TECHNICAL REPORT ARLCD-TR-78063

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

J. WENDELL LEACH

DECEMBER 1978

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

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ERRATA

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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 nitract 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.

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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.

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.

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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 Kenvil, 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 reimaging projected radiation through the use of ellipsodial 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 10,000 (69 MPa)	15,000 (103 MPa)	20,000 (138 MPa)	PSI AVG	RELATIVE FORCE %
RAD63574		90(32°C)	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
	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_o = .7 MPa, N_2
= 100 psi N_2
Q = 100 cal $cm^{-2} sec^{-1}$

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^2 sec)
*Percentages = frequency of initiation at the specified Q level

Table 3. Firing sequence

Date	Lot no.	No. rds	Phase	Temp
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 (control lot)	10	Uniformity	-50°F (-46°C)
"	PA-E-03624	10	"	"
"	PA-E-03625	10	"	"
3,4 Oct 74	PA-E-03626 (control lot)	10	Uniformity	+145°F (63°C)
"	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									
TEMP.		AVG	STD DEV	AVG	STD DEV	AVG	STD DEV	AVG	STD 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	9.6	3831	6.3	3839	10.0	3829	6.9
21°C	m/s	1184	2.9	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	5.0	601	5.8	604	5.5	598	5.6
21°C	MPa	426	3.4	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

LOT NO.	VELOCITY		PRESSURE	
	f/s/°F	m/sec/°C	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

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

110 05:89

NITROGUANIDINE SHIPMENT ANALYSIS

CYANAMID

WELLAND PLANT

CONTROL DEPARTMENT

COPIES TO:

1-6	[illegible]	[illegible]
7	[illegible] OAD	
8	[illegible]	OTTAWA
9	APSA SMJAP RE[illegible]	
10	APSA SMJAP R[illegible]	
11	SUPT. NITRO[illegible]DINE	
12	TECHNICAL F[illegible]	

240 M 01173

MATERIAL: NITROGUANIDINE TYPE II CLASS I	SPECIFICATION: EOPA - 45940-S MIL N 494A AMENDMENT
CONTRACT	CUSTOMER: PICATINNY ARSENAL
CAR NO: WHITTEN TRANSPORT	LOTS FROM U/AN 1 THROUGH U/ N

ANALYTICAL RESULTS

TEST	LIMIT	LOT NO. U/AN 1 1-100	LOT NO. U/AN 2 1-88	LOT NO.	LOT NO.
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_2SO_4)	0.06% MAX.	0.01	0.01		
TOTAL VOLATILE	0.25% MAX.	0.08	0.04		
SULFATE (NA_2SO_4)	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.

Roland Dell

LABORATORY SUPERVISOR

Figure 1. Nitroguanidine analysis results.

PROPELLANT DESCRIPTION SHEET

US ARMY LOT NO. PA-E-03623 OF 19 74 COMPOSITION NO. Propellant M30 for Cartridge 105 MM Heat-T, M456A1

MANUFACTURED AT Picatinny Arsenal, Dover, N. J. PACKED AMOUNT 952 lbs.

CONTRACT NO. *5573-06 DATE 15 Oct. 73 SPECIFICATION NO. Mil-P-46458D, 2 Feb. 68

*AMCMS: 4932.05.4169 Mil-STD-652B, 19 Sept. 69

NITROCELLULOSE

ACCEPTED BLEND NUMBERS	NITROGEN CONTENT	KI STARCH(65.5°C)	STABILITY(134.5°C)
HEP-2217L, Grade A, Type I	MAX 12.70 %	MINS	MINS
	MIN 12.50 %	MINS	30 MINS
	AVG 12.53 %	MINS	30 MINS
			EXPLOSION MINS

MANUFACTURE OF PROPELLANT

0.20 POUNDS SOLVENT PER POUND NC/DRY WEIGHT INGREDIENTS CONSISTING OF 60 POUNDS ALCOHOL AND 40 POUNDS Acetone PER 100 POUNDS SOLVENT

PERCENTAGE REMIX TO WHOLE None

TEMPERATURES FROM	TO	PROCESS-SOLVENT RECOVERY AND DRYING	TIME DAYS	HOURS
	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	

TESTS OF FINISHED PROPELLANT

PROPELLANT COMPOSITION

	CONSTITUENT	% FORMULA	% TOLERANCE	% MEASURED
	Nitrocellulose	28.00	± 1.30	27.94
	Nitroglycerin	22.50	± 1.00	22.66
**	Nitroguanidine	47.70	± 1.00	47.60
	Ethyl Centralite	1.50	± 0.10	1.49
	Cryolite	0.30	± 0.10	0.31
	Total Volatiles	0.50	Max	0.14
	Graphite (Glazed)	0.15	Max	0.11
**	U/AN2			

STABILITY AND PHYSICAL TESTS

	FORMULA	ACTUAL
HEAT TEST 120°C	40 Min	90
Explosion		300+
FORM OF PROPELLANT		Cyrlo
No. of perforations		7
Specific Gravity @ 15.6°C		1.68
No. of Grains/ lb		401.3
Grav. Density or lbs/Cu. ft.		55.6

CLOSED BOMB

	LOT NUMBER	TEMP °F	RELATIVE QUICKNESS	RELATIVE FORCE
TEST	PA-E-03623	90	107.7	99.5
	PA-E-03623	-40	106.9	100.0
STANDARD	RAD-63574	90	100.00%	100.00%
REMARKS	RAD-63574	-40	100.00%	100.00%

All standard and test Propellants were fired at a loading density of 0.2 GM/cc.

The values for R.Q. are based on an average of the figures obtained at the varied pressure points.

PROPELLANT DIMENSIONS (INCHES)

	SPEC	DIE	FINISHED	MEAN VARIATION IN % OF MEAN DIMENSION SPEC	ACTUAL
LENGTH (L)		0.6621	0.6711	6.25	Max 0.95
DIAMETER (D)		0.3200	0.2933	3.125	Max 0.92
PERF DIA (d)		0.0330	0.0304		
Wo		0.0540	0.0503		
Wi		0.0565	0.0508		
Wa		0.0553	0.0506		
Wc			0.0505		
WEB DIFFERENCE /STD DEV IN % OF WEB AVERAGE	15% Max.		0.99		
L/D	2.10 to 2.50		2.29		
D/d	5.0 to 15		9.65		

DATES
PACKED 4 April 74
SAMPLED 4 Apr. 74
TEST FINISHED 4-15-74
OFFERED 26 Apr. 74
DESCRIPTION SHEETS FORWARDED

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 J.R.Marsicovete
J.R.MARSICOVETE, CH, Props & Expls Div, IOD

GOVERNMENT QUALITY ASSURANCE REPRESENTATIVE E. E. Morris

SMU FORM 1047R MARCH 71

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

US ARMY LOT NO. PA-E-03624 OF 19 74 COMPOSITION NO. Propellant M30 for Cartridge 105 MM Heat-T, M456A1

MANUFACTURED AT Picatinny Arsenal, Dover, N. J. PACKED AMOUNT 5,350 lbs.

CONTRACT NO. *5573-06 DATE 15 Oct. 73 SPECIFICATION NO. Mil-P-46458D, 2 Feb. 68
*AMCMS: 4932.05.4169 Mil-STD-652B, 19 Sept. 69

NITROCELLULOSE

ACCEPTED BLEND NUMBERS	NITROGEN CONTENT	KI STARCH(65.5°C)	STABILITY(134.5°C)
HEP-2217L, Grade A, Type I	MAX 12.70 %	MINS	MINS
	MIN 12.50 %	MINS	30 MINS
	AVG 12.53 %	MINS	30 MINS
			EXPLOSION MINS

MANUFACTURE OF PROPELLANT

0.20 POUNDS SOLVENT PER POUND NC/DRY WEIGHT INGREDIENTS CONSISTING OF 60 POUNDS ALCOHOL AND 40 POUNDS Acetone PER 100 POUNDS SOLVENT

PERCENTAGE REMIX TO WHOLE None

TEMPERATURES FROM	TO	PROCESS–SOLVENT RECOVERY AND DRYING	TIME DAYS	HOURS
	20°C	Room Temperature		2½
20°C	50°C	Temperature Raised 2°c per hr.		15
	50°C	Dry House, Air Dry - Constant Temperature	3	

TESTS OF FINISHED PROPELLANT

PROPELLANT COMPOSITION

	CONSTITUENT	% FORMULA	% TOLERANCE	% MEASURED
	Nitrocellulose	28.00	± 1.30	28.33
	Nitroglycerin	22.50	± 1.00	22.10
**	Nitroguanidine	47.70	± 1.00	47.78
	Ethyl Centralite	1.50	± 0.10	1.49
	Cryolite	0.30	± 0.10	0.30
	Total Volatiles	0.50	Max.	0.38
	Graphite	0.15	Max	0.12
** | U/AN 2 | | | |

STABILITY AND PHYSICAL TESTS

	FORMULA	ACTUAL
HEAT TEST 120°C	40 Min	124
Emplosion		300+
FORM OF PROPELLANT		Cyl.
No. of perforations		7
Specific Gravity @ 15.6°C		1.67
No. of Grains/ lb		344.1
Grav. Density of lbs/Cu. Ft.		55.3

CLOSED BOMB

TEST	LOT NUMBER	TEMP °F	RELATIVE QUICKNESS	RELATIVE FORCE
	PA-E-03624	90	103.2	100.1
	PA-E-03624	-40	102.0	100.2
STANDARD	RAD-63574	90	100.00%	100.00%
REMARKS	RAD-63574	-40	100.00%	100.00%

All standard and test Propellants were fired at a loading density of 0.2 GM /cc.

The values for R.Q. are based on an average of the figures obtained at the varied pressure points.

PROPELLANT DIMENSIONS (INCHES)

	SPEC	DIE	FINISHED	MEAN VARIATION IN % OF MEAN SPEC	MEAN VARIATION IN % OF MEAN ACTUAL
LENGTH (L)		0.7023	0.7141	6.25	1.34
DIAMETER (D)		0.3380	0.3079	3.125	1.12
PERF DIA (d)		0.0350	0.0316		
Wo		0.0575	0.0521		
Wi		0.0590	0.0542		
Wa		0.0583	0.0533		
Wc			0.0533		
WEB DIFFERENCE /STD DEV IN % OF WEB AVERAGE	15% Max.		3.38		
d/D	2.10 to 2.50		2.32		
D/d	5.0 to 15		9.74		

DATES
PACKED 16 Apr. 74
SAMPLED 16 Apr. 74
TEST FINISHED 25 April 74
OFFERED 25 April 74
DESCRIPTION SHEETS FORWARDED 2 May 1974

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 J.R. Marsicovete
J.R.MARSICOVETE, CH, Props & Expls Div, IOD

GOVERNMENT QUALITY ASSURANCE REPRESENTATIVE E. E. Morris

SMCS FORM 1047R MARCH 71

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

PROPELLANT DESCRIPTIVE SHEET

US ARMY LOT NO. PA-E-03625 OF 19 74 COMPOSITION NO. Propellant M30 for Cartridge 105 MM Heat-T, M456A1

MANUFACTURED AT Picatinny Arsenal, Dover, N. J. PACKED AMOUNT 982 lbs.

CONTRACT NO. *5573-06 DATE 15 Oct. 73 SPECIFICATION NO. Mil-P-46458D, 2 Feb 68
*AMCMS: 4932.05.4169 Mil-STD-652B, 19 Sept. 69

NITROCELLULOSE

ACCEPTED BLEND NUMBERS: HEP-2217L, Grade A, Type 1

	NITROGEN CONTENT	KI STARCH (65.5°C)	STABILITY (134.5°C)
MAX	12.70 %	MINS	MINS
MIN	12.50 %	MINS	30 MINS
AVG	12.53 %	MINS	30 MINS
			EXPLOSION MINS

MANUFACTURE OF PROPELLANT

0.20 POUNDS SOLVENT PER POUND NC/DRY WEIGHT INGREDIENTS CONSISTING OF 60 POUNDS ALCOHOL AND 40 POUNDS Acetone PER 100 POUNDS SOLVENT

PERCENTAGE REMIX TO WHOLE None

TEMPERATURES FROM	TEMPERATURES TO	PROCESS—SOLVENT RECOVERY AND DRYING	TIME DAYS	TIME HOURS
	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	

TESTS OF FINISHED PROPELLANT

PROPELLANT COMPOSITION

	CONSTITUENT	% FORMULA	% TOLERANCE	% MEASURED
	Nitrocellulose	28.00	± 1.30	27.64
	Nitroglycerin	22.50	± 1.00	22.63
**	Nitroguanidine	47.70	± 1.00	47.93
	Ethyl Centralite	1.50	± 0.10	1.50
	Cryolite	0.30	± 0.10	0.30
	Total Volatiles	0.50	Max	0.15
	Graphite	0.15	Max	0.14
**	U/AN 2			

STABILITY AND PHYSICAL TESTS

	FORMULA	ACTUAL
HEAT TEST 120°C	40 Min.	90
Explosion		300+
FORM OF PROPELLANT		Cyld
No. of perforations		7
Specific Gravity @ 15.6°C		1.68
No. of Grains/ lb		319.8
Grav. Density of lbs/Cu. ft.		55.1

CLOSED BOMB

	LOT NUMBER	TEMP °F	RELATIVE QUICKNESS	RELATIVE FORCE
TEST	PA-E-03625	90	103.1	100.4
	PA-E-03625	-40	99.7	100.2
STANDARD	RAD-63574	90	100.00%	100.00%
REMARKS	RAD-63574	-40	100.00%	100.00%

All standard and test propellants were fired at a loading density of 0.2 GM/cc.

The values for R.Q. are based on an average of the figures obtained at the varied pressure points.

PROPELLANT DIMENSIONS (INCHES)

	SPEC	DIE	FINISHED
LENGTH (L)		0.7295	0.7337
DIAMETER (D)		0.3500	0.3167
PERF DIA (d)		0.0360	0.0322
Wo		0.0595	0.0538
W1		0.0615	0.0563
Wa		0.0605	0.0551
Wc			0.0550
WEB DIFFERENCE /STD DEV IN % OF WEB AVERAGE	15% Max.		4.54
L:D	2.10 to 2.50		2.32
D:d	5.0 to 19		9.84

MEAN VARIATION IN % OF MEAN DIMENSIONS

SPEC	ACTUAL
6.25	Max 1.24
3.125	Max 1.20

DATES

PACKED 4 Apr. 74
SAMPLED 4 Apr. 74
TEST FINISHED 4-15-74
OFFERED 26 Apr. 74
DESCRIPTION SHEETS FORWARDED 2 May 1974

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 J.R.MARSICOVETE, Ch, Props & Expls Div, IOD

GOVERNMENT QUALITY ASSURANCE REPRESENTATIVE E. E. Morris

SMU FORM 1047R MARCH 71

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

PROPELLANT DESCRIPTION SHEET

US ARMY LOT NO. PA-E-03626 OF 19 74 COMPOSITION NO. Propellant M30 for Cartridge 105 MM Heat-T, M456A1

MANUFACTURED AT Picatinny Arsenal, Dover, N. J. PACKED AMOUNT 970 lbs

CONTRACT NO. *5573-06 DATE 15 Oct. 73 SPECIFICATION NO. Mil-P-46458C, 2 Feb. 68

*AMCMS: 4932.05.4169 Mil-STD-652B, 19 Sept. 69

NITROCELLULOSE

ACCEPTED BLEND NUMBERS	NITROGEN CONTENT	KI STARCH(65.5°C)	STABILITY(134.5°C)
HEP-2217L, Grade A, Type 1	MAX 12.70 %	____ MINS	____ MINS
	MIN 12.50 %	____ MINS	30 MINS
	AVG 12.53 %	____ MINS	30 MINS
			EXPLOSION ____ MINS

MANUFACTURE OF PROPELLANT

0.20 POUNDS SOLVENT PER POUND NC/DRY WEIGHT INGREDIENTS CONSISTING OF 60 POUNDS ALCOHOL AND 40 POUNDS Acetone PER 100 POUNDS SOLVENT

PERCENTAGE REMIX TO WHOLE None

TEMPERATURES FROM	TO	PROCESS-SOLVENT RECOVERY AND DRYING	TIME DAYS	TIME HOURS
	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	

TESTS OF FINISHED PROPELLANT

PROPELLANT COMPOSITION

	CONSTITUENT	% FORMULA	% TOLERANCE	% MEASURED
	Nitrocellulose	28.00	± 1.30	27.56
	Nitroglycerin	22.50	± 1.00	22.69
**	Nitroguanidine	47.70	± 1.00	47.93
	Ethyl Centralite	1.50	± 0.10	1.52
	Cryolite	0.30	± 0.10	0.30
	Total Volatiles	0.50	Max	0.18
	Graphite	0.15	Max	0.13
**	Regular			

STABILITY AND PHYSICAL TESTS

	FORMULA	ACTUAL
HEAT TEST 120°C	40 Min	93
Explosion		300+
FORM OF PROPELLANT		Cyld
No. of perforations		7
Specific Gravity @ 15.5°C		1.70
No. of Grains/ lb		344.4
Grav. Density of lbs/Cu. Ft.		55.1

CLOSED BOMB

	LOT NUMBER	TEMP °F	RELATIVE QUICKNESS	RELATIVE FORCE
TEST	PA-E-03626	90	101.5	99.8
	PA-E-03626	-40	98.9	99.1
STANDARD	RAD-63574	90	100.00%	100.00%
REMARKS	RAD-63574	-40	100.00%	100.00%

All standard and test Propellants were fired at a loading density of 0.2 GM/cc.

The values for R.Q. are based on an average of the figures obtained at the varied pressure points.

PROPELLANT DIMENSIONS (INCHES)

	SPEC	DIE	FINISHED	MEAN VARIATION IN % OF MEAN DIMENSIONS SPEC	ACTUAL
LENGTH (L)		0.7023	0.7200	6.25	Max 1.62
DIAMETER (O)		0.3380	0.3060	3.125	Max 1.25
PERF DIA (d)		0.0350	0.0308		
Wo		0.0575	0.0518		
Wi		0.0590	0.0551		
Wa		0.0583	0.0535		
Wo			0.0534		
WEB DIFFERENCE (STD DEV IN % OF WEB AVERAGE	15% Max.		6.17		
L/O	2.10 to 2.50		2.35		
L/d	5.0 to 15		9.94		

DATES

PACKED 1 Apr. 74

SAMPLED 1 Apr. 74

TEST FINISHED 15 Apr. 74

OFFERED 26 Apr. 74

DESCRIPTION SHEETS FORWARDED 2 May 1974

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 J.R. Marsicovete

J.R.MARSICOVETE, Ch, Props & Expls Div, IOD

GOVERNMENT QUALITY ASSURANCE REPRESENTATIVE E. E. Morris

SMU FORM 1947R MARCH 71

Figure 5. Description of lot no. PA-E-03626.

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Aberdeen Proving Ground, MD 21005

Director of USA-BRL
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