

AD-4066 090

LEFL

**TECHNICAL  
LIBRARY**

AD

AD-E400 <sup>284</sup>~~285~~

TECHNICAL REPORT ARLCD-TR-78063

**BALLISTIC EVALUATION OF M30 PROPELLANT  
CONTAINING NITROGUANIDINE DERIVED FROM  
UREA/AMMONIUM NITRATE PROCESS**

M 456A1

J. WENDELL LEACH

DECEMBER 1978



**US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND  
LARGE CALIBER  
WEAPON SYSTEMS LABORATORY  
DOVER, NEW JERSEY**

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED.

The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other documentation.

Destroy this report when no longer needed. Do not return to the originator.

The citation in this report of the names of commercial firms or commercially available products or services does not constitute official endorsement or approval of such commercial firms, products, or services by the United States Government.

ERRATA

TECHNICAL REPORT ARLCD-TR-78063

BALLISTIC EVALUATION OF M30 PROPELLANT  
CONTAINING NITROGUANIDINE DERIVED FROM  
UREA/AMMONIUM NITRATE PROCESS

J. Wendell Leach

December 1978

The AD-E number on this report was assigned incorrectly. The correct number should be changed to AD-E400 284.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ARLCD-TR-78063	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Ballistic Evaluation of M30 Propellant Containing Nitroguanidine Derived from Urea/Ammonium Nitrate Process	5. TYPE OF REPORT & PERIOD COVERED Final Report	
	6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s) J. Wendell Leach	8. CONTRACT OR GRANT NUMBER(s)	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Commander, ARRADCOM LCWSL, MTD (DRDAR-LCM-E) Dover, NJ 07801	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS	
11. CONTROLLING OFFICE NAME AND ADDRESS Commander, ARRADCOM STINFO, TSD (DRDAR-TSS) Dover, NJ 07801	12. REPORT DATE December 1978	
	13. NUMBER OF PAGES 30	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report) Unclassified	
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE	
16. DISTRIBUTION STATEMENT (of this Report)  Approved for public release, distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Propellant M30 Cartridge 105mm, M456A1 Nitroguanidine Guanidine nitrate Urea/ammonium nitrate (U/AN) process British aqueous fusion (BAF) process Closed bomb tests Arc-image furnace Ballistic tests		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)  This study was conducted to determine if nitroguanidine converted from guanidine nitrate produced by the urea/ammonium nitrate (U/AN) process would meet military specifications and would be ballistically acceptable in M30 triple-base propellants.  M30 triple-base propellant lots were manufactured utilizing nitroguanidine prepared from guanidine nitrate produced by the urea/ammonium nitrate (U/AN) process.		

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

Ballistic and other test results indicated there was no significant difference between M30 propellant containing U/AN prepared nitroguanidine and the standard British aqueous fusion (BAF) process nitroguanidine.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

#### ACKNOWLEDGEMENTS

The author wishes to express his appreciation to the following persons who contributed to this investigation:

Mr. Gary Kazin, Office of the Project Manager for Munitions Production Base Modernization and Expansion, Dover, NJ

Mr. Elry Hayes of the Energetic Materials Division, LCWSL, ARRADCOM, Dover, NJ

Mr. Clifford D. Murphy of the Jefferson Proving Ground, Madison, IN.

## TABLE OF CONTENTS

	<u>Page no.</u>
Introduction	1
Discussion	1
Conclusions	3
Recommendations	4
References	4
Distribution List	17

## TABLES

<u>No.</u>		<u>Page no.</u>
1	Closed bomb test results	5
2	Radiant energy ignition of M30 propellants	6
3	Firing sequence	7
4	Extract from JPG rpt 74-2638 M30 propellant for 105 mm HEAT-T, M446A1	8
5	Temperature coefficients - velocity and pressure	9

## FIGURES

1	Nitroguanidine analysis results	11
2	Description of lot no. PA-E-03623	12
3	Description of lot no. PA-E-03624	13
4	Description of lot no. PA-E-03625	14
5	Description of lot no. PA-E-03626	15

## SUMMARY

M30 propellant lots were manufactured that contained nitroguanidine prepared from guanidine nitrate produced by the urea/ammonium nitrate process. The guanidine nitrate was produced at pilot facilities located at Hercules, Inc., Kenvil, NJ. The guanidine nitrate was converted to nitroguanidine at the Welland Plant, Cyanamid of Canada, Ltd. The nitroguanidine was used to prepare M30 propellant lots at ARRADCOM which were subsequently ballistically fired at the Jefferson Proving Ground. Ballistic and other test results indicated there were no significant differences between M30 propellants containing urea/ammonium nitrate process derived nitroguanidine and those containing standard British aqueous fusion process nitroguanidine.

## INTRODUCTION

This project was accomplished as part of the U.S. Army Manufacturing Technology Program. The primary objective of this program is to develop, on a timely basis, manufacturing processes, techniques, and equipment for use in the production of Army materiel.

In 1968, the U.S. Army was notified by North American Cyanamid Ltd that manufacture of nitroguanidine would be discontinued. Consequently, to meet future requirements, studies were initiated to evaluate new methods of manufacture and to obtain data on plant design. As a result of the studies, the already piloted British aqueous fusion (BAF) process engineering was updated. Although the urea/ammonium nitrate (U/AN) process was recommended as the preferred method primarily because of its simplicity, improved product quality, capital costs, and the availability of materials (ref. 1), the urgency of maintaining a source of supply dictated the selection of the more technically developed BAF process.

This report is a supplement to PATR 4566 (ref. 1). It covers additional technical and engineering efforts to provide data involving the ballistic evaluation of M30 propellant which contained nitroguanidine that was converted at the Welland Plant, Cyanamid of Canada, Ltd from guanidine nitrate produced by U/AN process.

## DISCUSSION

A total of 9102 kg (20,067 lb) of guanidine nitrate produced by the U/AN pilot plant at Hercules Inc. of Kenil, NJ, was shipped to the Welland Plant, Cyanamid of Canada, Ltd and converted to nitroguanidine using the standard process of the Welland Plant. No difficulties were encountered in processing and the product met specification requirements (fig. 1).

Using standard manufacturing procedures and operating conditions, as described in the Picatinny Arsenal Description of Manufacture 35-3-123, four lots of M30 propellant were manufactured without difficulty at Picatinny Arsenal. A Propellant Description Sheet (figs. 2-5) was completed for each lot. The lots met all the chemical and physical requirements of the applicable specifications. The M30 propellant manufactured from the U/AN process material consisted of three lots of different web sizes and one control lot in which standard nitroguanidine was used.

The lot designations and descriptions are as follows:

PA-E 03623 - 1.29 mm web - U/AN process nitroguanidine

PA-E 03624 - 1.35 mm web - U/AN process nitroguanidine

PA-E 03625 - 1.40 mm web - U/AN process nitroguanidine

PA-E 03626 - 1.36 mm web - Standard process nitroguanidine  
(control).

Closed bomb tests were evaluated for the three U/AN propellant lots and the standard process lot and were compared to the standard propellant lot RAD 63574 used in cartridge M456A1, 105 mm, HEAT-T. Tests were conducted at a loading density of 0.2 gm/cc at 32°C and -40°C (table 1).

Note, Lot RAD 63574 is an M30 calibration propellant produced at Radford Arsenal, VA, and is the standard calibration lot used at the Jefferson Proving Ground (JPG). This material has been tested extensively, is a known quantity, and has been satisfactorily tested in large quantities. The closed bomb tests showed satisfactory behavior of the test lots.

Relative ignitability tests were conducted on the propellant compositions that were produced with U/AN process nitroguanidine. The testing was conducted in an "Arc-Image Furnace." Ignition is achieved by reimagining projected radiation through the use of ellipsoidal mirrors. The radiant energy reaches the sample in predetermined, timed impulses through the use of a light "chopper" in the system. The operation of the arc-image apparatus is described in reference 2. The test data (table 2) indicates the U/AN process nitroguanidine is slightly more difficult to ignite than the standard material; however, the difference in ignitability is considered minor.

Ballistic firings of the M30 propellant lots were conducted at Jefferson Proving Ground and the data is reported in Test Report 74-2638 (ref. 3). Cartridge 105 mm HEAT-T, M456A1 was used in the ballistic tests. All M456A1 rounds were assembled in accordance with PA Dwg. NO. 886195 with the following exceptions:

1. The primers were not staked.
2. The cases were crimped with eight, equally-spaced tab crimps.

A charge assessment was performed using each of the four pilot lots and 10 calibration rounds. In addition, 10 rounds from each lot at the assessed charge weight were fired at 21°C. This procedure was repeated using two lots (PA-E 03624 and PA-E 03625) with the optimum web size, and the control lot (PA-E-03626) at 46 and 63°C. The firing sequence is shown in table 3. The control lot and the two test lots contained lower charge weights than the calibration lot as shown in table 4. Lot PA-E 03623 was not tested at -45.5°C (-50°F) and 62.8°C (145°F) because with a web size of 1.27 mm (0.05 in.), it was considered to burn too fast at the higher temperature which might have resulted in excessive combustion pressures that could have damaged the gun.

As shown in table 4, lots PA-E 03624 and PA-E 03625 compare favorably in velocity, pressure, and ignition delay times with the control lot (PA-E 03626) and the calibration lot (RAD 63574).

The test data shows that the U/AN process derived nitroguanidine propellants meet the ballistic requirements for the M456A1 HEAT cartridge; and, that the lot with the web most closely matching the control lot web is also a close match for the ballistic level. Velocity and pressure data values at temperature extremes are satisfactory and show approximately the same temperature coefficients (table 5). It was observed during loading that the assembly time was less than expected and also that an ease of loading prevailed. The shorter assembly time did not appear to be related to bulk density but could be related either to the graphite glaze on the newer propellant being slicker or to the lower charge weights.

## CONCLUSIONS AND RECOMMENDATIONS

### Conclusions

1. The conversion of guanidine nitrate, manufactured by the U/AN process, to nitroguanidine presented no manufacturing problems. The nitroguanidine met all applicable specifications.
2. The M30 propellant prepared with nitroguanidine, converted from the U/AN process derived guanidine nitrate, was found to be ballistically equivalent to M30 propellant made with BAF process derived nitroguanidine.
3. Ignitability tests showed no significant difference in the ignitability characteristics of M30 propellants prepared with nitroguanidine derived from either the U/AN or the BAF processes (ref.4).

4. No product performance difficulties are anticipated in the event that the U/AN process is selected for future facilities plant construction.

#### Recommendations

It is recommended that no further studies be conducted with U/AN process derived nitroguanidine.

#### REFERENCES

1. C.H. Nichols, PATR 4566, "Evaluation of Technologies to Produce Nitroguanidine," Picatinny Arsenal, Dover, NJ, Oct 1973.
2. E. Hayes, "Ballistics and Combustion Research Branch Report No. 75-FR-G-B-6," Picatinny Arsenal, Dover, NJ, Apr 1975.
3. Clifford D. Murphy, Test Report No. 74-2638, "Engineer Design Test of Propellant M-30 for Cartridge 105 mm, HEAT-T; M456A1 (Nitroguanidine)," Jefferson Proving Ground, IN, Dec 1974.
4. G.R. Kazin, Final Report MM&TE Project 5744169, "M-30 Propellant Manufactured with Nitroguanidine from the Urea Ammonium Nitrate Process Formulation and Ballistic Evaluation," Picatinny Arsenal, Dover, NJ, Nov 1975.

Table 1. Closed bomb test results

STANDARD	TEST PROPELLANT	TEST ° F	RELATIVE QUICKNESS % at Pressures, psi				PSI AVG	RELATIVE FORCE %
			10,000 (69 MPa)	15,000 (103 MPa)	20,000 (138 MPa)	26,000 (181 MPa)		
RAD63574		90 (32°C)	100.0	100.0	100.0	100.0	100.0	100.0
	PAE03623	90 (32°C)	108.9	106.8	107.3	107.7 (743kPa)	99.5	
	PAE03624	90 (32°C)	101.5	103.3	104.9	103.2 (712kPa)	100.1	
	PAE03625	90 (32°C)	105.5	102.5	101.4	103.1 (711kPa)	100.4	
	PAE 03626	90 (32°C)	100.0	101.8	102.8	101.5 (700kPa)	99.8	
RAD63574		-40 (-40°C)	100.0	100.0	100.0	100.0	100.0	
	PAE 03623	-40 (-40°C)	104.3	107.8	108.8	107.0 (738kPa)	100.0	
	PAE 03624	-40 (-40°C)	101.2	101.0	103.8	102.0 (703kPa)	100.2	
	PAE 03625	-40 (-40°C)	96.5	100.7	101.8	99.7 (687kPa)	100.2	
	PAE 03626	-40 (-40°C)	95.8	99.3	101.8	99.0 (683kPa)	99.1	

Table 2. Radiant energy ignition of M30 propellants

$$P_0 = .7 \text{ MPa. } N_2$$

$$= 100 \text{ Psi } N_2$$

$$Q = 100 \text{ cal cm}^{-2} \text{ sec}^{-1}$$

GRAPHITE GLAZED (As Received)

SAMPLE LOT NO.	LATERAL SECTION		END SECTION	
	* 50%	95%	50%	95%
	Q ± Std dev	Q	Q ± Std dev	Q
PAE-03623	2.06 ± .21	2.41	2.06 ± .21	2.41
PAE-03624	1.81 ± .11	2.00	2.25 ± .25	2.67
PAE-03625	1.88 ± .18	2.16	2.06 ± .21	2.41
PAE-03626 (Control)	1.65 ± .15	1.90	1.88 ± .18	2.16

LEGEND:

Po = pressure in sample chamber

Q = energy per unit area per unit time (cal/cm<sup>2</sup> sec)

\*Percentages = frequency of initiation at the specified Q level

Table 3. Firing Sequence

<u>Date</u>	<u>Lot no.</u>	<u>No. rds</u>	<u>Phase</u>	<u>Temp</u>
25 Jul 74	PA-E-03623	9	Chg assess	+70°F (21°C)
"	PA-E-03624	9	"	"
"	PA-E-03625	9	"	"
"	PA-E-03626	9	"	"
9 Aug 74	PA-E-03623	10	Uniformity	+70°F (21°C)
"	PA-E-03624	10	"	"
"	PA-E-03625	10	"	"
"	PA-E-03626	10	"	"
2 Oct 74	PA-E-03626	10	Uniformity	-50°F (-46°C)
"	(control lot)			
"	PA-E-03624	10	"	"
"	PA-E-03625	10	"	"
3,4 Oct 74	PA-E-03626	10	Uniformity	+145°F (63°C)
"	(control lot)			
"	PA-E-03624	10	"	"
"	PA-E-03625	10	"	"

Table 4. Extract from JPG rpt 74-2638  
M30 propellant for 105 mm HEAT-T, M456A1

PROP LOT	RAD 63574		PA-E 03626		PA-E 03624		PA-E 03625	
	CALIBRATION		CONTROL		U/AN		U/AN	
WEB/CHG.WT.	1.32MM/5.13 kg .052"/183.2 oz		1.36MM/5.02 kg .0535"/179.2 oz		1.35MM/5.03 kg .0533"/179.7 oz		1.40MM/5.06 kg .0551"/180.8 oz	
VELOCITY		STD		STD		STD		STD
TEMP.	AVG	DEV	AVG	DEV	AVG	DEV	AVG	DEV
145°F	F/S	---	3989	6.9	3992	13.0	3987	6.1
63°C	m/s	---	1216	2.1	1217	4.0	1215	1.9
70°F	F/S	3803	3831	6.3	3839	10.0	3829	6.9
21°C	m/s	1184	1168	1.9	1170	3.1	1167	2.1
-50°F	F/S	----	3723	8.2	3711	9.2	3707	9.7
-46°C	m/s	----	1135	2.5	1131	2.8	1130	5.9
PRESSURE								
145°F	psi/100	---	735	9.6	724	9.8	703	11.3
63°C	MPa	---	507	6.6	499	6.8	485	7.8
70°F	psi/100	618	601	5.8	604	5.5	598	5.6
21°C	MPa	426	414	4.0	416	3.8	412	3.9
-50°F	psi/100	---	525	7.5	514	14.7	516	14.7
-46°C		---	362	5.2	354	10.1	356	10.1
IGNITION DELAY - MILSEC								
145°F (63°C)	113	13.0	69	8.0	69	14.0	72	7.0
70°F (21°C)			82	8.0	76	11.0	77	10.0
-50°F (-46°C)			146	11.0	163	19.0	150	14.0

Table 5. Temperature coefficients - velocity and pressure

<u>LOT NO.</u>	<u>VELOCITY</u>		<u>PRESSURE</u>	
	f/s <sup>°F</sup>	m/sec <sup>°C</sup>	psi/°F	MPa/°C
PA-E 03624	1.44	.79	108	1.34
PA-E 03625	1.44	.79	96	1.19
PA-E 03626	1.36	.75	108	1.34

Temp. Coeff. =  $\Delta V / \Delta T$

Example: 
$$\frac{\Delta V}{\Delta T} = \frac{3992 \text{ fps} - 3711 \text{ fps}}{145^{\circ}\text{F} - (-50^{\circ}\text{F})} = \frac{281 \text{ fps}}{195^{\circ}\text{F}} = 1.44 \text{ fps}/^{\circ}\text{F}$$

Conversion to Metric

$$\frac{1.44 \text{ ft}}{\text{sec } ^{\circ}\text{F}} \times \frac{.3048\text{m}}{\text{ft}} \times \frac{1.8^{\circ}\text{F}}{^{\circ}\text{C}} = \frac{.79\text{m}}{\text{sec } ^{\circ}\text{C}}$$

$$\frac{\Delta P}{\Delta T} = \frac{73500 \text{ psi} - 52500 \text{ psi}}{145^{\circ}\text{F} - (-50^{\circ}\text{F})} = \frac{21,000 \text{ psi}}{195^{\circ}\text{F}} = \frac{108 \text{ psi}}{^{\circ}\text{F}}$$

Conversion to Metric

$$\frac{108 \text{ psi}}{^{\circ}\text{F}} \times \frac{6895 \text{ Pa}}{\text{psi}} \times \frac{1.8^{\circ}\text{F}}{^{\circ}\text{C}} \times \frac{\text{MPa}}{10^6 \text{ Pa}} = \frac{1.34 \text{ MPa}}{^{\circ}\text{C}}$$



NITROGUANIDINE  
SHIPMENT  
ANALYSIS

110 0389



COPIES TO:

1-6	HEAD	CANADIAN
7	HEAD	
8	HEAD	OTTAWA
9	ADSA SAJAP REP.	
10	ADSA SAJAP REP.	
11	SUPT. NITROGUANIDINE	
12	TECHNICAL FILE	

240 M 01173

CONTROL DEPARTMENT

MATERIAL	NITROGUANIDINE TYPE II CLASS I	SPECIFICATION	EOPA - 45940-8 MIL N 4924
CONTRACT		CUSTOMER	PICATINNY ARSENAL
CAR NO	WHITTEN TRANSPORT	LOTS FROM	U/AN 1 THROUGH U/AN

ANALYTICAL RESULTS		LOT NO.	LOT NO.	LOT NO.	LOT NO.
TEST	LIMIT	U/AN 1 1-100	U/AN 2 1-88		
AV. PARTICLE DIAMETER	6.0 MICRONS MAX. 3.4 MICRONS MIN.	5.0	5.1		
PURITY	99.0% MIN.	99.8	99.8		
ASH CONTENT	0.30% MAX.	0.06	0.05		
PH VALUE	4.5 MIN. 7.0 MAX.	5.5	5.8		
ACIDITY (H <sub>2</sub> SO <sub>4</sub> )	0.06% MAX.	0.01	0.01		
TOTAL VOLATILE	0.25% MAX.	0.08	0.04		
SULFATE (NA <sub>2</sub> SO <sub>4</sub> )	0.20% MAX.	0.06	0.03		
WATER INSOLUBLE	0.20% MAX.	0.03	0.05		

CERTIFIED THAT SAMPLING AND TESTING OF THE ABOVE DEFINED MATERIAL WAS CONDUCTED IN ACCORDANCE WITH THE "QUALITY ASSURANCE PLAN FOR NITROGUANIDINE" AND THAT THE RECORD OF ALL ANALYSES ARE ON FILE AT THE WELLAND PLANT OF CYANAMID OF CANADA LIMITED.

*Rolene Dell*  
LABORATORY SUPERVISOR

Figure 1. Nitroguanidine analysis results.

**PROPELLANT DESCRIPTION SHEET**

US ARMY LOT NO. <u>PA-E-03623</u>		OF 18 <u>74</u>		COMPOSITION NO. <u>Propellant M30 for Cartridge</u>					
105 MM Heat-T, M456A1									
MANUFACTURED AT <u>Picatinny Arsenal, Dover, N. J.</u>		PACKED AMOUNT <u>952 lbs.</u>							
CONTRACT NO. <u>*5573-06</u>		DATE <u>15 Oct. 73</u>		SPECIFICATION NO. <u>Mil-P-46158D, 2 Feb. 68</u>					
*AMCMS: <u>4932.05.4169</u>		<u>Mil-STD-652B, 19 Sept. 69</u>							
<b>NITROCELLULOSE</b>									
ACCEPTED BLEND NUMBERS									
<u>HDP-2217L, Grade A, Type 1</u>			NITROGEN CONTENT -		KI STARCH(65.6%)				
			MAX <u>12.70</u> %	MNS	STABILITY(1134.6%)				
			MIN <u>12.50</u> %	MNS	30 MNS				
			AVG <u>12.53</u> %	MNS	30 MNS				
EXPLOSION MNS									
0.20 POUNDS SOLVENT PER POUND NO/DRY WEIGHT INGREDIENTS CONSISTING OF <u>60</u> POUNDS ALCOHOL AND <u>40</u> POUNDS <u>Acetone</u> PER <u>100</u> POUNDS SOLVENT									
PERCENTAGE REMIX TO WHOLE <u>None</u>									
TEMPERATURES		PROCESS-SOLVENT RECOVERY AND DRYING				TIME			
FROM	TO					RATE			
	20°C	Room Temperature				24			
20°C	50°C	Temperature Raised 2°C per hr.				15			
	50°C	Dry House, Air Dry - Constant Temperature				3			
<b>TESTS OF FINISHED PROPELLANT</b>									
PROPELLANT COMPOSITION			STABILITY AND PHYSICAL TESTS						
CONSTITUENT	% FORMULA	% TOLERANCE	% MEASURED	HEAT TEST	FORMULA	ACTUAL			
Nitrocellulose	28.00	± 1.30	27.94	120°C	40 min	90			
Nitroglycerin	22.50	± 1.00	22.66	Explosion		300+			
* Nitroguanidine	47.70	± 1.00	47.60	FORM OF PROPELLANT		0.75			
Ethyl Centralite	1.50	± 0.10	1.49	No. of perforations		7			
Gryolite	0.30	± 0.10	0.31	Specific Gravity @ 15.5°C		1.68			
				No. of Grains/lb		401.3			
Total Volatiles	0.50	Max	0.14	Grav. Density or lb/cu ft		55.6			
Graphite (Glazed)	0.15	Max	0.11						
* U/AN2									
CLOSED BOMB			PROPELLANT DIMENSIONS (INCHES)						
TEST	LOT NUMBER	TEMP °F	RELATIVE QUICKNESS	RELATIVE FORCE	SPEC	DIE	FINISHED	SPEC	ACTUAL
	PA-E-03623	90	107.7	99.5		0.6621	0.6711	6.25	Max 0.95
	PA-E-03623	-40	106.9	100.0	LENGTH (L)				
					DIAMETER (DI)	0.3200	0.2933	1.25	Max 0.92
STANDARD	RAD-63574	90	100.00%	100.00%	PERF DIA (DI)	0.0330	0.0304		DATES
REMARKS	RAD-63574	-40	100.00%	100.00%	Wa	0.0540	0.0503		
					WT	0.0565	0.0508		PACKED April 74
					Wc	0.0553	0.0506		SAMPLED Apr. 74
					Wd	0.0505	0.0505		TEST FINISHED 4-15-74
GM/cc.					WEB DIFFERENCE (STD DEV IN % OF WEB AVERAGE)	15% Max.	0.99		OFFERED 26 Apr. 74
					L-D	2.10 to 2.50	2.29		DESCRIPTION SHEETS FORWARDED
					Ed	5.0 to 19	9.65		
TYPE OF PACKING CONTAINER <u>Box, Steel M2, Dwg. 76-4-53, 15 Aug. 1945.</u>									
REMARKS <u>This lot does meet all the chemical and physical requirements of the applicable specifications</u>									
CONTRACTOR'S REPRESENTATIVE <u>J.R. Marsicovete</u>					GOVERNMENT QUALITY ASSURANCE REPRESENTATIVE <u>E.E. Mans</u>				
J.R. MARSICOVETE, CH, Props & Expls Div, IOD									

SMU FORM 1047R MARCH 71

Figure 2. Description of lot no. PA-E-03623.

US ARMY LOT NO. <u>PA-E-03624</u> OF 18 <u>74</u> COMPOSITION NO. <u>Propellant M30 for Cartridge</u>									
105 MM Heat-T, M150A1									
MANUFACTURED AT <u>Picatinny Arsenal, Dover, N. J.</u> PACKED AMOUNT <u>5,350 lbs.</u>									
CONTRACT NO. <u>*5573-06</u> DATE <u>15 Oct. 73</u> SPECIFICATION NO. <u>Mil-P-16158B, 2 Feb 68</u>									
<u>*AMCMS:4932.05.4169</u> <u>Mil-STD-652B, 19 Sept. 69</u>									
<b>NITROCELLULOSE</b>									
ACCEPTED BLEND NUMBERS <u>HLP-2217/L, Grade A, Type 1</u>									
NITROGEN CONTENT %									
MAX <u>12.70</u>	KI STARCH(65.6%)								
MIN <u>12.50</u>	MINS								
AVG <u>12.53</u>	MINS								
	STABILITY(1134.5°C)								
	30 MINS								
	30 MINS								
	EXPLOSION MINS								
MANUFACTURE OF PROPELLANT									
0.20 POUNDS SOLVENT PER POUND NO/DRY WEIGHT INGREDIENTS CONSISTING OF 60 POUNDS ALCOHOL AND 40 POUNDS Acetone PER 100 POUNDS SOLVENT									
PERCENTAGE REMIX TO WHOLE <u>None</u>									
<b>PROCESS-SOLVENT RECOVERY AND DRYING</b>									
TEMPERATURES FROM TO	TIME								
20°C	Room Temperature								
20°C	Temperature Raised 2°C per hr.								
50°C	Dry House, Air Dry - Constant Temperature								
	3								
<b>TESTS OF FINISHED PROPELLANT</b>									
PROPELLANT COMPOSITION									
CONSTITUENT	% FORMULA								
Nitrocellulose	28.00								
Nitroglycerin	22.50								
Nitroguanidine	47.70								
Ethyl Centralite	1.50								
Cryolite	0.30								
Total Volatiles	0.50								
Graphite	0.15								
U/AN 2									
STABILITY AND PHYSICAL TESTS									
% TOLERANCE	% MEASURED								
± 1.30	28.33								
± 1.00	22.10								
± 1.00	47.78								
± 0.10	1.49								
± 0.10	0.30								
Max	0.38								
Max	0.12								
HEAT TEST 120°C									
40 Min									
300+									
FORM OF PROPELLANT									
No. of perforations									
7									
Specific Gravity @ 15.6°C									
1.67									
No. of Grains/lb									
344.1									
Grav. Density @ 15°C									
55.3									
<b>CLOSED BOMB</b>									
TEST	LOT NUMBER	TEMP °F	RELATIVE QUICKNESS	RELATIVE FORCE	PROPELLANT DIMENSIONS (INCHES)				
	PA-E-03624	90	103.2	100.1	LENGTH (L)	DIE	FINISHED	SPEC	ACTUAL
	PA-E-03624	40	102.0	100.2	DIAMETER (D)	0.7023	0.7141	6.25	1.34
STANDARD	RAD-63574	90	100.00%	100.00%	PERF DIA (d)	0.3380	0.3079	3.125	1.12
REMARKS	RAD-63574	40	100.00%	100.00%	Wc	0.0575	0.0521		
					Wd	0.0590	0.0542		
					Wd	0.0583	0.0533		
					Wc		0.0533		
					Wd		3.38		
					Wd		2.10 to 2.50		
					Wd		5.0 to 15		
					Wd		9.74		
TYPE OF PACKING CONTAINER		Box, Steel M2, Dwg. 76-4-53, 15 Aug. 1945.							
REMARKS		This lot does meet all the chemical and physical requirements of the applicable specifications							
CONTRACTOR'S REPRESENTATIVE					GOVERNMENT QUALITY ASSURANCE REPRESENTATIVE				
J.R. MARSICOVETE, CH, Props & Expls Div, IOD					E.E. Mans				

SMJ FORM 1047R MARCH 71

Figure 3. Description of lot no. PA-E-03624.

**PROPELLANT DESCRIPTION SHEET**

US ARMY LOT NO. <u>PA-E-03625</u> OF 19 <u>74</u> COMPOSITION NO. <u>Propellant M30 for Cartridge</u>								
105 MM Heat-T, M456A1								
MANUFACTURED AT <u>Picatinny Arsenal, Dover, N. J.</u> PACKED AMOUNT <u>982 lbs.</u>								
CONTRACT NO. <u>5573-06</u> DATE <u>15 Oct. 73</u> SPECIFICATION NO. <u>Mil-P-161580, 2 Feb. 68</u>								
<u>*AMCMS: 4932.05.4169</u> <u>Mil-STD-652B, 19 Sept. 69</u>								
NITROCELLULOSE								
ACCEPTED BLEND NUMBERS <u>HEP-221/L, Grade A, Type I</u>								
	NITROGEN CONTENT	KI STARCH(65.5°C)	STABILITY(134.5°C)					
	MAX <u>12.70</u> %	MINS	MINS					
	MIN <u>12.50</u> %	MINS	<u>30</u> MINS					
	AVG <u>12.53</u> %	MINS	<u>30</u> MINS					
			EXPLOSION MINS					
0.20 POUNDS SOLVENT PER POUND NO DRY WEIGHT INGREDIENTS CONSISTING OF <u>60</u> POUNDS ALCOHOL AND <u>40</u> POUNDS <u>Acetone</u> PER <u>100</u> POUNDS SOLVENT								
PERCENTAGE REMIX TO WHOLE <u>None</u>								
TEMPERATURES		PROCESS-SOLVENT RECOVERY AND DRYING						
FROM	TO		TIME					
			DAYS HOURS					
<u>20°C</u>	<u>Room Temperature</u>		<u>24</u>					
<u>20°C</u>	<u>Temperature Raised 2°C per hr.</u>		<u>15</u>					
	<u>50°C</u>	<u>Dry House, Air Dry - Constant Temperature</u>	<u>3</u>					
TESTS OF FINISHED PROPELLANT								
PROPELLANT COMPOSITION			STABILITY AND PHYSICAL TESTS					
CONSTITUENT	% FORMULA	% TOLERANCE	% MEASURED	FORMULA	ACTUAL			
Nitrocellulose	28.00	± 1.30	27.64	HEAT TEST 120°C	NO Min 90			
Nitroglycerin	22.50	± 1.00	22.83	Explosion	300+			
Nitroguanidine	47.70	± 1.00	47.93	FORM OF PROPELLANT	<u>3-2-2</u>			
Ethyl Centralite	1.50	± 0.10	1.50	No. of perforations	<u>7</u>			
Cryolite	0.30	± 0.10	0.30	Specific Gravity @ 25°C	<u>1.08</u>			
Total Volatiles	0.50	Max	0.15	No. of Grains/lb	<u>319.8</u>			
Graphite	0.15	Max	0.14	Grav. Density of lbs/cu ft	<u>55.1</u>			
** U/AN 2								
CLOSED BOMB				PROPELLANT DIMENSIONS (INCHES)				
TEST	LOT NUMBER	TEMP °F	RELATIVE QUICKNESS	RELATIVE FORCE	SPEC	DIE	FINISHED	MEAN VARIATION IN OF MEAN DIMENSIONS
	<u>PA-E-03625</u>	<u>90</u>	<u>103.1</u>	<u>100.4</u>				SPEC ACTUAL
	<u>PA-E-03625</u>	<u>-40</u>	<u>99.7</u>	<u>100.2</u>	LENGTH (L)	<u>0.7295</u>	<u>0.7331</u>	<u>6.25</u> Max <u>1.2</u>
					DIAMETER (D)	<u>0.3500</u>	<u>0.3167</u>	<u>3.125</u> Max <u>1.20</u>
STANDARD	<u>RAD-63574</u>	<u>90</u>	<u>100.00%</u>	<u>100.00%</u>	PERF DIA (d)	<u>0.0360</u>	<u>0.0322</u>	DATES
REMARKS	<u>RAD-63574</u>	<u>-40</u>	<u>100.00%</u>	<u>100.00%</u>	W <sub>0</sub>	<u>0.0595</u>	<u>0.0538</u>	
					W <sub>1</sub>	<u>0.0615</u>	<u>0.0563</u>	PACKED <u>4 Apr. 74</u>
					W <sub>2</sub>	<u>0.0605</u>	<u>0.0551</u>	SAMPLED <u>4 Apr. 74</u>
					W <sub>3</sub>		<u>0.0550</u>	TEST FINISHED <u>4-15-74</u>
					WEB DIFFERENCE (% TO DEV IN % OF WEB AVERAGE)	<u>15% Max.</u>	<u>4.54</u>	OFFERED <u>26 Apr. 74</u>
					L:D	<u>2.10 to 2.50</u>	<u>2.32</u>	DESCRIPTION SHEETS FORWARDED
					OD	<u>5.0 to 19</u>	<u>9.84</u>	<u>2 May 1974</u>
TYPE OF PACKING CONTAINER <u>Box, Steel M2, Dwg. 76-4-53, 15 Aug. 1945.</u>								
REMARKS <u>This lot does meet all the chemical and physical requirements of the applicable specifications</u>								
CONTRACTOR'S REPRESENTATIVE <u>J.R. Marsicovete, Ch, Props &amp; Expls Div, IOD</u>					GOVERNMENT QUALITY ASSURANCE REPRESENTATIVE <u>E. E. Mami</u>			

Figure 4. Description of lot no. PA-E-03625.





DISTRIBUTION LIST

Commander  
US Army Armament Research and Development Command  
ATTN: DRDAR-CG  
DRDAR-LCM-E (15)  
DRDAR-LCM-S (2)  
DRDAR-SF  
DRDAR-TSS (5)  
Dover, NJ 07801

Chairman  
Dept of Defense Explosive Safety Board (2)  
Forrestal Bldg, GB-270  
Washington, DC 20314

Administrator  
Defense Documentation Center  
ATTN: Accessions Division (12)  
Cameron Station  
Alexandria, VA 22314

Commander  
Department of the Army  
Office, Chief Research, Development and Acquisition  
ATTN: DAMA-CSM-P  
Washington, DC 20310

Office, Chief of Engineers  
ATTN: DAEN-MCZ  
Washington, DC 20314

Commander  
US Army Materiel Development and Readiness Command  
ATTN: DRCSF  
DRCDE  
DRCRP  
DRCIS  
Eisenhower Avenue  
Alexandria, VA 22333

Commander  
DARCOM Installations & Services Agency  
ATTN: DRCIS-RI  
Rock Island, IL 61299

Director  
Industrial Base Engineering Activity (IBEA)  
ATTN: DRXIB-MT and EN (2)  
Rock Island, IL 61299

Commander  
US Army Materiel Development & Readiness Command  
ATTN: DRCPM-PBM  
DRCPM-PBM-S  
DRCPM-PBL-L (2)  
DRCPM-PBM-E (2)  
Dover, NJ 07801

Commander  
US Army Armament Materiel Readiness Command  
ATTN: DRSAR-SF (3)  
DRSAR-SS  
DRSAR-EN  
DRSAR-IR  
DRSAR-IRC  
DRSAR-LE  
DRSAR-IS  
DRSAR-ASF  
DRSAR-LEP-L  
Rock Island, IL 61299

Commander  
Edgewood Arsenal  
ATTN: SAREA-TD  
SAREA-MTD  
Aberdeen Proving Ground, MD 21010

Commander  
Frankford Arsenal  
ATTN: SARFA-T  
Philadelphia, PA 19137

Director  
DARCOM Field Safety Activity  
ATTN: DRXOS-ES (2)  
Charlestown, IN 47111

Commander  
US Army Engineer Division  
ATTN: HNDED  
PO Box 1600-West Station  
Huntsville, AL 35809

Commander  
Radford Army Ammunition Plant  
Radford, VA 24141

Commander  
Badger Army Ammunition Plant  
Baraboo, WI 53913

Commander  
Indiana Army Ammunition Plant  
Charlestown, IN 47111

Commander  
Holston Army Ammunition Plant  
Kingsport, TN 37660

Commander  
Lone Star Army Ammunition Plant  
Texarkana, TX 75501

Commander  
Milan Army Ammunition Plant  
Milan, TN 38358

Commander  
Iowa Army Ammunition Plant  
Middletown, IA 52638

Commander  
Joliet Army Ammunition Plant  
Joliet, IL 60436

Commander  
Longhorn Army Ammunition Plant  
Marshall, TX 75670

Commander  
Louisiana Army Ammunition Plant  
Shreveport, LA 71130

Commander  
Cornhusker Army Ammunition Plant  
Grand Island, NB 68801

Commander  
Ravenna Army Ammunition Plant  
Ravenna, OH 44266

Commander  
Newport Army Ammunition Plant  
Newport, IN 47966

Commander  
Volunteer Army Ammunition Plant  
Chattanooga, TN 37401

Commander  
Kansas Army Ammunition Plant  
Parsons, KS 67357

District Engineer  
US Army Engineering District, Mobile  
Corps of Engineers  
PO Box 2288  
Mobile, AL 36628

District Engineer  
US Army Engineering District, Ft. Worth  
Corps of Engineers  
PO Box 17300  
Ft. Worth, TX 76102

District Engineer  
US Army Engineering District, Omaha  
Corps of Engineers 6014 US PO & Courthouse  
215 N 17th Street  
Omaha, NB 78102

District Engineer  
US Army Engineering District, Baltimore  
Corps of Engineers  
PO Box 1715  
Baltimore, MD 21203

District Engineer  
US Army Engineering District, Norfolk  
Corps of Engineers  
803 Front Street  
Norfolk, VA 23510

Division Engineer  
US Army Engineering District, Huntsville  
PO Box 1600, West Station  
Huntsville, AL 35807

Commander  
Naval Ordnance Station  
Indianahed, MD 20640

Commander  
US Army Construction Engr Research Laboratory  
Champaign, IL 61820

Commander  
Dugway Proving Ground  
Dugway, UT 84022

Commander  
Savanna Army Depot  
Savanna, IL 61704

Civil Engineering Laboratory  
Naval Construction Battalion Center  
ATTN: L51  
Fort Hueneme, CA 93043

Commander  
Naval Facilities Engineering Command  
(Code 04, J. Tyrell)  
200 Stovall Street  
Alexandria, VA 22322

Commander  
Southern Division  
Naval Facilities Engineering Command  
ATTN: J. Watts  
PO Box 10068  
Charleston, SC 29411

Commander  
Western Division  
Naval Facilities Engineering Command  
ATTN: W. Morre  
San Bruno, CA 94066

Officer in Charge  
Trident  
Washington, DC 20362

Officer in Charge of Construction  
Trident  
Bangor, WA 98348

Commander  
Atlantic Division  
Naval Facilities Engineering Command  
Norfolk, VA 23511

Commander  
Naval Weapons Support Center  
Crane, IN 47522

Technical Library  
ATTN: DRDAR-CLJ-L  
Aberdeen Proving Ground, MD 21005

Technical Library  
ATTN: DRDAR-TSB-S  
Aberdeen Proving Ground, MD 21010

Technical Library  
ATTN: DRDAR-LCB-TL  
Benet Weapons Laboratory  
Watervliet, NY 12189

U.S. Army Materiel Systems Analysis Activity  
ATTN: DRXSY-MP  
Aberdeen Proving Ground, MD 21005

Director of USA-BRL  
Propulsion Division  
ATTN: DRDAR-BLP  
Aberdeen Proving Grounds, MD 21005