolved from 5 g of explosive in the standard vacuum stability test of 40 hours at 120°C. Most of the entries were taken from Picatinny Arsenal Technical Report 1372,

CONFIDENTIAL

November, 1943, and are accurate to within 0.5-1.0 cc. For some explosives, however, the evolution of gas increases rapidly as the temperature rises so that the rate at 120°C is not a fair measure of the stability at ordinary storage temperatures. This is true particularly of PETN, pentolite, and tetrytol, which ordinarily keep well even though the decomposition rates given in the table are high.

4. STORAGE PROPERTIES. Those explosives which require only the usual precautions for storage are listed in the table as satisfactory. Since the keeping-quality of plastic explosives is determined largely by the rate at which the plasticizing oils are exuded, exudation data are included for as many of these as possible. In the most commonly used exudation test the explosive is placed in a half-inch glass cylinder which is set on 10 layers of filter paper in a closed weighing bottle. Results are expressed as per cent loss of weight after the bottle has been stored in an oven for one week at 50°C. The greater part of the exudation data given in the table are from the Explosives Research Laboratory (ERL), Bruceton, and are recorded in the Interim Reports on the Preparation and Testing of Explosives, Division 8, NDRC.

5. METALS CORRODED. These columns indicate whether the explosive in question attacks the metals commonly used in munitions. The abbreviations used are (s) for slightly and (vs) for very slightly. The information has been taken from many sources, one of the more important being Picatinny Arsenal Technical Report 1368, February, 1944. The Picatinny tests on a number of the newer explosives covered a period of one year.

6. EXPLOSION TEMPERATURE. Temperature of ignition or explosion is not a well-defined property, since the reaction of an explosive at a given temperature depends upon the time during which the heat is applied and the amount of confinement of the explosive. It is important, however, to have some measure of the range of temperatures near which the explosive can be expected to give violent reaction. For this reason the table lists the temperatures of ignition obtained at the Naval Powder Factory, Indian Head. These measures were made by placing 0.5 g of the explosive in a test-tube immersed in Wood's metal, the temperature of which was raised by 5° to 10°C per minute. The explosives generally ignited with a sudden puff within a rather small range of temperatures, the values of which are tabulated. A few values from other sources have been used when NPF data were lacking. The ERL measures, of the temperature at which the rate of rise of temperature within the explosive is just double that of the confining bomb agree well with the NPF values and have been inserted for several explosives.

7. INDEX OF INFLAMMABILITY. This is a measure of the likelihood that a bare charge will catch fire when exposed to flames. The test is made by bringing an oxyhydrogen flame to bear on the explosive. The maximum time of exposure which gives no ignitions in ten trials, and the minimum exposure which gives ignition in each of ten trials are determined. The index of inflammability is 100 divided by the mean of the two times in seconds. The most inflammable substances have high indices (~250). The measurements given in the table were made at the Explosives Research Laboratory at Bruceton and are reported in NDRC Interim Reports, Preparation and Testing of Explosives,

(PT Series) Nos. 19 and 20, February-April, 1944.

8. IMPACT SENSITIVITY. The most commonly used measure of the sensitivity of an explosive to initiation by blows or shock is the height from which a given weight (usually 2 to 5 kg) must be dropped upon a specified small amount of explosive in order to produce a certain percentage of explosions. Unfortunately this quantity varies with the design of the particular laboratory impact-machine used in the testing. In order to obtain a useful mean scale the heights for 50% detonations from five machines at the ERL, Hercules and duPont laboratories have been averaged and are tabulated as percentages of the height for TNT. It should be noted that this is really a scale of insensitivity, since lower heights of fall indicate greater sensitivity of the explosive.

9. BULLET SENSITIVITY. Although numerous tests of the sensitivity of munitions to attack by shell fire have been made, the conditions have varied so much that the comparison of explosives is difficult. The most extensive set of measurements under standardized conditions is the material on rifle-bullet sensitivity collected in OSRD 3156 and in later Interim Reports, PT Series. The figures tabulated in the present table were obtained by reducing the recorded percentage of passes to the corresponding value for 0.30 cal. ball-ammunition at 75 feet, with allowance made for partial detonations. The result is a scale of insensitivity with RDX taken as 0 and TNT as 100. Since the less sensitive explosives give scale values in excess of 100 it is to be remembered that the final scale is an arbitrary one and does not represent the actual percentage of passes under any conditions. It does appear to represent reasonably well the results to be expected from explosives in small containers. In larger charges the increased volume of explosive will

sometimes allow deflagration to pass over into detonation; consequently, the table can be expected to provide only a rough approximation to the relative safety of different explosives.

10. PRIMER SENSITIVITY. In this column the weight of diazodinitrophenol required for consistent initiation of 0.5 g of the explosive is tabulated. Values for this particular primer are used because it has been tested against a considerable number of explosives at the Experiment Station of the Hercules Powder Company (NDRC Interim Reports, PT-27 and PT-28). These figures are useful in estimating requirements of primers and boosters for good initiation; two explosives having the same tabulated primer sensitivity can usually be fired with detonating caps of the same strength. In using the table it should be kept in mind that DDNP alone will not give high order detonation of the less-sensitive explosives, but must be used in conjunction with a booster such as PETN.

11. DETONATION VELOCITY. The tabulated detonation velocities apply to the loading densities given in the second column of the same page. The velocity at any other density can be estimated by adding 370 meters/sec to the given values for each increment of 0.10 g/cc in density. The data of the table are based for the most part on the optical measurements carried out at the Explosives Research Laboratory, Bruceton, and recorded in the NDRC Interim Reports on Detonation, Fragmentation, and Air Blast.

12. HEAT OF EXPLOSION. The total energy released by an explosion can be computed when the composition of the final explosion products is known. Not all of this energy is made available fast enough to contribute to the damaging power

of the explosion and for this reason the heat of explosion is usually computed as the energy set free before the exploding gases have cooled much below their peak temperature. The values given in the table were computed for the temperature of the explosion gases when they occupy the same volume as the original solid explosive; ie., the adiabatic constant volume explosion temperature. The method of computation and tables of temperatures and equilibrium compositions are to be found in several NDRC reports, particularly OSRD 2022, November, 1943.

13. TRAUZL LEAD-BLOCK TEST. The measured quantity in this test is the volume hollowed out of a block of lead by 10 g of explosive. The Trauzl test was originally designed to simulate the conditions of use of explosives in mines, its significance as applied to military explosives is questionable. It is, however, a widely used test and is of some value in comparing new explosives with the older ones. The data given here are drawn from a number of sources, many of them included in the compilation of data on explosives in OSRD Report 2014, Compilation of Data on Organic Explosives, February, 1944. The entries in the table are relative volumes expressed as percentage of the volume obtained for picric acid.

14. BALLISTIC MORTAR TEST. In a ballistic mortar test the sample of explosive is placed in a special gun and fired directly into a heavy mortar suspended as a pendulum. The mortar test value is the amount of sample necessary to raise the ballistic pendulum to the same height as it is raised by 10 g TNT. The test is a measure of the velocity given to the mortar by the exploding gases and was designed to evaluate approximately the total energy from the explosion. The data used in the table come from various British and American laboratories,

chiefly those at Bruceton and Picatinny.

15. SHAPED-CHARGE EFFECT. The effectiveness of an explosive in shaped charges can be measured in terms of the volume of the hole which the jet from a charge of standard size and shape cuts out of a thick steel plate. Such determinations have been carried out at the duPont Eastern Laboratory (duPont Reports on Investigation of Cavity Effect, Section III and Final Report, 1943). The results are given in the table as percentages of the volume measured for TNT. The charges actually fired were cylinders of constant volume, 2" in diameter and 6" in length, but the entries in the table have been corrected to give the relative shaped-charge effect per unit weight of explosive. The value for torpex has been enclosed in parentheses, since the sample fired was not torpex 2 but had the composition RDX/TNT/Al 50/36.5/13.5. It appears that brisance of the explosive determines essentially the velocity given to the jet of a shaped charge; consequently, the values in the table show only rough agreement with the laboratory measures of total energy developed.

16. AIR-BLAST ENERGY. As a measure of the practical effectiveness of military explosives in causing blast damage, the energy of the shock wave (blast wave) has been tabulated. Other measured properties of the blast wave, such as total impulse or peak pressure, might have been used in place of energy as an indicator of ability to cause damage. Energy, however, is a particularly convenient measure for the comparison of different explosives, since it is directly proportional to the weight of charge used. The data used were the best British and American measurements of pressure, impulse and total energy of bombs and other large charges. The observational details and methods of reduction will be discussed in a forthcoming Explosives Research Report from the Bureau of

Ordnance. The entries in the table are again percentages relative to TNT, and refer to unit weight of explosive.

17. ENERGY OF SHOCK IN WATER. The last column of Part 4 gives the corresponding relative energy of the shock wave produced by charges fired under water. The agreement between the figures for air and water is close when account is taken of the uncertainty of the data, the mean error of most of the entries varying from 2 to 3 units. Thus differences of less than 5 in the tabulated percentages are scarcely significant.

18. PHYSICAL PROPERTIES. The thermal and mechanical properties of solid explosives are tabulated in Part 5. The data on specific heats and thermal conductivity are based upon new determinations by the Naval Ordnance Laboratory, reported in NOLM 6405, January, 1945, which contains also a rediscussion of the material from other sources. The measurements of the coefficient of thermal expansion and of Young's modulus were also made at the Naval Ordnance Laboratory (NOLM 6405). At the request of the Bureau of Ordnance the Explosives Research Laboratory at Bruceton determined the compressive strength of several explosives. Their results, given in the last column of Part 5, have been taken from the NDRC Interim Reports, PT-27 and PT-28. These measurements were made on samples cast in the form of cylinders 2" in diameter and 4" long.

19. LIQUID EXPLOSIVES. The liquid explosives are listed separately in Part 6 because in many cases the methods of determining their properties differ from those employed with solid explosives. Several of these explosives are still in an experimental stage and a rather limited number of tests have been performed on them. In regard to sensitivity it should be pointed out that

 CONFIDENTIAL

while the test results given in the table show that the desensitized nitroglycerines are not very sensitive to impacts all liquid explosives are particularly subject to initiation by squeezing between metal surfaces. For this reason the equipment in which liquids are used must be carefully designed to avoid metal-to-metal contacts in such parts as couplings.

BUREAU OF ORDNANCE

TABLE OF MILITARY HIGH EXPLOSIVES

CONFIDENTIAL

PART 1. COMPOSITION AND DESCRIPTION

EXPLOSIVE	COMPOSITION	COLOR	USES	NOTES ON LOADING	
				METHOD	DENSITY
					g/cc
Amatol	NH_4NO_3/TNT, 50/50	Buff to yellow	British Bombs	Cast, Shrinks 5% on cooling	1.54-1.56
Comp. A	RDX/wax, 91/9	White to buff	Projectiles	Pressed	1.60-1.63
Comp. B	RDX/TNT/wax, 59.5/39.5/1.0	Yellow to brown	Bombs	Cast	1.60-1.65
Comp. B-2	RDX/TNT, 60/40	Yellow to brown			
Comp. C	RDX/Plasticizing oil, 98/12	Yellow to brown	Demolition Charges	Plastic	1.60
Comp. C-2	RDX/TNT/MNT/DNT/etc. 79/5/2/12/2	Yellow to brown	Demolition Charges	Plastic	1.57-1.60
Comp. C-3	RDX/TNT/MNT/DNT/Tetryl etc. 77/4/5/10/3/1	Light brown	Demolition Charges	Plastic	1.59
DBX	RDX/NH_4NO_3/TNT/Al, 21/21/40/18	Gray		Cast. Shrinks 4% on cooling	1.61-1.69
DDNP	Diazodinitrophenol	Yellow to brown	Primers	Pressed	
DINA	**Diethanolnitramine** Dinitrate	White	Propellant	Pressed	
Ednatol	**Haleite/TNT. 60/40**	Yellow	Bombs (Experimental)	Cast	1.58-1.62
Explosive "D"	Ammonium Picrate	Yellow to orange	AP Projectiles	Pressed	1.40-1.54
Haleite (Edna)	Ethylenedinitramine	White	Used only in mixtures with other explosives	**Pressed**	
HBX	RDX/TNT/Al/ **dssens.*** 39.8/38.1/17.1/5	Slate gray	Underwater munitions: depth bombs, etc.	Cast	1.58-1.65
HBX-1	HBX + 0.5% $CaCl_2$	Slate gray	Underwater munitions: depth bombs, etc.	Cast	1.58-1.65
Hexanite	HND/TNT/Al, 23/61/16	**Yellow-brown**	German munitions	Cast	1.72-1.73
HND (Hexil)	Hexanitrodiphenylamine	Yellow	Used only in German and	Pressed	

[illegible]	[illegible]
HBX	RDX/TNT/Al/ desens.* 39.8/38.1/17.1/5
HBX-1	HBX + 0.5% $CaCl_2$
Hexanite	HND/TNT/Al, 23/61/16
HND(Hexil)	Hexanitrodiphenylamine
Lead Azide	PbN_6
Mercury Fulminate	$C_2N_2O_2Hg$
Minol 2	NH_4NO_3/TNT/Al, 40/40/20
Minol 3	NH_4NO_3/TNT/Al, 32/40/28
Pentolite	PETN/TNT, 50/50
Pentolite D-1	Pentolite desensitized by paraffin wax
PEP-3	PETN/oil, 86/14
PETN	Pentaerythritol Tetranitrate
Picratol	Am.Picrate/TNT, 52/48
Picric Acid	Trinitrophenol
PTX-2	RDX/PETN/TNT, 43.2/28/28.8
RDX(Cyclonite)	Cyclotrimethylene-trinitramine
Tetryl(CE)	Trinitrophenylmethyl-nitramine
Tetrytol	Tetryl/TNT, 75/25
TNT	Trinitrotoluene
Torpex 2	RDX/TNT/Al/Wax, 41.6/39.7/18.0/0.7
Torpex 3	Torpex 2 + 0.5% $CaCl_2$
Tritonal	TNT/Al, 80/20

*The desensitizer ordinarily used

	other explosives		
Slate gray	Underwater munitions: depth bombs, etc.	Cast	1.58-1.65
Slate gray	Underwater munitions: depth bombs, etc.	Cast	1.58-1.65
Yellow-brown	German munitions	Cast	1.72-1.73
Yellow	Used only in German and Japanese explosive mixtures	Pressed	
Buff to white	Primers	Pressed	
White when pure. Occasionally gray	Primers	Pressed	
Gray	British bombs, mines, war heads, etc.	Cast. Shrinks 4% on cooling	1.62-1.68
Gray	British bombs, mines, war heads, etc.	Cast	1.72-1.75
Yellow to white	Boosters, shaped charges (demolition)	Cast. Shrinks 5% on cooling	1.65
Yellow to white	British mines	Cast	1.49-1.62
	Demolition Charges		
White	Boosters, primacord	Pressed	1.69-1.70
	SAP bombs	Cast	1.62
Vivid yellow	Japanese bombs	Pressed or cast	
Yellow	Boosters, shaped charges	Cast. Shrinks 4% on cooling	1.68-1.71
White	Used only in mixtures with other explosives	Pressed	1.71
Yellow	Boosters	Pressed Cast	1.45-1.55 1.70
Yellow	Demolition Charges	Cast	
Yellow	Bombs, warheads, demolition charges, depth charges	Pressed or cast Cast shrinks 8% on cooling	1.55-1.59
Slate Gray	Warheads, depth bombs, mines, etc.	Cast. Shrinks 4% on cooling	1.70-1.74
Slate Gray	Warheads, depth bombs, mines, etc.	Cast. Shrinks 4% on cooling	1.70-1.74
Gray	Bombs	Cast	1.62-1.72

in HBX has the composition: wax/nitrocellulose/lecithin, 84/14/2.

RT 1. COMPOSITION AND DESCRIPTION

PART 2. STORAGE CHARACTERISTICS

EXPLOSIVE	HYGROSCOPICITY	VACUUM STABILITY	STORAGE PROPERTIES	METALS CORRODED	
				DRY	MOIST
	% gain at 30°C and 90% relative humidity	cc of gas evolved in 40 hours at 120°C			
Amatol	0.6	1.0	Keeps well in hot climate. Damaged by moisture	Steel(vs)	Brass,bronze
Comp. A	none	1.0	Satisfactory. Exudation about 1% per week at 150°C	Brass(vs) steel(vs)	Cu(s), brass(s) Mg(s), steel(s)
Comp. B Comp. B-2	none	0.7	Satisfactory. Exudation about 0.023 % per week at 60°C		
Comp. C	0.25	0.7	Keeps well in hot climate. Exudation about 0.7% per week at 150°C		
Comp. C-2	0.55	9.0	Similar to Comp. C. Exudation about 3% per week at 150°C		
Comp. C-3		11 + (18 hr)	Similar to Comp. C-2, but should retain plasticity better		
DBX			Satisfactory		
DDNP			Stored saturated with water		
DINA					
Ednatol	none	11 +	Satisfactory	Cu(vs), brass(vs), steel(vs)	Strong action on all metals except Al and stainless steel
Explosive "D"	0.02 (25°C)	0.4	Satisfactory. Stored in dry magazine, wooden containers		All(s)
Haleite (Edna)	0.01	1.5		Not corrosive	Same as Ednatol
HBX	none		Satisfactory, except that gas evolution becomes appreciable if water content exceeds 0.2%	Steel(s)	Steel(s)
HBX-1	0.01		Satisfactory		
Hexanite			Very toxic. Causes dermatitis when handled		
HND (Hexil)	0.5		Very toxic. Causes dermatitis		

Explosive "D"	0.02 (25°C)	0.4
Haleite (Edna)	0.01	1.5
HBX	none	
HBX-1	0.01	
Hexanite		
HND (Hexil)	0.5 (25°C)	
Lead Azide	0.3	0.77
Mercury Fulminate	none	
Minol 2	3.5 (25°C)	2.7
Minol 3		
Pentolite		11 +
Pentolite D-1		
PEP-3		1.24 (100°C, 48 hr
PETN	none	11 +
Picratol	none	
Picric Acid	0.05	0.5
PTX-2		0.7 (100°C, 40 hr)
RDX (Cyclonite	none	0.5
Tetryl (CE)	0.04	3.0
Tetrytol		11 +
TNT	none	0.4
Torpex 2	none	1.0
Torpex 3	0.03	
Tritonal		0.4

Satisfactory. Stored in dry magazine, wooden containers		Al(s)
	Not corrosive	Same as Ednatol
Satisfactory, except that gas evolution becomes appreciable if water content exceeds 0.2%	Steel(s)	Steel(s)
Satisfactory		
Very toxic. Causes dermatitis when handled		
Very toxic. Causes dermatitis when handled		
Stored saturated with water.	Not corrosive	Cu, Ni, brass. Forms sensitive azides
Less sensitive when stored with water. Deteriorates in 2 or 3 months at 60°C (140°F)	Al	Cu, brass, Al
Should not be stored more than six months	Brass, Cu, steel(vs)	Steel, brass, Cu
Same as Minol 2	"	"
Satisfactory	Steel, zinc plated(vs)	Cu(vs), brass (vs)
	"	"
Satisfactory. Exudation about 1.5% per week at 150°C		
Satisfactory		brass(vs)
Damaged by moisture	Steel(s)	Cu, brass, lead
	Brass	Brass, steel
Mixed with water for storage and shipping	Not corrosive unless acid content is high	
Satisfactory. Keep dry	Steel	Steel
Satisfactory	Al(vs)	Cu(s), Al(vs) brass(vs) steel(vs)
Satisfactory	Not corrosive	
Satisfactory, except that gas evolution becomes appreciable if water content exceeds 0.2%	brass(vs)	brass(vs)
Satisfactory	Brass(vs)	Brass(vs)
Satisfactory		

<u>STORAGE CHARACTERISTICS</u>

PART 3. SENSITIVITY AND T

EXPLOSIVE	MELTING POINT	EXPLOSION TEMPERATURE	INDEX OF INFLAMMABILITY
Amatol	81°C	254-256°C	
Comp. A			195
Comp. B	81	188-194	177
Comp. B-2	81	188-194	
Comp. C	81	177-180	
Comp. C-2	67	172-177	178
Comp. C-3			
DBX			
DDNP	157		
DINA	51	154-174	Will not continue to burn
Ednatol	80 ±	159-165	Will not continue to burn
Explosive "D"	265	288-291	
Haleite (Edna)	178	169-173	138
HBX			
HBX-1			
Hexanite			
HND (Hexil)	242	237-246	

HERMAL PROPERTIES

IMPACT SENSITIVITY	BULLET SENSITIVITY	PRIMER SENSITIVITY
TNT = 100	TNT = 100	g of DDNP
84	100	0.25 Pressed
	---	0.57 Cast
75	100	
73	---	0.21 Pressed
	80	0.33 Cast
68	---	0.17 Pressed
	60	0.27 Cast
(80)	90 ±	
	100 ±	
	100 ±	
59	---	0.19 Pressed
	58	0.43 Cast
27 ±	---	0.15 Pressed
	---	0.29 Cast
70	87	
38	100 ±	
36	---	0.19 Pressed
82	75	
82	75	

[illegible]	[illegible]	[illegible]
Explosive "D"	265	288-291
Haleite (Edna)	178	169-173
HBX		
HBX-1		
Hexanite		
HND (Hexil)	242	237-246
Lead Azide	Detonates before melting	
Mercury Fulminate	Detonates before melting	177-180
Minol	81	254-264
Pentolite	76-100	174-178
PEP-3		
PETN	141	172-175
Picratol		
Picric Acid	122	300-304
PTX-2	80-84	
RDX (Cyclonite)	190-205	197-204
Tetryl (CE)	129.5	164-165
Tetrytol	67-116 (Varies with composition)	179-181
TNT	80.6	288-292
Torpex 2	88	185-190
Torpex 3	88	185-190
Tritonal	81	292-294

... to burn	[illegible]	[illegible]	
	38	100 ±	
138	36	---	0.19 Pressed
	82	75	
	82	75	
	15		
	9		
	68	--- 40	0.27 Pressed 0.85 Cast
Will not continue to burn	44	--- 50	0.13 Pressed 0.21 Cast
Will not burn			
Will not continue to burn	13	---	0.09 Pressed
	71	76 45 ±	0.21 Pressed 0.55 Cast
	44	40	
278	28	---	0.13 Pressed
244	49	65 ±	0.17 Pressed
Will not continue to burn	59	65 ---	0.19 Pressed 0.31 Cast
100	100	100 100	0.29 Pressed 0.72 Cast
196	64	45	0.35 Cast
	64	45	
	94	79	

3. SENSITIVITY AND THERMAL PROPERTIES

BUREAU OF ORDNANCE

TABLE OF MILITA

PART 4 .

EXPLOSIVE	APPROXIMATE LOADING DENSITY	DETONATION VELOCITY	HEAT OF EXPLOSION
	g/cc	m/sec	cal/g
Amatol	1.54	6340	970
Comp. A	1.62	8270	1210
Comp. B	1.63	7640	1200
Comp. B-2	1.65	7700	
Comp. C	1.50	8090	
Comp. C-2	1.57	7840	
Comp. C-3	1.59		
DBX	1.68	6800	1700
DDNP			
DINA	1.50	7500	
Ednatol	1.60	7400	
Explosive "D"	1.48	6580	
Haleite (Edna)	1.50	7620	
	1.54	7040 ±	
	1.64		
	1.72		
1)	1.58		

RY HIGH EXPLOSIVES

EFFECTIVENESS

LABORATORY TESTS		SHAPED CHARGE EFFECT	ENERGY OF AIR BLAST	ENERGY OF SHOCK IN WATER
TRAUZL LEAD BLOCK	BALLISTIC MORTAR			
(Picric Acid = 100)	(TNT = 100)	(TNT = 100)	(TNT = 100)	(TNT = 100)
	118	54	82	94
	134			
122	134	169	116	121
122	134	169	116	121
120	124	121		
	126			
110	126			
	146		132	136
97				
150	142			
117	117		106	113
	99			
	136			
			134	140
			134	140
98				
101	113			

Comp. C-2	1.57	7340	
Comp. C-3	1.59		
DBX	1.68	6800	1700
DDNP			
DINA	1.50	7500	
Dinatol	1.60	7400	
Explosive "D"	1.48	6580	
Haleite (Edna)	1.50	7620	
HBX	1.64	7040 ±	
HBX-1	1.64		
Hexanite	1.72		
HND (Hexil)	1.58		
Lead Azide	4.00	5130	
Mercury Fulminate	4.00	5000	
Minol 2	1.65	5830	1660
Minol 3	1.73		
Pentolite	1.63	7460	1130
Pentolite D-1	1.50		
PEP-3	1.48	7780	
PETN	1.60	7950	1390
Picratol	1.62	6970	
Picric Acid	1.60	7140	
PTX-2	1.70		
RDX (Cyclonite)	1.65	8190	1230
[illegible])	1.55	7340	1130
[illegible]	1.60	7300	
[illegible]	1.57	6800	1030
[illegible]	1.72	7250	1820
Torpex 3	1.72	7250	1820

	126				
110	126				
	146		132	136	
97					
150	142				
117	117		106	113	
	99				
	136				
			134	140	
			134	140	
98					
101	113				
40					
44					
155	143		130	135	
115	129	149			
115					
166	145				
				92	
100					
		163			
166	151				
120	129				
	122	123			
94	100	100	100	100	
154	134	134	140	140	
154	134	134	140	140	

Explosive "D"	1.48	6580	
Haleite (Edna)	1.50	7620	
HBX	1.64	7040 ±	
HBX-1	1.64		
Hexanite	1.72		
HND (Hexil)	1.58		
Lead Azide	4.00	5180	
Mercury Fulminate	4.00	5000	
Minol 2	1.65	5830	1660
Minol 3	1.73		
Pentolite	1.63	7460	1130
Pentolite D-1	1.50		
PEP-3	1.48	7780	
PETN	1.60	7950	1390
Picratol	1.62	6970	
Picric Acid	1.60	7140	
PTX-2	1.70		
RDX (Cyclonite)	1.65	8190	1230
Tetryl (CE)	1.55	7340	1130
Tetrytol	1.60	7300	
TNT	1.57	6800	1080
Torpex 2	1.72	7250	1820
Torpex 3	1.72	7250	1820
Tritonal	1.65	6410	1800

3

PART 4.

-	98			
	136			
			134	140
			134	140
98				
101	113			
40				
44				
155	143		130	135
115	129	149		
115				
156	145			
				92
100				
		163		
166	151			
120	129			
	122	123		
94	100	100	100	100
154	134	134	140	140
154	134	134	140	140
117	118		122	120

EFFECTIVENESS

TABLE OF MILITARY H

PART 5. PHYSICAL PR

EXPLOSIVE	SPECIFIC HEAT		THERMAL CONDUCTIVITY		LINEAR COEFFICIENT OF THE EXPANSION	
	c	Density	k	Density	α	Temper Ran
	cal/g-°C at-5°C	g/cc	cal/sec-cm-°C	g/cc	% change in length per °C	°(
Comp. B						
Comp. B-2						
DBX	0.25	1.75	13.2×10^{-4}	1.75	4.5×10^{-5}	-73 t
HBX						
Minol 2	0.30	1.74	16.5×10^{-4}	1.74		
Pentolite						
TNT	0.24	1.54	5.6×10^{-4}	1.54	5.4×10^{-5}	-73 t
Torpex 2	0.22	1.82	9.7×10^{-4}	1.82	4.7×10^{-5}	-73 t
Tritonal	0.23	1.73	11.0×10^{-4}	1.73		

1

CONFIDENTIAL

TABLE OF MILITARY HIGH EXPLOSIVES

PART 5. PHYSICAL PROPERTIES

ERMAL CTIVITY		LINEAR COEFFICIENT OF THERMAL EXPANSION		YOUNG'S MODULUS OF ELASTICITY			COMPRESSIVE STRENGTH	
	Density	α	Temperature Range	E'	E	Density	s	Density
n-°C	g/cc	% change in length per °C	°C	$\frac{dynes}{cm^2}$	lb/in^2	g/cc	lb/in^2	g/cc
							1610-2580	1.68
							2200-3000	1.70
0^{-4}	1.75	4.5×10^{-5}	-73 to +75	10.4×10^{10}	1.51×10^6	1.72	3210-3380	1.78
				7.8×10^{10}	1.13×10^6	1.67	3110-3440	1.72
0^{-4}	1.74			5.03×10^{10}	0.73×10^6	1.66	1910-2070	1.68
							2000-2200	1.68
0^{-4}	1.54	5.4×10^{-5}	-73 to +75	5.45×10^{10}	0.79×10^6	1.61	1380-1400	1.62
0^{-4}	1.82	4.7×10^{-5}	-73 to +75	9.53×10^{10}	1.38×10^6	1.77	2100-2300	1.77
0^{-4}	1.73			6.67×10^{10}	0.97×10^6	1.72	2340	1.75

2

.E OF MILITARY HIGH EXPLOSIVES

PART 5. PHYSICAL PROPERTIES

	LINEAR COEFFICIENT OF THERMAL EXPANSION		YOUNG'S MODULUS OF ELASTICITY			COMPRESSIVE STRENGTH	
ty	α	Temperature Range	E'	E	Density	s	Density
c	% change in length per °C	°C	$\frac{dynes}{cm^2}$	lb/in²	g/cc	lb/in²	g/cc
						1610-2580	1.68
						2200-3000	1.70
	4.5×10^{-5}	-73 to +75	10.4×10^{10}	1.51×10^{6}	1.72	3210-3380	1.78
			7.8×10^{10}	1.13×10^{6}	1.67	3110-3440	1.72
			5.03×10^{10}	0.73×10^{6}	1.66	1910-2070	1.68
						2000-2200	1.68
	5.4×10^{-5}	-73 to +75	5.45×10^{10}	0.79×10^{6}	1.61	1380-1400	1.62
	4.7×10^{-5}	-73 to +75	9.53×10^{10}	1.38×10^{6}	1.77	2100-2300	1.77
			6.67×10^{10}	0.97×10^{6}	1.72	2340	1.75

1

BUREAU OF ORDNANCE

TABLE OF MILITARY

PART 6. LIQUID

EXPLOSIVE	COMPOSITION	USES	STORAGE PROPERTIES	VISCOSITY	
				20°C	0°C
				Centipoises	Centipoise
Nitroglycerine	$C_3H_5N_3O_9$	Explosive base or sensitizer for dynamites and double-base powders	Stable indefinitely at ordinary temperature in absence of acid		
EL-389A	NG*/DNT/TNT/Stabilizer 55/31.12/13.33/.55	Filler for 3" hose for minefield clearance	Stable at 80-120°F	40	85
EL-389B	NG*/DNT/TNT/Stabilizer, 60/27.6/11.8/.6	Filler for 1" hose for minefield clearance	"	40	78
EL-389C	NG*/DNT/TNT/Stabilizer, 50/35/15/.5	Filler for hose for minefield clearance	"	40	84
Methylite 20 (Explosive N)	NG*/Dimethylthalate/stabilizer, 80/19.2/.8	"	"	39	72
Methylite 25	NG*/Dimethylthalate/stabilizer, 75/24.25/.75	"	"	39	72
Dithekite 10	HNO_3/MNB/H_2O 64.7/25.3/10.0	Experimental bombs	Stable up to 113°F Corrodes metal containers		
Dithekite 13	HNO_3/MNB/H_2O 62.6/24.4/13.0	Experimental bombs	"		
Molten TNT	Trinitrotoluene				

*The nitroglycerine used in these mixtures is usually commercial nitroglycerine containing 25% ethylene glyco

2

TABLE OF MILITARY HIGH EXPLOSIVES

PART 6. LIQUID EXPLOSIVES

S	STORAGE PROPERTIES	VISCOSITY 20°C	VISCOSITY 0°C	FREEZING POINT	IMPACT SENSITIVITY	BULLET SENSITIVITY	INITIATION REQUIRED FOR CONSISTENT DETONATION	DENSITY	DETONATI VELOCIT
		Centipoise	Centipoise		Solid TNT=100			g/cc	m/sec
ise or for and e	Stable indefinitely at ordinary temperature in absence of acid			13°C	14		¼ of charge of #1FC cap.	1.59	7760
" hose eld	Stable at 80-120°F	40	85	-20			ES cap and booster	1.50	7000-730
" hose eld	"	40	78	-20	58	Not detonated in hose by .50 cal. ball unless backed by steel	"	1.52	7000-730
ose for clear-	"	40	84				"		
	"	39	72	-30	60	"	"	1.48	7000-7300
	"	39	72	-20	76 ±		"	1.47	7000-7300
bombs	Stable up to 113°F Corrodes metal containers					In thin steel boxes, detonated by .30 cal. ball		1.38	
bombs	"			-39		Less sensitive than Dithekite 10	"	1.50	7000
				80.2	42 ±	Slightly more sensitive than EL-389B or Me20	"	1.50	3380

mercial nitroglycerine containing 25% ethylene glycol dinitrate or 30% diglycerin tetranitrate, which are added to depress the freezing poi

CONFIDENTIAL

E OF MILITARY HIGH EXPLOSIVES

PART 6. LIQUID EXPLOSIVES

ES	VISCOSITY		FREEZING POINT	IMPACT SENSITIVITY	BULLET SENSITIVITY	INITIATION REQUIRED FOR CONSISTENT DETONATION	DENSITY	DETONATION VELOCITY	TRAUZL LEAD BLOCK
	20°C	0°C							
	Centipoise	Centipoise		Solid TNT=100			g/cc	m/sec.	P.A.= 100
ly			13°C	14		¼ of charge of #1FC cap.	1.59	7760	160
F	40	85	-20			ES cap and booster	1.50	7000-7300	
	40	73	-20	58	Not detonated in hose by .50 cal. ball unless backed by steel	"	1.52	7000-7300	
	40	84				"			
	39	72	-30	60	"	"	1.48	7000-7300	
	39	72	-20	76 ±		"	1.47	7000-7300	
F					In thin steel boxes, detonated by .30 cal. ball		1.38		
			-39		Less sensitive than Dithekite 10	"	1.50	7000	113
			80.2	42 ±	Slightly more sensitive than EL-389B or Me20	"	1.50	3380	

aining 25% ethylene glycol dinitrate or 30% diglycerin tetranitrate, which are added to depress the freezing point.

3