TECHNICAL REPORT

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FINAL QUALITY ASSURANCE REPORT ON

FOULING TEST INVESTIGATION OF 5.56MM AMMUNITION / WEAPON SYSTEM

DECEMBER 1967

U.S. ARMY
FRANKFORD ARSENAL
PHILADELPHIA PA., 19137

FINAL QUALITY ASSURANCE REPORT
ON
FOULING TEST INVESTIGATION
OF
5.56MM AMMUNITION/WEAPON SYSTEM

BY

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INTRODUCTION

1. Fouling test investigation was initiated at this Installation in accordance with instructions contained in USAMUCOM Teletype No. 12-0843 (Appendix A). The investigation was initiated in an effort to identify the cause of excessive accumulation of fouling on the bolt groups of the M16A1 and M16 rifles.

2. The original plan was that each producer of 5.56MM Ammunition would conduct monthly fouling tests on one lot of each type cartridge currently being loaded; however, in an effort to control the testing more closely, all testing was conducted at Frankford Arsenal (Appendix "B"). Upon completion of each test, rifle was disassembled, fouling was removed from various parts of the rifle and subjected to chemical analysis.

3. Twelve (12) new rifles (M16A1) were acquired from WECOM. One rifle was assigned to each producer, in which only his ammunition was fired.

4. This report includes a summary of findings and accumulated test data compiled during this investigation together with final conclusions and recommendations.

MONTHLY FOULING TESTS

1. In an effort to identify the cause of excessive fouling accumulating on the bolt group of the M16A1 and M16 rifles, the monthly fouling tests were initiated during March 1967. Each producer was instructed to furnish a 1,000 round sample of each type cartridge being produced during the current month. If a producer was loading either cartridge (Ball or Tracer) with both types of propellant (IMR 8208 and WC 846) during the month, he would be required to submit a 1,000 round sample of each.

2. The 1,000 round fouling test was fired in the following manner: Rifle was cleaned, inspected and lubricated in accordance with TM9-1005-249-14. Four magazines (20 rounds each) were fired semi-automatic, one magazine (20 rounds) was fired full-automatic, on which cyclic rate was measured. Rifle was then permitted to cool to ambient temperature. This sequence was repeated nine more times unless test was terminated earlier due to weapon stoppage caused by fouling. Upon completion of each test, the rifle was disassembled, fouling was then removed from the Bolt carrier pin, Firing pin, Bolt, Bolt carrier, Receiver group, Charging handle, Retaining pin, Gas tube and Barrel; samples were kept separate and subjected to chemical analysis.

3. Twelve (12) new rifles (M16A1) were acquired from Weapons Command. Each producer was assigned one rifle in which only his ammunition was fired. Initially, the rifles were equipped with the old buffers; however, after the first months firing had been completed, new buffers were received and immediately inserted into all the rifles.

4. Prior to initiation of the monthly fouling tests, the sample size for the Fouling Test in the Propellant specification (MIL-P-3984) was 100 rounds, whereas the sample size in the Cartridge specifications (MIL-C-9963 and MIL-C-60111) is 1,000 rounds. The requirement in MIL-P-3984 has been amended and is now 1,000 rounds; however, 5.56MM is the only ammunition with the 1,000 round requirement, all other bullet-type cartridges have a 100 round requirement for Fouling.

FIRING DATA

1. Thirty-five (35) samples representative of all producers production from February through June 1967 were fired during the monthly fouling tests. Thirty-one (31) samples passed and four (4) failed the 1,000 round criteria.

Lot Number	Ammo Type	Prop.	Rifle Number	Rds In Rifle Rec'r	Rds in Barrel	Type Buffer	Cyclic Rate	Rounds fired
WCC 6079	Tracer	W-846	163336	1000	1000	Old	813	1000
LC 12050	Tracer	W-846	165783	822	822	Old	864	822
TW 18108	Ball	W-846	165802	1000	1000	Old	950	1000
FCC 1868	Ball	W-846	165806	1000	1000	Old	891	1000
RA 5265	Ball	W-846	166440	1000	1000	Old	926	1000
LC 12141	Ball	W-846	165783	1822	1822	Old	933	1000
WCC 6080	Tracer	W-846	163336	2360	2360	New	758	1000
LC 12053	Tracer	W-846	165783	3422	3422	New	809	1000
WCC 6142	Ball	W-846	163336	3400	3400	New	832	1000
LC 12152	Ball	W-846	165783	4422	4422	New	886	1000
RA 5047	Tracer	CR-8136	167375	1000	1000	New	677	1000
FCC 1870	Ball	W-846	165806	2000	2000	New	850	1000
RA 5048	Tracer	IMR8208	166440	2680	2680	New	749	933
RA 5270	Ball	W-846	166440	3680	3680	New	809	636
WCC 6147	Ball	W-846	163336	4600	4600	New	846	1000
WCC 6083	Tracer	W-846	166460	1000	1000	New	850	1000
RA 5281	Ball	W-846	167375	2000	2000	New	893	1000
TW 18149	Ball	IMR8208	165802	2000	2000	New	833	1000
FCC 1873	Ball	W-846	165806	3200	3200	New	887	1000
FCC 1873	Ball	W-846	165806	4800	4800	Old	894	1000
LC 12182	Ball	W-846	166650	1000	1000	New	892	1000
LC 12068	Tracer	IMR8208	166650	2000	2000	New	729	1000
LC 12070	Tracer	W-846	166650	3000	3000	New	882	1000
TW 18173	Ball	IMR8208	167361	1000	1000	New	844	1000
LC 12189	Ball	W-846	166650	4000	4000	New	878	1000
TW 18002	Tracer	IMR8208	167361	2000	2000	New	803	1000
RA 5053	Tracer	IMR8208	167375	3000	3000	New	819	1000
RA 5053	Tracer	IMR8208	167375	4000	4000	Old	835	1000
WCC 6088	Tracer	W846	163336#2	5600	1000	New	840	1000
WCC 6088	Tracer	W-846	163336#2	6600	2000	Old	920	1000*
FCC 1879	Ball	W-846	165806#2	5800	1000	New	887	1000
FCC 1879	Ball	W-846	165806#2	6800	2000	Old	950	1000

* Lot failed at 249 rounds due to misfire on round No. 250. Test was continued for information, no stoppages were experienced through 1000 rounds.

Powder Acceptance

RAD44344	Ball	IMR8208	141067	2080	2080	Old	823	1000

Pre-Production Test

TW	Ball	IMR8208	595493	1000	1000	New	740	1000
TW	Tracer	IMR8208	595493	2000	2000	New	763	1000

Note: Cyclic Rate shown is average of ten (20 rounds) bursts for each 1000 round test.

During the first 600 rounds of various tests, some fired cases were suspected of having pierced primers; closer inspection revealed carbon buildup in firing-pin indent. Condition would disappear during last 400 rounds of test.

2. Details of the four (4) failing lots follow:

Lot Number	Type	Prop.	Buffer	Cyclic Rate	Rounds Fired	Remarks
RA 5270	Ball	W-846	New	809	636	Misfire
RA 5048	Tracer	IMR8208	New	749	933	Misfire
LC 12050	Tracer	W-846	Old	864	822	Misfire
WCC 6088*	Tracer	W-846	Old	920	249	Misfire

All misfires were caused by light firing pin blows. Upon examination of the bolts, it was difficult to remove firing pin due to excessive residue.

* Misfire occurred with round No. 250. Round was ejected and firing continued through 1000 rounds. One thousand rounds of WCC 6088 had been previously fired in the same rifle equipped with a new buffer, cyclic rate was 840 RPM.

3. Test data compiled using the old and new buffers follows:

Ctg. Type	Prop.	Buffer	No. of Lots	No. of Bursts	Cyclic Rate Average	Cyclic Rate Maximum	Cyclic Rate Minimum
Ball	W-846	Old	6	60	924	950	891
Ball	W-846	New	10	96	866	893	809
Ball	IMR8208	Old	1	10	823	---	---
Ball	IMR8208	New	3	30	806	844	740
Tracer	W-846	Old	3	28	866	920	813
Tracer	W-846	New	5	50	828	882	758
Tracer	IMR8208	Old	1	10	835	---	---
Tracer	IMR8208	New	5	49	773	819	729
Tracer	CR 8136	New	1	10	677	---	---

CHEMICAL ANALYSIS

See Appendix "C".

LUBRICANT TESTS

1. Due to the nature of the Chemical Analysis, in regard to lubricant breakdown, WECOM Technical Report 67-1380, and "Connie Radds Briefs" (Appendix "D"), tests were conducted utilizing two different lubricants. Lubricant #1 was PL Special VVL-800, FSN-9150-231-6689, this is the lubricant used throughout the monthly fouling tests. Lubricant #2 is Anderol 735 lube oil semi-fluid MIL-L-46000 Batch 6706, referenced in WECOM Technical Report 67-1380 and "Connie Radds Briefs".

2. Three rifles (M16A1) were selected for the test, Rifle #1 was completely cleaned, all traces of lubricant were removed, rifle was then fired in dry condition. Rifle #2 was cleaned, then lubricated with PL Special lubricant in accordance with TM9-1005-249-14. Rifle #3 was cleaned, the bolt groups were then saturated with PL Special lubricant. Details of test follow:

a. Dry Rifle.-
Rifle, M16A1, #165783 fired 5822 rounds, Barrel #2 fired 1000 rounds.

Ammunition Lot RA 5290, Ball, M193 containing W846 propellant.

Rifle was cleaned at Proof House and then taken to Q6000 where all traces of lubricant were removed. Rifle was returned to Proof House in a completely dry condition. 1000 rounds were fired, stoppages occurred at 785, 790, 886, 890 and 986 rounds. All stoppages were encountered during automatic firing cycles. All stoppages were identical, cartridges failed to chamber completely, these were corrected by exerting minimum amount of pressure on forward assist. New magazines were used for the test, difficulty was experienced inserting magazines into magazine well.

Cyclic Rate

80 - 100 rds.	-	799 RPM
180 - 200 rds.	-	845 "
280 - 300 rds.	-	845 "
380 - 400 rds.	-	845 "
480 - 500 rds.	-	859 "
580 - 600 rds.	-	859 "
680 - 700 rds.	-	859 "
780 - 800 rds.	-	814 "
880 - 900 rds.	-	814 "
980 -1000 rds.	-	828 "
AVERAGE		837 RPM

b. Normal lubrication
Rifle, M16A1, #167375 fired 5000 rounds

Ammunition Lot RA 5297, Ball, M193 containing W846 propellant.

Rifle was cleaned at Proof House using normal cleaning procedure. 1000 rounds were fired without encountering any stoppages. Eleven stretched cases were encountered.

Cyclic Rate

80 - 100	rds. -	845 RPM
180 - 200	rds. -	845 "
280 - 300	rds. -	859 "
380 - 400	rds. -	859 "
480 - 500	rds. -	859 "
580 - 600	rds. -	859 "
680 - 700	rds. -	859 "
780 - 800	rds. -	845 "
880 - 900	rds. -	845 "
980 -1000	rds. -	845 "
	AVERAGE	852 RPM

c. Saturated rifle
Rifle, M16A1 #167361 fired 3000 rounds

Ammunition Lot RA 5290, Ball, M193, W846 propellant.

Rifle was cleaned at Proof House using normal cleaning procedure. Rifle upper and lower receiver groups were then saturated with oil (PL Special VVL-800 FSN 9150-231-6689). 1000 rounds were fired without encountering any stoppages. Three stretched cases were encountered. Carbon build-up in firing-pin indent in primers was found in 38 cartridge cases, these were encountered between 100 and 600 rounds.

Cyclic Rate

80 - 100	rds. -	895 RPM
180 - 200	rds. -	895 "
280 - 300	rds. -	912 "
380 - 400	rds. -	912 "
480 - 500	rds. -	912 "
580 - 600	rds. -	912 "
680 - 700	rds. -	912 "
780 - 800	rds. -	912 "
880 - 900	rds. -	912 "
980 -1000	rds. -	912 "
	AVERAGE	909 RPM

NOTE: All rifles were equipped with new buffer.

Upon completion of firing, the three rifles were taken to Q6000 to collect and analyze fouling residue. Rifles were disassembled at Q6000 by PH Personnel.

3. Chemical Analysis

Test firings were made on weapons which were: (1) degreased and fired with no lubricant; (2) normal lubrication; and (3) liberal lubrication.

Fouling residue was collected from each part of the weapon by scrubbing in methylene chloride. All the previous parts were included in the sampling plus the lower receiver group. The total fouling residue was found to be: 512 mg for the non-lubricated; 681 mg for the normal lubricated; and 1700 mg for the liberally lubricated.

Spectrographic analysis for the cations present did not indicate any significant differences from previous fouling samples.

Infra-red analysis indicated the presence of dibutylphthalate and diphenylamine in the non-lubricated weapon; the lubricated weapons were typical of previous studies and indicated the presence of the platiciser and stabilizer used in the propellant.

Carbon analysis of the fouling residue showed approximately twenty percent carbon for the non-lubricated weapon with a greater carbon content as the amount of lubricant increased.

A test firing is presently underway which is intended to evaluate a semi-fluid tube oil (Anderol 735 - Batch 6706, Lehigh Chemical Co., Chestertown, Maryland). This oil has been tested under MIL-L-46000A and found to comply with this specification.

4. Analysis of results

a. The lower cyclic rate with the dry rifle is attributed to no lubrication.

b. The stoppages encountered with the dry rifle could be attributed to no lubrication.

c. The stretched cases obtained is believed not abnormal, since this has been encountered in other lots of ammunition of this type.

d. The carbon build-up in the firing-pin indent of the cartridge cases is attributed to the excess oil used on the rifle.

5. Two rifles (M16A1) were selected for the test with Lubricant #2; Rifle #1 was cleaned, then lubricated with Anderol 735 lube oil in accordance with TM9-1005-249-14. Rifle #2 was cleaned, the bolt groups were then saturated with Anderol 735 lube oil. Details of test follow:

a. Normal lubrication
Using new lubricant, rifle was lubricated in normal manner:
Rifle, M16A1, #167361, fired 4000 rounds.

Ammunition Lot WCC6151, Ball, M193 containing W846 propellant.

Rifle was cleaned at Proof House, all traces of PL Special VVL-800, FSN-9150-231-6689 was removed. Rifle was than lubricated with new lubricant in normal manner. Five stoppages were encountered, these were attributed to trapped rounds, due to lazy ejection. They were encountered during automatic firing, the first two occurred between 381 and 400 rounds.

Cyclic Rate

81 - 100 rds.	- 912	RPM
181 - 200 rds.	- 912	"
281 - 300 rds.	- 912	"
381 - 400 rds.	- 912	"
481 - 500 rds.	- 912	"
581 - 600 rds.	- 912	"
681 - 700 rds.	- 931	"
781 - 800 rds.	- 931	"
881 - 900 rds.	- 931	"
981 -1000 rds.	- 895	"
AVERAGE	916	RPM

b. Saturated Rifle
Rifle, M16A1, #165783 fired 6822 rds., Barrel #2 fired 2000 rounds.

Ammunition Lot WCC6151, Ball, M193 containing W846 propellant.

Rifle was cleaned at Proof House, all traces of PL Special VVL-800, FSN-9150-231-6689 was removed. Rifle upper and lower receiver groups were then saturated with new type lubricant. 1000 rounds were fired without encountering any stoppages.

Cyclic Rate

81 - 100 rds.	- 895	RPM
181 - 200 rds.	- 912	"
281 - 300 rds.	- 895	"
381 - 400 rds.	- 895	"
481 - 500 rds.	- 895	"
581 - 600 rds.	- 895	"
681 - 700 rds.	- 895	"
781 - 800 rds.	- 895	"
881 - 900 rds.	- 895	"
981 -1000 rds.	- 912	"
AVERAGE	898	RPM

Both rifles were taken to Q6000 where they were disassembled and fouling residue removed for chemical analysis.

6. Chemical Analysis

Chemical results on weapon fouling:

No further amplification can be made relative to concentration of propellant ingredients due to the nature of the synthetic lubricant used. (Anderol (735) lube oil semi-fluid MIL-L-46000, Batch 6706.

CONCLUSIONS:

1. Visual Observations

a. No noticeable difference in fouling build-up was observed on the bolt or bolt carrier with the various lots of ammunition.

b. No definite trend could be determined as to the difficulty of removing the firing-pin from the bolt assembly.

c. Fouling on the shoulder of the barrel and metal fouling in the bore were noticeably heavier with W-846 propellant than with IMR8208. Metal fouling was heaviest in area of gas port. Metal fouling in bore was light to nil with IMR8208 propellant.

2. Current fouling test of 1000 rounds is adequate. oh?!

3. Addition of 1000 round Fouling Test to Propellant Specification, in lieu of 100 rounds, should eliminate conflict with Cartridge specification.

4. Numerous stoppages occurred throughout the testing due to defective magazines. what?

5. Occasional first-round stoppages were encountered when cartridge would fail to chamber fully, since the M16A1 is equipped with a forward-assist, stoppages were considered minor.

RECOMMENDATIONS:

1. Due to repetition of results, monthly Fouling tests be terminated.
If the problem will not go away, stick your head in a sand pile!

2. Environmental tests be conducted, utilizing ammunition from all producers. Weapons should be conditioned along with the ammunition.

3. Since numerous stoppages were encountered due to defective magazines, tests be conducted to investigate the possibility of spring tension loss within the magazines due to excess use of magazines.

4. Establish a ratio of Ball & Tracer rounds in a magazine in lieu of present method of 20 Tracer cartridges to a magazine.

APPENDIX "A"

NNNNCZUPA165
RTTU JAW RUCGCTA9924 3470000-UUUU--RUEOPUA.
ZNR UUUUU
DE RUEPPA0094 3462133
Z-NR UUUUU
R 121846Z DEC 66
FM CG MUCOM DOVER NJ
TO CO FA PHILA PA
BT
UNCLAS 12-0843 FOR SMUFA1Q3000 INFO SMUFA-U4000
SMUFA-C1000 SMUFA-B1000 FROM MUCOM SGD THOMAS

SUBJ: PROPELLANT FOR 5.56MM CARTRIDGES

REF: BRIEFING 8 DEC 66 AT AMC FOR CG AMC AND DCSLOG SUBJ: 5.56MM PROPELLANT

1. PER PROJECT MANAGER's REQUEST WHICH RESULTED FROM REFERENCED BRIEFING THE FOLLOWING SHALL BE ACCOMPLISHED:

A. CONDUCT MONTHLY FOULING TESTS FOR INFORMATION AT EACH PLANT MANUFACTURING 5.56MM CARTRIDGES. TEST SHALL CONSIST OF ONE TEST OF 1000 ROUNDS ON EACH CARTRIDGE TYPE (BALL AND TRACER) FOR EACH PROPELLANT TYPE LOADED DURING THE MONTH. TEST SHALL BE CONDUCTED IN ACCORDANCE WITH APPENDIX L OF PERTINENT SPEC MIL-C-9963 OR MIL-C-60111. RESULTS SHALL BE REPORTED MONTHLY TO THIS HEADQUARTERS WITH A COPY TO PROJECT MANAGER/RIFLES.

B. ESTABLISH BY 31 MAR 67 A MORE COMPREHENSIVE FOULING TEST WHICH CONSIDERS SUCH ADDITIONAL FACTORS AS TIME BETWEEN FIRING AND CLEANING CLIMATIC EXTREMES AND OTHER ADVERSE CONDITIONS. WORK MAY CONTINUE BEYOND 31 MAR 67 BUT THE NEED FOR AN IMPROVED FOULING TEST MERITS IMPLEMENTATION OF THE BEST TEST AVAILABLE AT THAT TIME.

C. ASSURE THAT TCAAP AND LCAAP ACTIVELY PURSUE LOADING OF 5.56MM CARTRIDGES WITH IMR 8208M PROPELLANT TO OBTAIN LOADING EXPERIENCE AND TO DETERMINE WHETHER A GENERAL PROBLEM EXISTS WITH CHAMBER PRESSURE/VELOCITY RELATIONSHIP.

D. TO EXPEDITE PROCESSING OF RFWS NOTIFY THIS HEADQUARTERS AS FAR IN ADVANCE AS POSSIBLE OF PROBLEMS EXPECTED ON A LOT-BY-LOT BASIS AT PLANTS LOADING IMR 8208M.

2. WITH REFERENCE TO MUCOM BRIEFING 18 NOV 66 REQUEST AGRESSIVE ACTION BE TAKEN TO RESOLVE THE DISCREPANCIES IN PROPELLANT ASSESSMENT BETWEEN LOADING PLANTS AND PROPELLANT MANUFACTURERS E.G. LCAAP AND DUPONT AND RADFORD.

APPENDIX "B"

VZCZCPUA457
RITU JAW RUEOPUA0017 0121815-UUUU--RUEPPA.
ZNR UUUUU
R 121801Z JAN 67
FM COFA PHIIA PA
TO CG USAMUCOM DOVER NJ

UNCLAS FOR AMSMU-Q, MR THOMAS FROM SMUFA-Q3220 TT00359 SGD VANDYKE

SUBJ: PROPELLANT FOR 5.56MM CARTRIDGES

REF: AMSMU-Q TT 12-0843 DTD 13 DEC 1966

1. REFERENCE PARAGRAPH 1.A

ACTION HAS BEEN TAKEN TO INITIATE THE MONTHLY FOULING TESTS: HOWEVER, IN ORDER TO MAINTAIN IMPROVED CONTROL AND ASSURE UNIFORM TESTING AND TREATMENT OF DATA, TESTING WILL BE CONDUCTED AT FRANKFORD ARSENAL. REQUEST FOR 12 NEW RIFLES, TO BE USED FOR THESE TESTS, HAS BEEN INITIATED.

2. REFERENCE PARAGRAPH 1.B

RESULTS OF FOULING TESTS, REFERENCED IN PARAGRAPH 1 ABOVE WILL BE UTILIZED IN ESTABLISHING A MORE COMPREHENSIVE TEST. ALTHOUGH THESE TESTS WILL BE CONDUCTED IN ACCORDANCE WITH THE EXISTING TEST PROCEDURE, NEW PARAMETERS WILL BE EXPLORED AS POSSIBLE ADDITIONS TO FUTURE TESTS IN ORDER TO DEVELOP A MORE COMPREHENSIVE FOULING TEST.

3. REFERENCE PARAGRAPH 1.C

LCAAP IS CURRENTLY LOADING IMR 8208M PROPELLANT IN PRODUCTION OF 5.56MM TRACER AMMUNITION. LCAAP WILL HAVE A QUANTITY OF IMR 8208M PROPELLANT AVAILABLE FOR LOADING 5.56MM BALL AMMUNITION APPROXIMATELY MARCH 1967.

TCAAP HAS NOT YET INITIATED PRODUCTION OF 5.56MM AMMUNITION LOADED WITH IMR 8208M PROPELLANT. TCAAP IS CURRENTLY ASSESSING EVERY LOT OF IMR 8208M RECEIVED TO DATE. ACCEPTABILITY OF ASSESSMENT DATA WILL DICTATE INITIATION DATE OF LOADING IMR 8208M INTO 5.56MM BALL AMMUNITION. TCAAP WILL HAVE A QUANTITY OF IMR 8208M PROPELLANT AVAILABLE FOR PRODUCTION LOADING 5.56MM TRACER AMMUNITION APPROXIMATELY MARCH 1967.

4. REFERENCE PARAGRAPH 1.D

ASSESSMENT OF EACH AND EVERY LOT OF IMR 8208M PROPELLANT WILL BE MADE AT BOTH LCAAP AND TCAAP IMMEDIATELY UPON RECEIPT OF PROPELLANT AT THOSE INSTALLATIONS. THIS PROCEDURE SHOULD AFFORD MAXIMUM ADVANCE NOTICE OF IMPENDING VELOCITY PRESSURE RELATIONSHIP PROBLEMS.

5. REFERENCE PARAGRAPH 2

AGGRESSIVE ACTION IN THE FORM OF A COORDINATED TESTING PROGRAM IS BEING CONDUCTED TO RESOLVE BALLISTIC DIFFERENCES BETWEEN CARTRIDGE LOADING PLANTS AND THE PROPELLANT PRODUCER.

APPENDIX "C"

PROGRESS REPORT

Title: 5.56mm Gun Fouling Residue

Sub-title: W-846 and IMR8208 Propellant

Period: 1 April to 30 June 1967

Introduction:

The continuation of the study of the residue accumulating on the working assembly of the 5.56mm rifle was conducted during this period. Table I lists the subsequent samples submitted for study.

The previous report indicated that: the cations present in the weapon fouling were essentially the same for each sample location in the weapon and for WC846 or IMR8208 propellant; the presence of plasticizer and/or stabilizer was indicated as a probable contaminant.

Experimental:

The sampling technique was changed from brushing with a nylon brush to extraction of each of the weapon components with an organic solvent (i.e. methylene chloride) in order to obtain complete sampling of the organic material present throughout the weapon. Table I shows the pertinent history of the fouling samples; Table II A, B, C, shows the fouling breakdown.

A study of the degradation of the weapon lubricants used (MIL-C-372B Stock #6850-224-6658 and V.V.L - 800 Stock #9150-231-6689) was initiated. A test fixture was constructed which would work the lubricant through a simulated firing cycle at a controlled temperature and with selected contaminants.

Identification of the white crystals observed and mentioned in the previous progress report, and selection of unusual materials present in the sample was completed. Satisfactory identification of these materials was not accomplished because separation and purification of individual crystals from the bulk of the material was impractical.

Analysis of the water extractable materials was completed and observed to have no significant difference from the bulk fouling.

Discussion:

Solvent extraction of the weapon component parts was made with methylene chloride. The infra-red spectrograph of the extractables showed that: many

different contaminants were present; there was virtually no difference in the kind of contaminants within the weapon assembly; there was a difference in the quantity from one section of the weapon to another.

A degradation study was made using the weapon lubricants with a test fixture designed and constructed within this laboratory. The complexity of the equipment required to duplicate the back and forth movement as well as the rotational movement of the bolt was recognized. Of necessity the test fixture constructed was thus limited to a 3-1/2 inch stroke of an air driven piston assembly which simulated the back an forth motion of the bolt of a weapon. This fixture was used to work the lubricants.

Each of the lubricants were test worked for one thousand cycles under the following conditions: at 300° C.; at 300° C. contaminated with a fine grind copper metal powder; at 200°C.; at 200° C. contaminated with dibutylphthalate; at 200° C. contaminated with diphenylamine; at 200° C. contaminated with copper and dibutylphthlate; at 200° C. contaminated with copper and diphenylamine. Determination of the effects induced was made by infra-red spectroscopy using an unused oil as the standard.

It was noted that testing at 300° C. produced excessive amounts of smoke and a considerable loss of the sample oil. Testing at 200° C. however produced a very small amount of smoke and this temperature was used throughout the testing.

Oil obtained from each 200° C. 1000 cycle study contained visible carbon contaminants. Infra-red spectrographic analysis indicated a breakdown of the oil, but the peaks obtained were not identical to those observed with the weapon fouling extracts. This indicated that a shift in the position of a peak occured with selected contaminants.

A study of the catalytis effect of the cations present in the weapon fouling residue showed that the breakdown of the oil alone is independent of the metal contaminants.

A study for the possible formation of dimers and/or polymers due to the interaction of the plasticizer and/or stabilizer of the propellant was made with and without copper metal as a catalyst for the interreaction of the organic constituents or the catalytic oxidation or formation of degradation products. Working of the oil under the test conditions described produced visible carbon inclusions with each oil and with each of the test conditions. The overall appearance of the oil is similar to the extractable materials present in the fouling residue. Infra-red spectrographic determinations indicated a material similar to that present in the fouling residue.

Proposed work:

The weapon fouling residue investigation is considered complete. A final report is presently being prepared and will be published shortly.

Conclusions:

The residue accumulating in the working assembly of the 5.56mm rifle is a complex composite of the metal oxide contaminants from the bullet; organic and metal oxide contaminants from the remainder of the round; and the breakdown of the weapon lubricant.

Recommendations:

The degradation of the weapon lubricant indicates that consideration should be given toward the selection of a lubricant which does not form reaction products and functions at higher temperatures than the material presently in use.

A reduction in the quantity of contaminant contributed by the round components also requires evaluation and consideration.

TABLE I

Type & Lot	Total Residue	Type	#	°F.	Gun	Date
IMR RAD44344	178 mg	Ball	1000	70°F.	141067	3/28/67
IMR TW146	59	Ball	1000	70°F.	595493	4/3/67
WC WC6080	52	Tracer	1000	70°F.	163336	4/5/67
WC LC12053	88	Tracer	1000	70°F.	165783	4/6/67
WC WC6142	72	Ball	1000	70°F.	163336	4/7/67
WC LC12152	92	Ball	1000	70°F.	165783	4/10/67
IMR RA5047	Water	Tracer	1000	70°F.	167375	4/11/67
WC FC1870	Water	Ball	1000	70°F.	165806	4/12/67
IMR RA5048	125	Tracer	2680	70°F.	166440	4/18/67
WC RA5270	86	Ball	3680	70°F.	166440	4/19/67
WC WC6147	180	Ball	4600	70°F.	163336	5/9/67
WC LC6083	123	Tracer	1000	70°F.	166460	5/10/67
WC RA5281	317(wet)	Ball	1000	70°F.	167375	5/11/67
IMR TW18149	211	Ball	1000	70°F.	165802	5/15/67
	Solvent					
WC FC1873	261	Ball	1000	70°F.	165806	5/23/67
WC LC12182	172	Ball	1000	70°F.	166650	5/24/67
IMR LC12068	253	Tracer	1000	70°F.	166650	6/5/67
WC FC1873	181	Ball	1000	70°F.	165806	6/12/67
WC LC12070	427	Tracer	1000	70°F.	166650	6/13/67
IMR TW18173	227	Ball	1000	70°F.	167361	6/16/67
WC LC12189	384	Ball	1000	70°F.	166650	6/19/67
IMR TW18002	493	Tracer	1000	70°F.	167361	6/20/67
IMR RA5053	611	Tracer	1000	70°F.	167375	6/21/67
WC WC6088	1236	Tracer	1000	70°F.	163336	6/26/67
IMR RA5053	414	Tracer	1000	70°F.	167375	6/28/67

TABLE II - B

Fouling Residue (in mg) Organic Extract

Type & Lot	Bolt Cam Pin	Firing Pin	Bolt	Bolt Carrier	Receiver Group	Charge Handle	Retaining Pin	Gas Tube	Barrel	Flash Suppressor	Front Sight	Total Residue
WC FC1873	11	9	19	13	117	20	6	19	47	N.S.	N.S.	261
WC LC12182	3	2	14	11	83	5	2	3	49	N.S.	N.S.	172
IMR LC12068	1	1	24	13	98	1	3	1	69	5	37	253
WC FC1873	3	1	12	49	N.S.	33	1	3	79	N.S.	N.S.	181
WC LC12070	1	2	9	38	275	N.S.	2	4	71	2	23	427
IMR TW18173	1	1	3	9	114	6	1	2	18	4	68	227

N.S. - no sample received

TABLE II - C

Fouling Residue (in mg) Organic and Inorganic Residue

Type & Lot	Bolt Cam Pin	Firing Pin	Bolt	Bolt Carrier	Receiver Group	Charge Handle	Retaining Pin	Gas Tube	Barrel	Flash Suppressor	Front Sight	Total Residue
WC LC12189	2	4	8	26	117	11	1	2	65	4	144	384
IMR TW18002	2	1	13	41	186	9	1	N.S.	65	12	163	493
IMR RA5053	2	2	20	55	381	15	2	N.S.	119	15	N.S.	611
WC WC6088	N.S.	18	97	139	492	188	N.S.	3	53	10	236	1236
IMR RA5053	N.S.	7	48	103	123	49	N.S.	1	48	23	12	414

N.S. - no sample received

TABLE II - A

Fouling Residue (in mg) by Brushing

Type & Lot	Bolt Carrier Pin	Firing Pin	Bolt	Carrier Bolt	Receiver Group	Charge Handle	Total Residue
IMR RAD44344	0	3	10	58	53	54	178
IMR TW146	0	3	9	23	16	8	59
WC WC6080	1	1	6	11	19	14	52
WC LC12053	2	2	14	31	21	18	88
WC WC6142	1	1	11	34	13	12	72
WC LC12152	1	3	12	41	19	16	92
IMR RA5048	1	1	9	54	40	20	125
WC RA5270	1	4	17	27	28	8	85
WC WC6147	1	1	16	50	83	28	179
WC WC6083	2	2	17	17	59	27	124
WC RA5281	5	11	30	92	127(wet)	52	317
IMR TW18149	2	11	35	87	55	23	213

APPENDIX "D"

CONNIE RADD'S BRIEFS

LSA'S IT FOR M16A1 RIFLES

M16A1 Riflemen, hear this!

Word's been flashed by the Army Weapons Command that Lubricating Oil, Semi-Fluid, automatic weapons MIL-L-46000A--known as LSA---is the best lube-preservative for your 5.56-MM M16A1 rifle.

Here're the stock numbers for LSA: 4-oz tube, FSN 9150-889-3522; 1-qt can, FSN 9150-687-4241; 1-gal can, FSN 9150-753-4686.

It may be a little scarce to begin with so don't sweat it. Keep on using PL Special (FSN 9150-273-2389...4-oz can) and rifle grease (FSN 9150-754-0063... 1-lb can) until you get your LSA.

Remember this: How good a job your lubricants will do for you depends on how often and how well you clean your rifle and apply these lubes. Here's the system found best by test:

1. Clean your rifle thoroughly after every firing, like the TM requires.

2. Lube the bore and chamber, and the spring in the magazine lightly. Lightly--that means with a clean rag dampened with the lubricant. If you've latched on to some LSA, use it. If not, stick to the PL Special.

3. Lube all other metal parts of your rifle with LSA or PL Special. The working parts should get generous and frequent applications.

4. If you're still using PL Special, don't forget to use rifle grease like it says in the TM. But, after you've switched to LSA, you can forget the rifle grease.

5. No matter what lubes you've got, never use any grease or oil on your ammo or in your magazines. Never!

Incidentally, these instructions don't apply to you arctic-type guys. Stick to your low temperature lubricant (LAW) when firing below zero degrees Fahrenheit.

APPENDIX "E"

SMUFA-Q3000 — Fouling Test Investigation of 5.56MM Ammo/ Weapon System

Dir, ADEL, J1000 — Dir, Qual Assurance Q1000 — 20 Jul 67

REFERENCE: Report of Telecon, Mr. Scott Spaulding, MUCOM and Dr. H.P. Manning, 19 Jul 67, same subject.

1. A summary of the results of the monthly fouling test currently being conducted are as follows:

a. Of 34 samples from each producer, 30 met the thousand round criteria; four failed after the following number of rounds: 636,933, 822, 249. Failure was due to causes identified as being other than ammunition.

2. Status and results of the study to define and improve fouling test are as follows:

a. In order to try to identify the causes for fouling, the residue from these tests have been subjected to chemical analysis with the findings that a small amount of residue consisting of metal oxide contaminants from the bullet, and organic and metal oxide contaminants from the remainder of the round, were found. These are considered normal in firing of ammunition. However, the bulk of the residue was identified as product of breakdown of the weapon lubricant. Consideration should be given to the selection of a lubricant which does not form reaction products and functions at higher temperatures than the material presently in use. Indications are that the type and amount of lubricant and frequency of cleaning of the weapon plays a most significant part in the accumulation of fouling.

b. Action has been taken to reflect the thousand round test for fouling in the powder specification in lieu of the cartridge specification as presently required. It is to be noted that all other bullet type cartridges have a 100 round test requirement for fouling made on the propellant.

JOHN J. CUMMINGS

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