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Final Report
for the
M855A1 Conformance Testing on Commercial Magazines

ATEC Project No: 2014-DT-ATC-M4CAR-F9278
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(b) (6)
Small Arms Systems Division, Firepower Directorate

Report Produced By
The U.S. Army Aberdeen Test Center (ATC)
Aberdeen Proving Ground (APG), MD 21005-5059

Report Produced For
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Picatinny Arsenal, NJ 07806-5000

DEPARTMENT OF THE ARMY
US ARMY ABERDEEN TEST CENTER
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FINAL REPORT
M855A1 Conformance Testing on Commercial Magazines

U.S. ARMY ABERDEEN TEST CENTER
ABERDEEN PROVING GROUND, MD 21005-5059

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None

14. ABSTRACT
The U.S. Army Aberdeen Test Center (ATC), Aberdeen Proving Ground (APG), Maryland, conducted conformance testing of M855A1 ammunition on commercial magazines. Areas of testing were physical inspection of the commercial magazines and endurance testing.

This test report summarizes the test results.

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SECTION 1. EXECUTIVE DIGEST

1.1 SYSTEM DESCRIPTION

a. The M855A1 is the environmentally friendly lead-free, 5.56-mm ball cartridge.

b. The commercial magazines are lightweight, 5.56- x 45-mm, North Atlantic Treaty Organization (NATO) cartridge, 30-round magazine primarily for the M16/M4 platform. Due to request from the customer, magazine vendor codes were assigned to remove the actual commercial names. One weapon per weapon type (M4A1, M16A4 and M27) was assigned a specific commercial vendor or government magazine as provided in Table 1-1. Twelve magazine designs in total were tested, two were government and ten were commercial off the shelf (COTS). Two of the commercial magazine types did not fit into the M27 and could not be used. The M27 has a slightly different magazine well geometry than the M4/M16 and raised side portions of the magazine prevented them from being fully inserted (Fig 1-1).

Figure 1-1. Support weapons; M4A1 (top), M27 (middle), M16A4 (bottom).

TABLE 1-1. MAGAZINE AND WEAPON VENDOR CODES

WEAPON TYPE	WEAPON NO.	WEAPON SN	MAGAZINE NO.	MAGAZINE VENDOR CODE
M4A1	C41-1	10588388	M4-1	Kilo
	C41-2	10588390	M4-2	Lima
	C41-3	10588393	M4-3	Alpha
	C41-4	10588659	M4-4	Bravo
	C41-5	10588660	M4-5	Delta
	C41-6	10588861	M4-6	Hotel
	C41-7	10592419	M4-7	Charlie
	C41-8	W281627	M4-8	Echo
	C41-9	W282305	M4-9	Foxtrot
	C41-10	W499818	M4-10	Golf
	C41-11	W499994	M4-11	India
	C41-12	W937460	M4-12	Juliet
M16A4	T164-1	10514979	M16-1	Kilo
	T164-2	10515097	M16-2	Lima
	T164-3	10515188	M16-3	Alpha
	T164-4	10515213	M16-4	Bravo
	T164-5	10515266	M16-5	Delta
	T164-6	10515284	M16-6	Hotel
	2T164-1	10514979	2M16-1	Charlie
	2T164-2	10515097	2M16-2	Echo
	2T164-3	10515188	2M16-3	Foxtrot
	2T164-4	10515213	2M16-4	Golf
	2T164-5	10515266	2M16-5	India
	2T164-6	10515284	2M16-6	Juliet
M27*	T27-1	172-003750	M27-1	Kilo
	T27-2	172-003777	M27-2	Lima
	T27-3	172-006441	M27-3	Alpha
	T27-4	172-006442	M27-4	Bravo
	T27-5	172-006596	M27-5	Delta
	T27-6	172-006597	M27-6	Hotel
	T27-7	172-006598	M27-7	Charlie
	T27-8	172-006599	M27-8	Echo
	T27-10	172-006603	M27-10	Juliet
	T27-11	172-006605	M27-11	Foxtrot
	T27-12	172-006606	M27-12	Golf
	T27-14	172-006609	M27-14	India

Note - Magazine vendors Golf and India could not be tested in the M27 weapons because they would not physically fit, due to external geometry.

1.2 SUMMARY

a. On 16 December 2013, the U.S. Army Evaluation Center (AEC) issued a Test Execution Directive (app g, ref 1) to the U.S. Army Aberdeen Test Center (ATC), Aberdeen Proving Ground (APG), Maryland to plan, perform, and report the M855A1 Conformance Testing on Commercial Magazines under U.S. Army Test and Evaluation Command (ATEC) Project No. 2014-DT-ATC-M4CAR-F9278.

b. The objective of this test was to study the effect M855A1 ammunition has on commercial magazines.

1.3 INTRODUCTION

a. Where more detailed information is not provided, the following test conditions should be assumed:

(1) Weapons were fired from a test stand, they were not shoulder-fired.

(2) The weapons were lubricated before the start and after each 600 rounds of firing. The weapons were cleaned, inspected, and lubricated (CIL) before the start and after each 1200 rounds of firing. In tests of short duration, the weapons were CIL only before the test. Cleaner, lubricant, and preservative (CLP) conforming to MIL-PRF-63460E (ref 2) was used for all testing.

(3) Key weapon components subjected to high stress underwent initial and final inspection by nondestructive test (NDT) methods. Ferrous metallic weapon components were inspected by the fluorescent magnetic particle wet continuous method. The item was magnetized using direct current (DC), sprayed with a bath consisting of size 14A fluorescent magnetic particles (Magnaflux Corporation) suspended in a petroleum distillate liquid (kerosene), and inspected under black light for patterns indicative of cracks or other defects. This inspection method was performed in accordance with MIL-STD-271F (ref 3), MIL-STD-1949 (ref 4), and U.S. Army Materiel Command Pamphlet (AMCP)-702-10 (ref 5).

(4) Nonferrous metallic weapon components were inspected using the liquid penetrant method. A type ZL-22 fluorescent penetrant, a type ZE-3 emulsifier solution, a warm water spray wash, and type ZP-9 developer were used. The test items were inspected under black light for fluorescent penetrant bleed-out patterns indicative of cracks or other surface defects. This method was performed in accordance with MIL-STD-271F (Group V Material), MIL-I-6866B (ref 6) (Type I, Test Method B), and AMCP-702-10.

(5) Generally, parts were not replaced solely because they appeared to exhibit wear, cracks, or chipping in noncritical areas, unless there was a possibility of a safety hazard or other catastrophic weapon failure. Once a functional failure occurred that was attributable to such a part, or a broken part was discovered during scheduled maintenance (CIL), the part was replaced. Therefore, during each scheduled maintenance period, each test sample was disassembled. There was no scheduled parts replacement during the test. Each time a part was replaced in a weapon, a complete history was obtained, including the part name and number, reason for replacement, description of functional failure mode, and total number of rounds fired from the weapon and the part.

b. Incidents were divided into six classes in accordance with the following definitions:

(1) Class I/Essential Function Failure (EFF). Clearable stoppages that could be cleared by the weapon operator within 10 sec.

(2) Class II/EFF. Operator correctable stoppages that could not be cleared by the operator within 10 sec, but could be corrected at the operator level using only equipment immediately available to the operator.

(3) Class III/EFF. System failure that was not correctable at the operator level and required a higher level of maintenance.

(4) Dependent Failures (DF). A failure event that occurred as a result of a specified primary (prior) event or caused by (directly attributed to) another "primary" failure.

(5) Nonessential Function Failure (NEFF). A failure event that rendered the weapon system incapable of performing one or more nonessential functions, but which did not adversely/significantly impact on the ability to perform an essential function.

(6) Ammunition Induced Malfunction. A malfunction/stoppage that was confirmed (through evaluation/analysis) as having been caused by (i.e., induced by) the ammunition.

c. Throughout this report the term "magazine" refers to the plastic or metallic container that holds the reserve cartridges in the weapon and presents each cartridge in turn to the operating mechanism to be fed, chambered, and fired. Standard capacity for the M4A1 is a 30-round magazine.

SECTION 2. SUBTESTS

2.1 PHYSICAL INSPECTION OF MAGAZINES

2.1.1 Objective

The objective of this test was to document the physical characteristics and appearance of the test items and to provide a set of baseline measurement data on the test items.

2.1.2 Criteria Compliance and Analysis

None. This test was performed to document technical performance.

2.1.3 Test Procedures and Findings

a. Upon receipt, the vendor magazines were visually inspected. Each was assigned a unique ATC identification number as provided in Table 1-1. Deficiencies were documented in Test incident Reports (TIRs) (TIR index, Appendix B). The following physical inspections were performed on each vendor's magazines.

(1) Capacity. All magazines were loaded to full capacity.

(2) Fit and Retention.

(a) All empty magazines were inserted into M4A1/M16A4/M27 lower receiver. Each magazine was verified that it fit into the lower receiver and could not be removed without activating the magazine release button.

(b) All fully loaded magazines were inserted into M4A1/M16A4/M27 lower receiver. Each magazine was verified that it fit into the lower receiver and could not be removed without activating the magazine release button.

(3) Weight. All empty magazines were weighed and recorded in ounces. The results are provided in Table 2.1-1.

(4) Spring Force. Only magazines that were fired during the Endurance test (para 2.2), plus two replacement magazines per vendor were measured for spring force. They were marked: A, B, C, D, E and F. E and F were the possible replacement magazines.

(a) For loading, the magazines were held in an upright, vertical position. Dummy bullets (5.56-mm) were loaded into the magazine by using an Instron force gauge (ATC Physical test Laboratory). The peak readings were recorded every 5th bullet. The loading is shown in Figure 2.1-1. The results are provided in Appendix C.

(b) For unloading, the magazines were held horizontal with bullet point down. An Instron force gauge with an extension rod was used to push bullets out of the magazine. The peak readings were recorded every 5th bullet. Unloading is shown in Figure 2.1-2. The results are provided in Appendix C.

TABLE 2.1-1. MAGAZINE WEIGHTS, OZ

WEAPON TYPE	WEAPON NO.	MAGAZINE WEIGHTS						MAGAZINE VENDOR CODE
		A	B	C	D	E	F	
M4A1	C41-1	4.31	4.28	4.26	4.34	4.32	4.30	Kilo
	C41-2	4.21	4.22	4.23	4.24	4.25	4.25	Lima
	C41-3	8.46	8.45	8.47	8.43	8.44	8.47	Alpha
	C41-4	3.86	3.86	3.87	3.85	3.86	3.86	Bravo
	C41-5	8.90	8.96	8.89	8.91	8.85	8.94	Delta
	C41-6	3.93	3.93	3.93	3.93	3.94	3.93	Hotel
	C41-7	5.41	5.41	5.42	5.43	5.42	5.42	Charlie
	C41-8	4.46	4.44	4.44	4.44	4.46	4.44	Echo
	C41-9	4.94	4.99	4.98	4.98	4.97	4.93	Foxtrot
	C41-10	4.34	4.32	4.35	4.34	4.34	4.35	Golf
	C41-11	4.98	4.98	4.97	4.98	4.98	4.97	India
	C41-12	4.37	4.34	4.36	4.35	4.30	4.34	Juliet
M16A4	T164-1	4.31	4.29	4.28	4.31	4.3	4.31	Kilo
	T164-2	4.22	4.24	4.23	4.24	4.23	4.23	Lima
	T164-3	8.46	8.44	8.44	8.44	8.47	8.42	Alpha
	T164-4	3.83	3.86	3.85	3.85	3.86	3.86	Bravo
	T164-5	8.89	8.95	8.91	8.94	8.93	8.96	Delta
	T164-6	3.95	3.95	3.93	3.94	3.93	3.94	Hotel
	2T164-1	5.41	5.4	5.41	5.42	5.41	5.42	Charlie
	2T164-2	4.46	4.46	4.44	4.44	4.44	4.46	Echo
	2T164-3	4.98	4.99	4.92	4.99	4.95	4.96	Foxtrot
	2T164-4	4.33	4.35	4.32	4.33	4.33	4.35	Golf
	2T164-5	4.98	4.97	4.98	4.98	4.98	4.98	India
	2T164-6	4.32	4.35	4.31	4.34	4.35	4.35	Juliet
M27	T27-1	4.26	4.27	4.36	4.26	4.33	4.3	Kilo
	T27-2	4.22	4.24	4.22	4.24	4.23	4.22	Lima
	T27-3	8.44	8.42	8.45	8.46	8.45	8.47	Alpha
	T27-4	3.86	3.87	3.88	3.86	3.84	3.86	Bravo
	T27-5	8.91	8.89	8.88	8.92	8.92	8.95	Delta
	T27-6	3.94	3.94	3.94	3.94	3.92	3.93	Hotel
	T27-7	5.42	5.41	5.41	5.41	5.41	5.41	Charlie
	T27-8	4.46	4.44	4.44	4.46	4.44	4.45	Echo
	T27-10	4.3	4.29	4.28	4.28	4.28	4.32	Juliet
	T27-11	4.93	4.97	4.96	4.98	4.95	4.94	Foxtrot
	T27-12	4.33	4.34	4.35	4.33	4.34	4.35	Golf
	T27-14	4.98	4.98	4.97	4.98	4.97	4.98	India

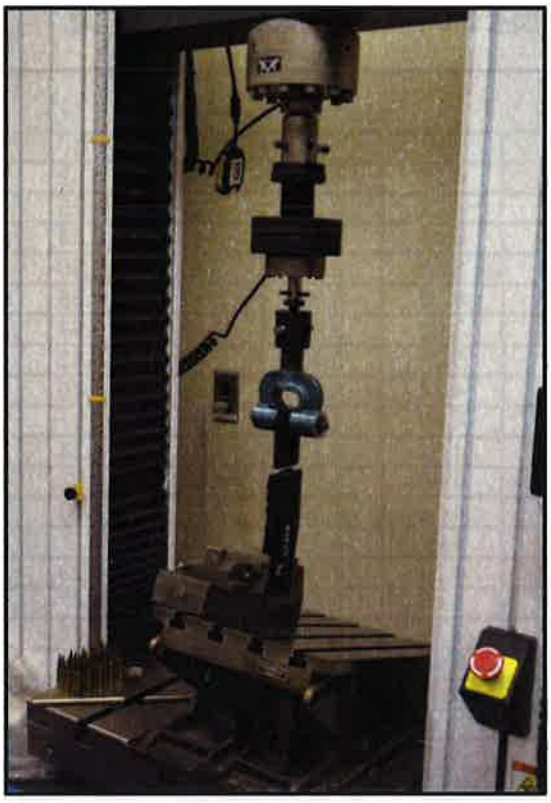


Figure 2.1-1. Magazine being loaded by an Instron machine.

Figure 2.1-2. Magazine being unloaded by an Instron machine.

(5) One magazine from each vendor underwent Computed Tomography (CT) X-ray scanning. Magazines were CT X-ray scanned in 5-round increments from 0 to 30 rounds for a total of seven scans per magazine (using dummy bullets). These CT X-ray scans display magazine follower position throughout the loading process. The CT X-ray scans results are provided in Appendix D. An example of a CT X-ray of a standard magazine is shown in Figure 2.1-3.

Figure 2.1-3. CT X-ray standard magazine.

b. An initial inspection of the support weapons (M4A1/M16A4/M27) was performed. The physical weights and measurements are provided in Tables 2.1-2 through 2.1-5.

c. An NDT inspection was performed and the results are provided in Appendix A.

TABLE 2.1-2. INITIAL MEASUREMENTS, M4A1

WEAPON NO.	FIRING PIN INDENT			FIRING PIN PROTRUSION	BARREL EROSION	HEADSPACE	DRIVE SPRING	HAMMER PIN	TRIGGER PIN	TRIGGER PULL, lb			AIR FLOW, psi
	in.												
C41-1	0.024	0.023	0.024	0.033	13/32	1.4676	10.5	0.155	0.155	7.0	7.0	7.5	2.7
C41-2	0.023	0.021	0.021	0.032	13/32	1.4666	10.8	0.155	0.155	7.0	7.0	7.0	2.7
C41-3	0.021	0.021	0.021	0.031	13/32	1.4666	10.8	0.155	0.155	7.5	7.5	7.0	2.6
C41-4	0.023	0.023	0.022	0.030	13/32	1.4666	10.8	0.155	0.155	7.5	7.5	7.5	2.7
C41-5	0.021	0.022	0.021	0.033	13/32	1.4676	10.6	0.155	0.155	7.5	7.5	7.0	2.7
C41-6	0.022	0.021	0.021	0.033	13/32	1.4646T	10.7	0.155	0.155	6.5	6.5	7.0	2.6
C41-7	0.022	0.022	0.022	0.028	13/32	1.4666	10.5	0.155	0.156	7.0	7.0	7.5	2.7
C41-8	0.023	0.021	0.022	0.031	13/32	1.4656	10.5	0.157	0.156	7.0	6.5	6.5	2.6
C41-9	0.024	0.024	0.023	0.033	13/32	1.4676	10.6	0.156	0.156	7.5	7.5	7.0	2.6
C41-10	0.022	0.022	0.022	0.033	13/32	1.4676	10.4	0.156	0.156	7.0	7.0	7.0	2.6
C41-11	0.024	0.022	0.022	0.030	13/32	1.4666	10.7	0.156	0.156	6.5	7.0	7.0	2.6
C41-12	0.022	0.023	0.024	0.030	13/32	1.4646	10.7	0.156	0.156	7.0	7.0	7.0	2.6

TABLE 2.1-3. INITIAL GAS KEY LEAKAGE, M4A1

WEAPON NUMBER	GAS KEY LEAKAGE
C41-1	Medium steady left and right front
C41-2	Small occasional left and right front
C41-3	Medium steady left and right front
C41-4	Medium steady left front
C41-5	No leaks
C41-6	Small steady left and right front
C41-7	Large steady left and right front
C41-8	Large steady left and right front
C41-9	Small occasional right front
C41-10	Large steady left front
C41-11	Medium steady left and right front
C41-12	Small steady left front

TABLE 2.1-4. INITIAL MEASUREMENTS, M16A4

WEAPON NO.	FIRING PIN INDENT			FIRING PIN PROTRUSION	BARREL EROSION	HEADSPACE	DRIVE SPRING	HAMMER PIN	TRIGGER PIN	TRIGGER PULL, lb			AIR FLOW, psi
	in.												
T164-1	0.025	0.024	0.024	0.031	13/32	1.4646T	12.6	0.156	0.156	6.0	6.0	6.0	1.7
T164-2	0.022	0.023	0.023	0.030	13/32	1.4646T	12.2	0.156	0.156	5.5	5.5	5.5	1.7
T164-3	0.024	0.024	0.024	0.031	13/32	1.4646	12.3	0.156	0.157	7.0	6.5	6.5	1.7
T164-4	0.022	0.022	0.023	0.029	13/32	1.4646T	12.1	0.156	0.156	7.0	6.5	7.0	1.7
T164-5	0.024	0.024	0.024	0.031	13/32	1.4666	12.3	0.156	0.156	6.0	6.0	5.5	1.7
T164-6	0.023	0.021	0.021	0.030	13/32	1.4656	12.2	0.156	0.156	7.0	6.5	7.0	1.7

TABLE 2.1-5. INITIAL MEASUREMENTS, M27

WEAPON NO.	FIRING PIN INDENT			FIRING PIN PROTRUSION	BARREL EROSION STD	BARREL EROSION H&K	HEADSPACE	DRIVE SPRING	HAMMER PIN	TRIGGER PIN	TRIGGER PULL, lb		
	in.												
T27-1	0.019	0.020	0.019	0.037	-7/32	11/32	1.4646T	11.7	0.156	0.156	6.0	6.0	6.0
T27-2	0.017	0.017	0.018	0.038	-1/32	12/32	1.4646T	11.7	0.157	0.157	6.0	6.0	6.0
T27-3	0.017	0.018	0.018	0.038	-7/32	11/32	1.4646T	11.4	0.156	0.156	6.0	6.0	6.0
T27-4	0.017	0.018	0.018	0.038	-8/32	11/32	1.4646T	11.5	0.156	0.156	6.0	6.0	6.0
T27-5	0.017	0.018	0.017	0.038	-9/32	8/32	1.4646T	11.3	0.157	0.157	6.0	6.0	6.0
T27-6	00.17	0.017	0.018	0.038	-8/32	12/32	1.4646T	11.3	0.156	0.157	6.0	6.0	6.0
T27-7	0.017	0.017	0.017	0.038	-7/32	11/32	1.4646T	11.2	0.156	0.156	6.0	6.0	6.0
T27-8	0.018	0.018	0.018	0.038	-8/32	11/32	1.4646T	11.3	0.156	0.156	6.0	6.0	6.0
T27-10	0.018	0.018	0.018	0.038	-8/32	12/32	1.4646T	11.4	0.156	0.156	6.5	6.5	6.0
T27-11	0.017	0.018	00.18	0.039	-8/32	11/32	1.4646T	11.5	0.157	0.157	6.0	6.0	6.0
T27-12	00.18	0.018	00.18	0.038	-6/32	12/32	1.4646T	11.5	0.156	0.156	6.0	6.0	6.0
T27-14	0.017	0.019	0.018	0.039	-9/32	9/32	1.4646T	11.4	0.157	0.156	6.0	6.0	6.0

2.2 ENDURANCE

2.2.1 Objective

The objective of this test was to determine the functional reliability of the commercial magazines using M855A1 ammunition.

2.2.2 Criteria Compliance and Analysis

None. This test was performed to document technical performance.

2.2.3 Test Procedures and Findings

a. Testing was performed in accordance with Test Operations Procedure (TOP) 3-2-045 (ref 7). Testing was as follows:

(1) Four loaded magazines per vendor were fired using a M4A1 Carbine (one weapon per vendor). When a magazine failed, it was replaced by another magazine from same vendor. Each magazine was reloaded and repeated until 2,400 rounds were fired per magazine for a total of 9,600 rounds per weapon per vendor. Two magazines were replaced on weapon C41-10 (Table 2.2-2). The weapon identification is provided in Table 2.2-1.

(2) Four loaded magazines per vendor were fired using a M16A4 Rifle (two vendors per weapon). When a magazine failed, it was replaced by another magazine from same vendor. Each magazine was reloaded and repeated until 300 rounds were fired per magazine for a total of 1,200 rounds per vendor. No magazines were replaced. The weapon identification is provided in Table 2.2-1.

(3) Four loaded magazines per vendor were fired using a M27 (one weapon per vendor). When a magazine failed, it was replaced by another magazine from same vendor. Each magazine was reloaded and repeated until 2,400 rounds were fired per magazine for a total of 9,600 rounds per weapon per vendor. Four magazines were replaced on weapons T27-2, T27-4, and T27-7 (Table 2.2-2). The weapon identification is provided in Table 2.2-1.

TABLE 2.2-1. WEAPON IDENTIFICATION

	WEAPON TYPES AND IDENTIFICATIONS		
VENDOR	M4A1	M16A4	M27
Alpha	C41-3	T164-3	T27-3
Bravo	C41-4	T164-4	T27-4
Charlie	C41-7	2T164-1	T27-7
Delta	C41-5	T164-5	T27-5
Echo	C41-8	2T164-2	T27-8
Foxtrot	C41-9	2T164-3	T27-11
Golf	C41-10	2T164-4	None
Hotel	C41-6	T164-6	T27-6
India	C41-11	2T164-5	None
Juliet	C41-12	2T164-6	T27-10
Kilo	C41-1	T164-1	T27-1
Lima	C41-2	T164-2	T27-2

TABLE 2.2-2. MAGAZINE REPLACEMENT

WEAPON TYPE	VENDOR (WEAPON NO.)	MAGAZINE NO.	TEST ROUND	
			MAGAZINE	WEAPON
M4A1	Golf (C41-10)	B replaced with B-1	1,470	5,820
	Golf (C41-10)	C replaced with C-1	1,800	7,170
M27	Bravo (T27-4)	B replaced with B-1	1,560	6,180
	Bravo (T27-4)	C replaced with C-1	2,010	8,010
	Charlie (T27-7)	C replaced with C-1	1,230	4,890
	Lima (T27-2)	D replaced with D-1	1,530	6,090

(4) The weapons were wipe and lubricated after every 600 rounds. After every 1,200 rounds, the weapons had a full cleaning.

(5) Cyclic rate-of-fire (ROF) was recorded using the last magazine of each weapon during the first cycle after each 1,200 round maintenance procedure. The results are provided in the TIRs.

(6) Functional measurements were repeated at 1,200-round scheduled maintenance intervals. Measurements included, but were not limited to, headspace, firing pin protrusion, and bore erosion. The results are provided in Appendix A, Tables A-2-2-1 through A-2.2-6.

b. Malfunction incidents that occurred during reliability and durability testing were assessed as to cause and possible corrective action. Incidents related to the weapons or magazines were assigned a chargeability of hardware/government furnished equipment (GFE). Incidents related to ammunition were assigned a chargeability of support equipment/GFE. Preliminary classifications of all malfunctions were recorded at the test site, reviewed and preliminary scored by ATC personnel. All incidents were reviewed and officially scored against the failure definition/scoring criteria (FD/SC) (ref 8). Summaries of all incidents that occurred during testing by incident classification are provided in Tables 2.2-3 through 2.2-5 and shown in Figures 2.2-1 through 2.2-3. Malfunctions were divided into six classes in accordance with the following definitions:

(1) Class I/EFF. Clearable stoppages that could be cleared by the weapon operator within 10 sec.

(2) Class II/EFF. Operator correctable stoppages that could not be cleared by the operator within 10 sec, but could be corrected at the operator level using only equipment immediately available to the operator. No class II/EFF stoppages occurred during this reliability testing.

(3) Class III/EFF. System failure that was not correctable at the operator level and required a higher level of maintenance.

(4) DF. A failure event that occurred as a result of a specified primary (prior) event or caused by (directly attributed to) another "primary" failure. These incidents were not used in any calculations.

(5) NEFF. A failure event that rendered the weapon system incapable of performing one or more nonessential functions, but which did not adversely/significantly impact on the ability to perform an essential function. These incidents were not used in any calculations.

(6) Ammunition Induced Malfunction. A malfunction/stoppage that was confirmed (through evaluation/analysis) as having been caused by (i.e., induced by) the ammunition. These incidents were not used in any calculations.

c. Summaries of failure modes for all weapons firing M855A1 ammunition are provided in Tables A-2.2-7 through A-2.2-11 and are shown in Figures A-2.2-1 through A-2.2-5. Detailed test data of weapon stoppages/failures and part breakages by round count are available from ATC upon request. Note: No class III/EFFs occurred on any of the M16A4 weapons.

d. During firing, all malfunction charge types were recorded and remarks were documented where additional explanation was required. The reliability related stoppages and failure events are provided in Tables A-2.2-12 through A-2.2-14. The TIRs are provided in Appendix B.

TABLE 2.2-3. SUMMARY OF INCIDENT CLASSIFICATION FOR M4A1 WEAPONS

FD/SC SCORE	VENDOR/WEAPON NO.											
	ALPHA (C41-3)	BRAVO (C41-4)	CHARLIE (C41-7)	DELTA (C41-5)	ECHO (C41-8)	FOXTROT (C41-9)	GOLF (C41-10)	HOTEL (C41-6)	INDIA (C41-11)	JULIET (C41-12)	KILO (C41-1)	LIMA (C41-2)
AMMUNITION												
Class I/EFF	-	-	-	-	-	-	1	-	-	-	-	-
MAGAZINE												
Class I/EFF	-	8	5	-	-	-	23	1	16	-	-	-
Class III/EFF	-	-	-	-	-	-	2	-	-	-	-	-
Dependent Malfunction	-	-	-	-	-	-	3	-	-	-	-	-
WEAPON												
Class I/EFF	-	-	3	1	-	-	-	-	-	-	-	3
Class III/EFF	1	1	1	-	1	1	-	1	2	1	1	-
Dependent Malfunction	1	1	1	1	1	1	-	3	1	1	1	1
NEFF	1	-	-	-	-	-	-	-	-	-	-	-
SYSTEM												
Class I/EFF	1	-	-	-	-	-	-	-	-	-	-	-
OVERALL												
Class I/EFF	1	8	8	1	-	-	24	1	16	-	-	3
Class III/EFF	1	1	1	-	1	1	2	1	2	1	1	-
Dependent Malfunction	1	1	1	1	1	1	3	3	1	1	1	1
NEFF	1	-	-	-	-	-	-	-	-	-	-	-
Overall	4	10	10	2	2	2	29	5	19	2	2	4

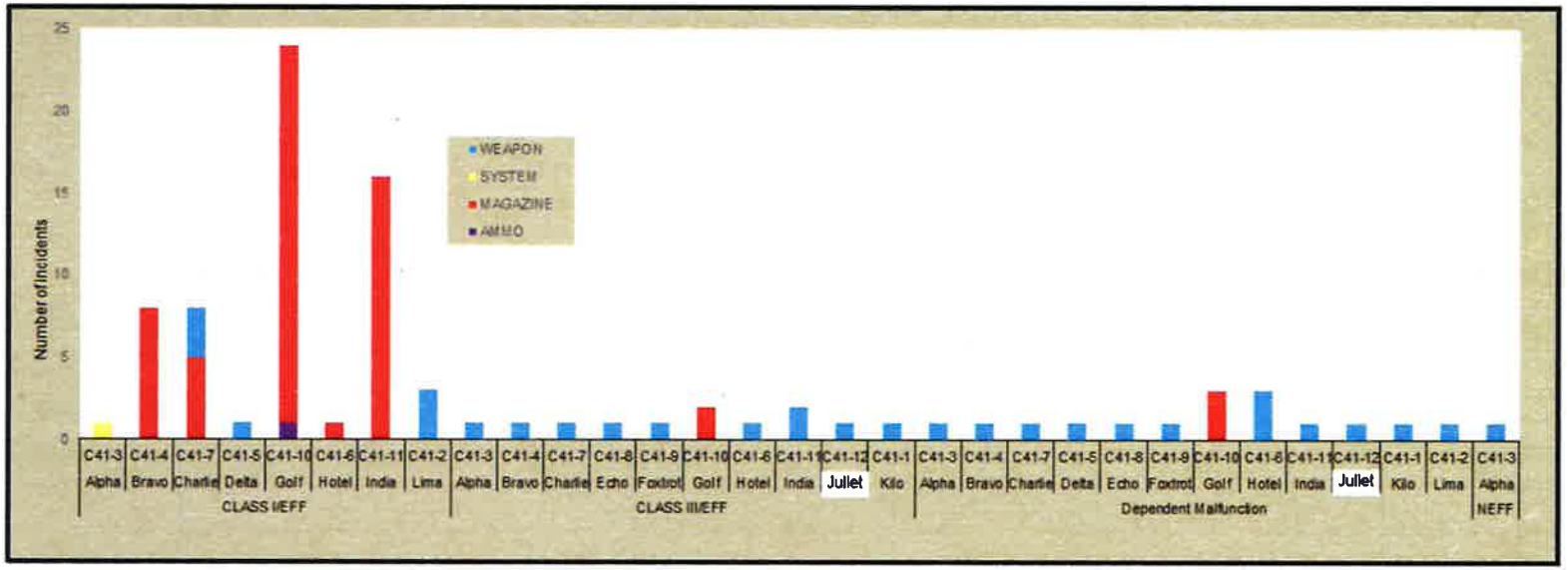


Figure 2.2-1. Summary of incident classification for M4A1 weapons.

TABLE 2.2-4. SUMMARY OF INCIDENT CLASSIFICATION FOR M16A4 WEAPONS

FD/SC SCORE	VENDOR/WEAPON NO.											
	ALPHA (T164-3)	BRAVO (T164-4)	CHARLIE (2T164-1)	DELTA (T164-5)	ECHO (2T164-2)	FOXTROT (2T164-3)	GOLF (2T164-4)	HOTEL (T164-6)	INDIA (2T164-5)	JULIET (2T164-6)	KILO (T164-1)	LIMA (T164-2)
MAGAZINE												
Class I/EFF	-	-	-	-	-	-	1	1	1	-	-	-
WEAPON												
Class I/EFF	-	2	-	-	-	-	1	-	-	-	-	1
Dependent Malfunction	-	-	-	-	-	-	1	-	-	-	-	-
OVERALL												
Class I/EFF	-	2	-	-	-	-	2	1	1	-	-	1
Dependent Malfunction	-	-	-	-	-	-	1	-	-	-	-	-
Overall	-	2	-	-	-	-	3	1	1	-	-	1

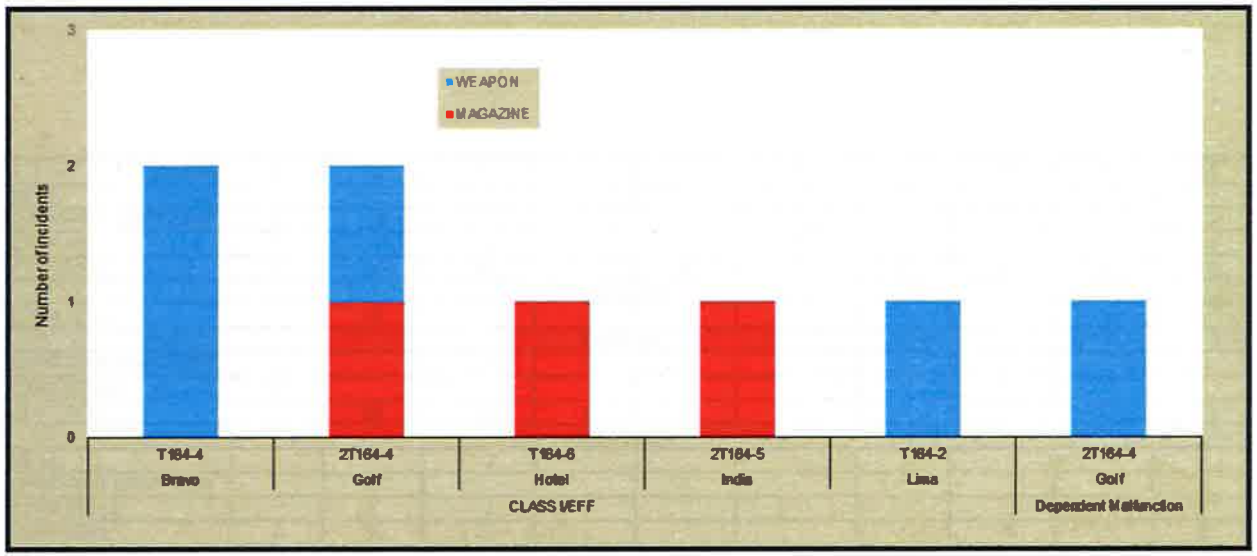


Figure 2.2-2. Summary of incident classification for M16A4 weapons.

TABLE 2.2-5. SUMMARY OF INCIDENT CLASSIFICATION FOR M27 WEAPONS

FD/SC SCORE	VENDOR/WEAPON NO.									
	ALPHA (T27-3)	BRAVO (T27-4)	CHARLIE (T27-7)	DELTA (T27-5)	ECHO (T27-8)	FOXTROT (T27-9)	HOTEL (T27-6)	JULIET (T27-10)	KILO (T27-1)	LIMA (T27-2)
AMMUNITION										
Class I/EFF	-	-	-	-	-	1	-	3	-	1
MAGAZINE										
Class I/EFF	1	26	17	-	-	-	-	4	-	4
Class III/EFF	-	2	1	-	-	-	-	-	-	1
Dependent Malfunction	-	8	-	-	-	-	-	-	-	3
NEFF	-	-	1	-	-	-	-	-	-	-
WEAPON										
Class I/EFF	2	30	30	1	1	1	1	7	6	8
Class III/EFF	1	-	1	-	-	1	-	-	-	-
Dependent Malfunction	1	-	1	-	-	1	-	-	-	-
SYSTEM										
Class I/EFF	-	13	-	-	-	-	-	1	-	-
OVERALL										
Class I/EFF	3	69	47	1	1	2	1	15[b]	6	13
Class III/EFF	1	2	2	-	-	1	-	-	-	1
Dependent Malfunction	1	8	1	-	-	1	-	-	-	3
NEFF	-	-	1	-	-	-	-	-	-	-
Overall	5	79	51	1	1	4	1	15	6	17

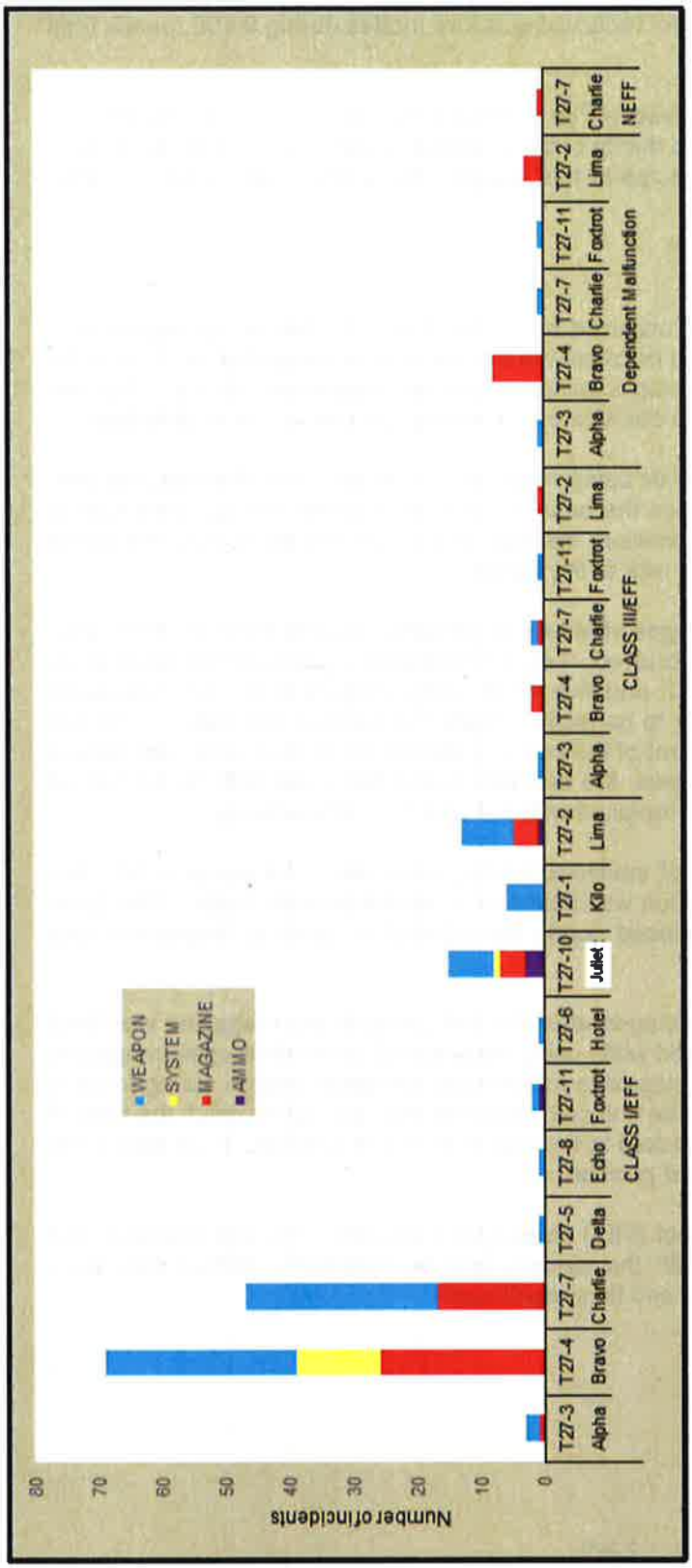


Figure 2.2-3. Summary of incident classification for M27 weapons.

e. An analysis of the M4A1 significant reoccurring failure modes during 9,600 rounds fired was as follows:

(1) Vendor Bravo. Eight failure-to-feed (FFD) stoppages occurred. The magazine was feeding low into the weapon, which caused the tip of the projectile to get caught on the feed ramp in the upper receiver. Note: The feed ramps in this weapon show more wear than any other magazine vendor across M4A1 weapons.

(2) Vendor Charlie.

(a) Three stoppages of double feed occurred on rounds 1 and 2 while using magazine A. In one incidence, the double feed occurred because the top round was presented too high in the magazine due to the magazine experiencing significant feed lip separation. In the other two incidents, the rounds were replaced due to damage on the casing caused by the double feed.

(b) Four FFD stoppages occurred while using magazine D. In all cases, the bolt was over the base of the cartridge. The bolt overrode the base of the cartridge and damaged the side of the cartridge case due to being pinched between the lugs of the bolt and the lugs of the barrel extension. The round was stubbed on the rear of the barrel.

(3) Vendor Golf. Twenty five stoppages of failure of the bolt to lock to the rear (FBR) after the last round in the magazine was fired occurred. Ten of these stoppages occurred while using magazine B, ten while using magazine C, and five while using magazine D. The magazine follower did not apply enough spring force to correctly actuate the weapon bolt catch. The bolt catch was not high enough to catch the front of the bolt and did not allow the bolt to stay locked to the rear in the open position. In all cases, the bolt was pulled back manually to the locked position. Note: Magazines B and C were replaced with B-1 and C-1, respectively.

(4) Vendor Hotel. Three incidents of inadvertent firing occurred. The weapon fired two rounds with one trigger pull while the weapon was selected to semi-automatic mode. This issue was resolved when the hammer was replaced during the scheduled cleaning, inspection, and lubrication.

(5) Vendor India. Sixteen FBR stoppages after the last round in the magazine was fired occurred. One of these stoppages occurred while using magazine B, nine while using magazine C, and six while using magazine D. The magazine follower did not apply enough spring force to correctly actuate the weapon bolt catch. The bolt catch was not high enough to catch the front of the bolt and did not allow the bolt to stay locked to the rear in the open position. In all cases, the bolt was pulled back manually to the locked position.

(6) Vendor Lima. Two failure-to-eject (FEJ) stoppages occurred. The bolt extractor and ejector were visually inspected along with the springs and no noticeable deficiencies were observed. The weapon was reassembled and firing continued.

f. No significant reoccurring failure modes occurred on the M16A4 weapons during 1,200 rounds fired.

g. An analysis of the M27 significant reoccurring failure modes during 9,600 rounds fired are as follows:

(1) Vendor Bravo. Out of the 69 stoppages scored as class I/EFF, 68 were FFD stoppages. Thirteen of these stoppages occurred while using magazine A, 18 while using magazine B, 16 while using magazine C, and 14 while using magazine D. Two and five additional stoppages occurred on the replaced magazines B and C, respectively. It should be noted that 70-percent of the FFDs occurred on magazine rounds 23, 25, 27, and 29 (47 out of 68) fired from a fully loaded magazine. In all cases, the bolt was over the base of the cartridge. The bolt overrode the base of the cartridge and damaged the side of the cartridge case due to being pinched between the lugs of the bolt and the lugs of the barrel extension. The round was stubbed on the rear of the barrel.

(2) Vendor Charlie. Out of the 47 stoppages scored as class I/EFF, 42 were FFD stoppages. Ten of these stoppages occurred while using magazine A, ten while using magazine B, ten while using magazine C, and seven while using magazine D. Five additional stoppages occurred on the replaced magazine C. It should be noted that 57-percent of the FFDs occurred on magazine rounds 2, 3, and 4 (24 out of 42) fired from a fully loaded magazine. In all cases, the bolt was over the base of the cartridge. The bolt overrode the base of the cartridge and damaged the side of the cartridge case due to being pinched between the lugs of the bolt and the lugs of the barrel extension. The round was stubbed on the rear of the barrel.

(3) Vendor Juliet. Out of the 15 stoppages scored as class I/EFF, 10 were FFD stoppages. Three of these stoppages occurred while using magazine A, three while using magazine B, two while using magazine C, and two while using magazine D. In all cases, the bolt was over the base of the cartridge. The bolt overrode the base of the cartridge and damaged the side of the cartridge case due to being pinched between the lugs of the bolt and the lugs of the barrel extension. The round was stubbed on the rear of the barrel.

(4) Vendor Lima. Out of the 13 stoppages scored as class I/EFF, 12 were FFD stoppages. Seven of these stoppages occurred while using magazine D. Two additional stoppages occurred on the replaced magazine D. In all cases, the bolt was over the base of the cartridge. The bolt overrode the base of the cartridge and damaged the side of the cartridge case due to being pinched between the lugs of the bolt and the lugs of the barrel extension. The round was stubbed on the rear of the barrel.

h. A total of 19 parts were replaced during endurance testing. The parts replacement data along with the test rounds when the parts failed for the M4A1 and M27 weapons are provided in Tables 2.2-4 and 2.2-5. Note: No parts were replaced for the M16A4 weapons. All parts replaced for the M4A1 and M27 weapons were scored as class III/EFF failures.

TABLE 2.2-4. PARTS REPLACEMENT DATA FOR THE M4A1 WEAPONS

SEQUENCE NO.	VENDOR	WEAPON NO.	TEST ROUND	PART NOMENCLATURE/ NO.	REASON FOR REPLACEMENT
1971	Alpha	C41-3	7,360	Bolt assembly (P/N 13004787)	One of the bolt lugs was sheared off of the bolt.
2281	Bravo	C41-4	8,760		
1708	Charlie	C41-7	6,914		
1722	Echo	C41-8	6,922		
2355	Foxtrot	C41-9	9,351		
1769	India	C41-11	7,152		
2393	Juliet	C41-12	9,480		
2242	Kilo	C41-1	8,678		
2308	Hotel	C41-6	8,400	Hammer (P/N 8448612)	To correct a double firing issue
869	India	C41-11	3,000	Sear Assembly (P/N 8448595)	The spring in the sear assembly was noted deformed and displaced
1450	Golf	C41-10	5,820	Magazine B (P/N Unknown)	Due to multiple failures of the bolt to lock to the rear when using magazine B.
1754	Golf	C41-10	7,170	Magazine C (P/N Unknown)	Due to the multiple failures of the bolt to lock to the rear when using magazine C.

TABLE 2.2-5. PARTS REPLACEMENT DATA FOR THE M27 WEAPONS

SEQUENCE NO.	VENDOR	WEAPON NO.	TEST ROUND	PART NOMENCLATURE/ NO.	REASON FOR REPLACEMENT
2134	Alpha	T27-3	7,936	Bolt assembly (P/N 233672)	One of the bolt lugs was sheared off of the bolt.
2526	Charlie	T27-7	9,316		
2469	Foxtrot	T27-11	8,706		
1831	Bravo	T27-4	6,180	Magazine B (P/N 04120067)	Due to multiple FFD stoppages that occurred due to the bolt being over the base of the cartridge.
2157	Bravo	T27-4	8,010	Magazine C (P/N 04120067)	Due to multiple FFD stoppages that occurred due to the bolt being over the base of the cartridge.
1567	Charlie	T27-7	4,890	Magazine C (P/N Unknown)	Due to multiple bolt over base stoppages and the feed lip separation being measured at .500 inches when fully loaded.
1797	Lima	T27-2	6,090	Magazine D (P/N 13021312)	Due to multiple FFD stoppages that occurred due to the bolt being over the base of the cartridge.

i. Reliability estimates provided are based on rounds fired on each magazine during reliability testing. Statistical comparisons between the magazines for each individual weapon/vendor were made to determine if differences existed between the mean rounds between stoppage (MRBS) for class I/EFF stoppages at the 10-percent significance level. For M4A1

weapons, test results indicated differences between the individual magazines provided by vendors Charlie, Golf, and India. The same statistical tests were conducted for class III/EFF failures and no differences were detected. For M16A4 weapons, test results indicated no statistical differences. For M27 weapons, test results indicated differences between the individual magazines provided by vendors Bravo, Charlie, and Lima. A summary of the results from the statistical comparisons is as follows:

(1) M4A1 weapons.

(a) Vendor Charlie. Test results indicated statistical differences between the four magazines in terms of MRBS for class I/EFF stoppages. Magazines A and D were found to be from the same population and statistically worse than magazines B and C. Differences could not be linked to a specific failure mode. See paragraph 2.2.3 e.(2) for more information. Although statistical differences existed, the results were combined for information purposes only. The same statistical tests were made for class III/EFF failures and no differences were detected. A scatter plot of all failure modes is shown in Figure 2.2-4.

(b) Vendor Golf. Test results indicated statistical differences between the four magazines in terms of MRBS for class I/EFF stoppages. Magazines B, C, and D were found to be from the same population and statistically worse than magazine A. Magazines B and C were later replaced with magazines B-1 and C-1, respectively. FBR was the single contributor to the statistical differences. See paragraph 2.2.3 e.(3) for more information. Although statistical differences existed, the results were combined for information purposes only. The same statistical tests were made for class III/EFF failures and no differences were detected. A scatter plot of all failure modes is shown in Figure 2.2-4.

(c) Vendor India. Test results indicated statistical differences between the four magazines in terms of MRBS for class I/EFF stoppages. Magazines C and D were found to be from the same population and statistically worse than the magazines A and B. FBR was the single contributor to the statistical differences. See paragraph 2.2.3 e.(5) for more information. Although statistical differences existed, the results were combined for information purposes only. The same statistical tests were made for class III/EFF failures and no differences were detected. A scatter plot of all failure modes is shown in Figure 2.2-4.

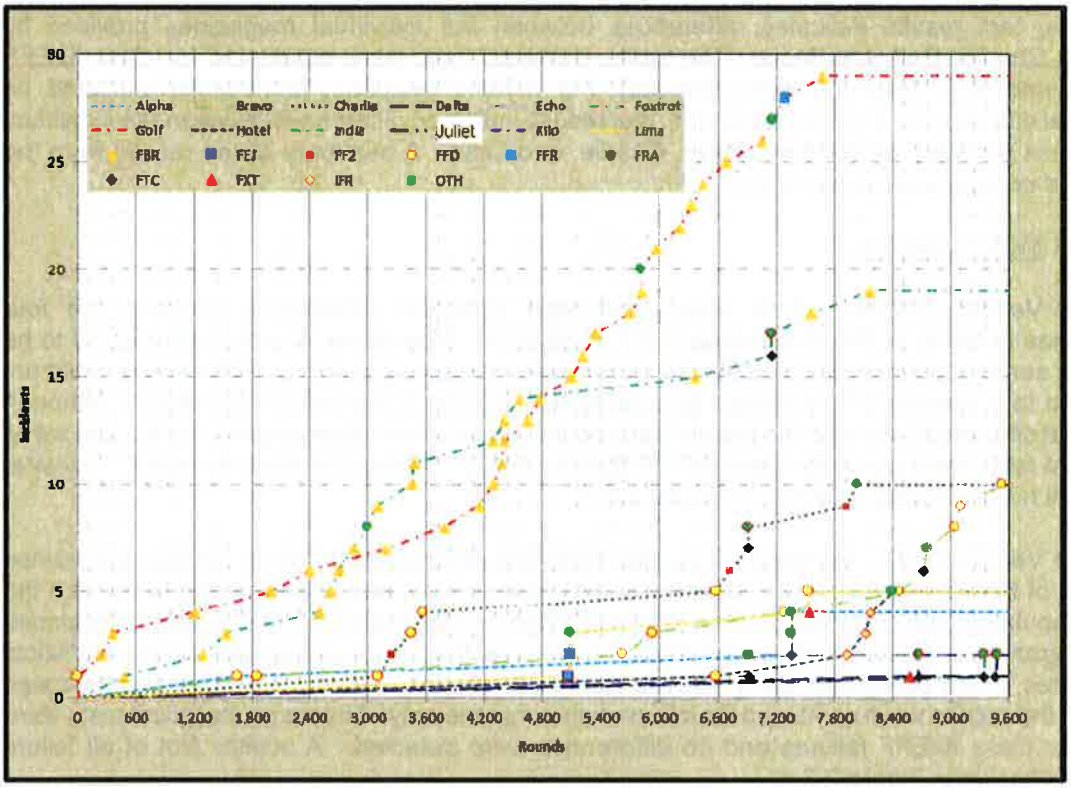


Figure 2.2-4. Hardware/GFE related incidents for M4A1 weapons.

(2) M27 Weapons.

(a) Vendor Bravo. Test results indicated statistical differences between the four magazines in terms of MRBS for magazine related class I/EFF stoppages only. Magazines A and D were found to be from the same population and statistically worse than the remaining magazines. FFD was the single contributor to the statistical differences. See paragraph 2.2.3 g.(1) for more information. Although statistical differences existed, the results were combined for information purposes only. The same statistical tests were made for class III/EFF failures and no differences were detected. A scatter plot of all failure modes is shown in Figure 2.2-5.

(b) Vendor Charlie. Test results indicated statistical differences between the four magazines in terms of MRBS for system related class I/EFF stoppages only. Magazine C was found to be statistically worse than the remaining magazines. FFD was the single contributor to the statistical differences. See paragraph 2.2.3 g.(2) for more information. Although statistical differences existed, the results were combined for information purposes only. The same statistical tests were made for class III/EFF failures and no differences were detected. A scatter plot of all failure modes is shown in Figure 2.2-5.

(c) Vendor Lima. Test results indicated statistical differences between the four magazines in terms of MRBS for system related class I/EFF stoppages only. Magazine D was found to be statistically worse than the remaining magazines. FFD was the single contributor to the statistical differences. See paragraph 2.2.3 g.(4) for more information. Although statistical differences

existed, the results were combined for information purposes only. The same statistical tests were made for class III/EFF failures and no differences were detected. A scatter plot of all failure modes is shown in Figure 2.2-5.

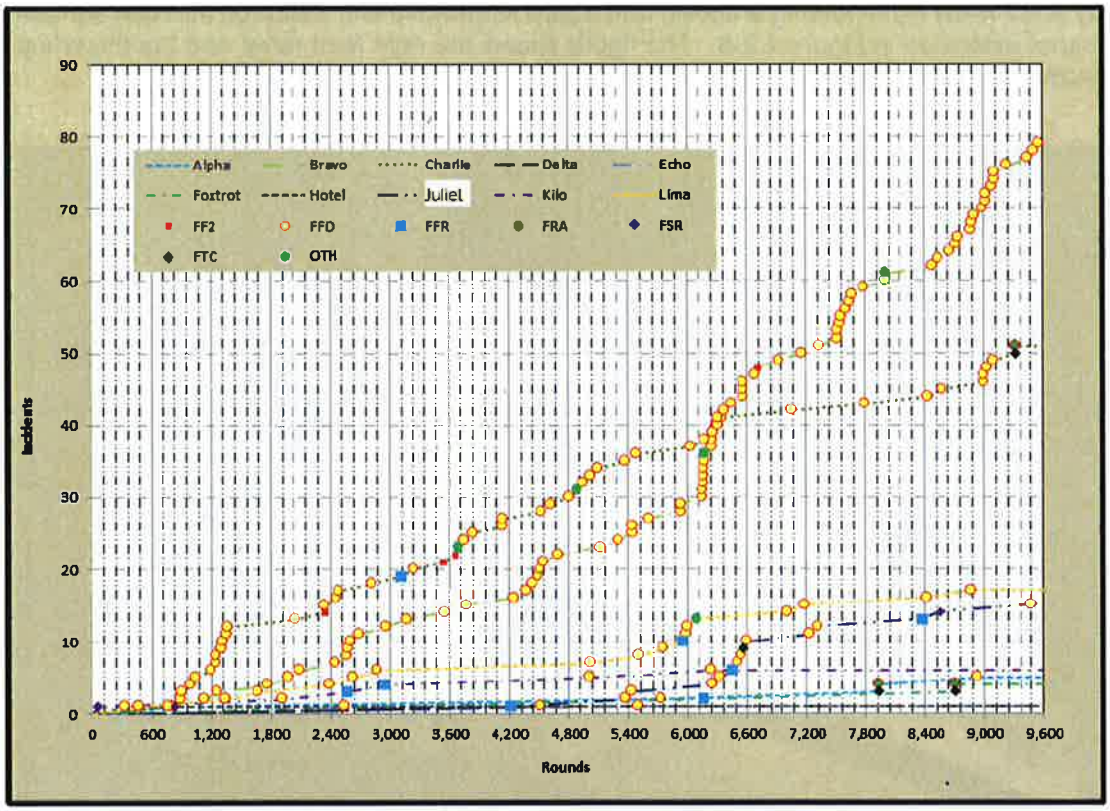


Figure 2.2-5. Hardware/GFE related incidents for M27 weapons.

g. The point estimate (PE) and 80- and 90-percent lower confidence limits (LCLs) for class I/EFF MRBS and class III/EFF MRBF for each magazine and overall were calculated and presented in Tables A-2.2-15 through A-2.2-20. The 80-percent LCL for each weapon type is illustrated in Figures A-2.2-6 through A-2.2-11. TOP 1-1-030 (ref 9) was used as a guide for all reliability calculations. It was assumed that the number of rounds between stoppages/failures was an exponentially distributed random variable.

h. Bravo and Charlie had a higher stoppage rate than the other magazine vendors, as shown in Figures 2.2-4 and 2.2-5.

(1) The Bravo magazine was feeding too low, which caused wear (beyond all other tested magazine types) on the feed ramp portion of the aluminum upper receiver. One visual indicator that should be noticed is that marks left on the rear of the barrel from the M855A1 penetrator are directly related to how many FFD bolt over base (BOB) stoppages that specific weapon incurred. The increased hardness of the M855A1 exposed steel penetrator compared to copper jacketed

M855 makes this possible. The other interesting visual queue is that the angular placement of these marks differs between different magazine vendor types. This is also influenced by other geometries due to the differing weapon types. The wear on the rear of the barrel, unlike feed ramp wear, does not noticeably contribute to stoppages, it is more of a visual diagnostic tool.

(2) A CT X-ray file rendering is shown with a slice lengthwise and a slice on the back surface of the barrel extension in Figure 2.2-6. The figure shows the right feed ramp and the threading that attaches the barrel extension to the barrel.

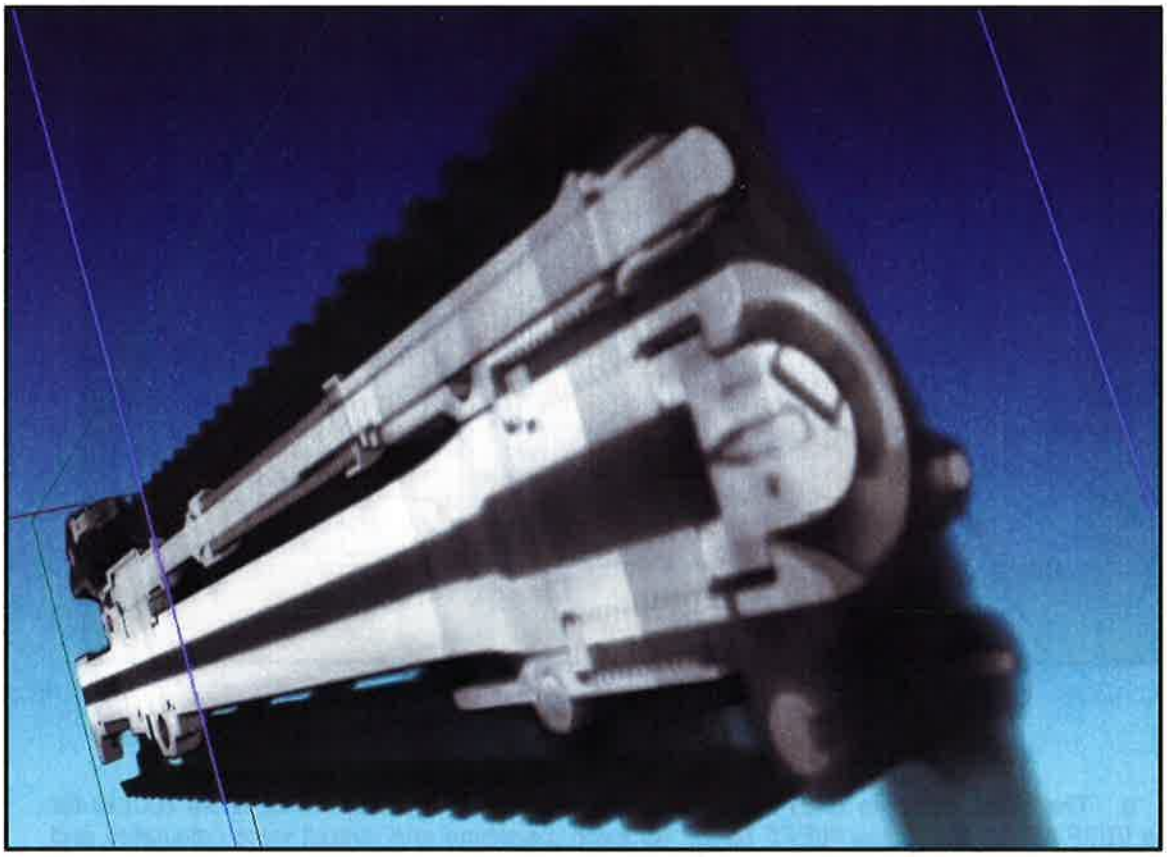


Figure 2.2-6. CT X-ray file, barrel extension.

(3) The M4A1 weapon C41-4 was used with vendor Bravo magazines. The pre- and post-test areas of the rear of the barrel and the feed ramps are shown in Figure 2.2-7. Two focal planes at the same position had to be taken to show the rear of the barrel and the feed ramps in focus.

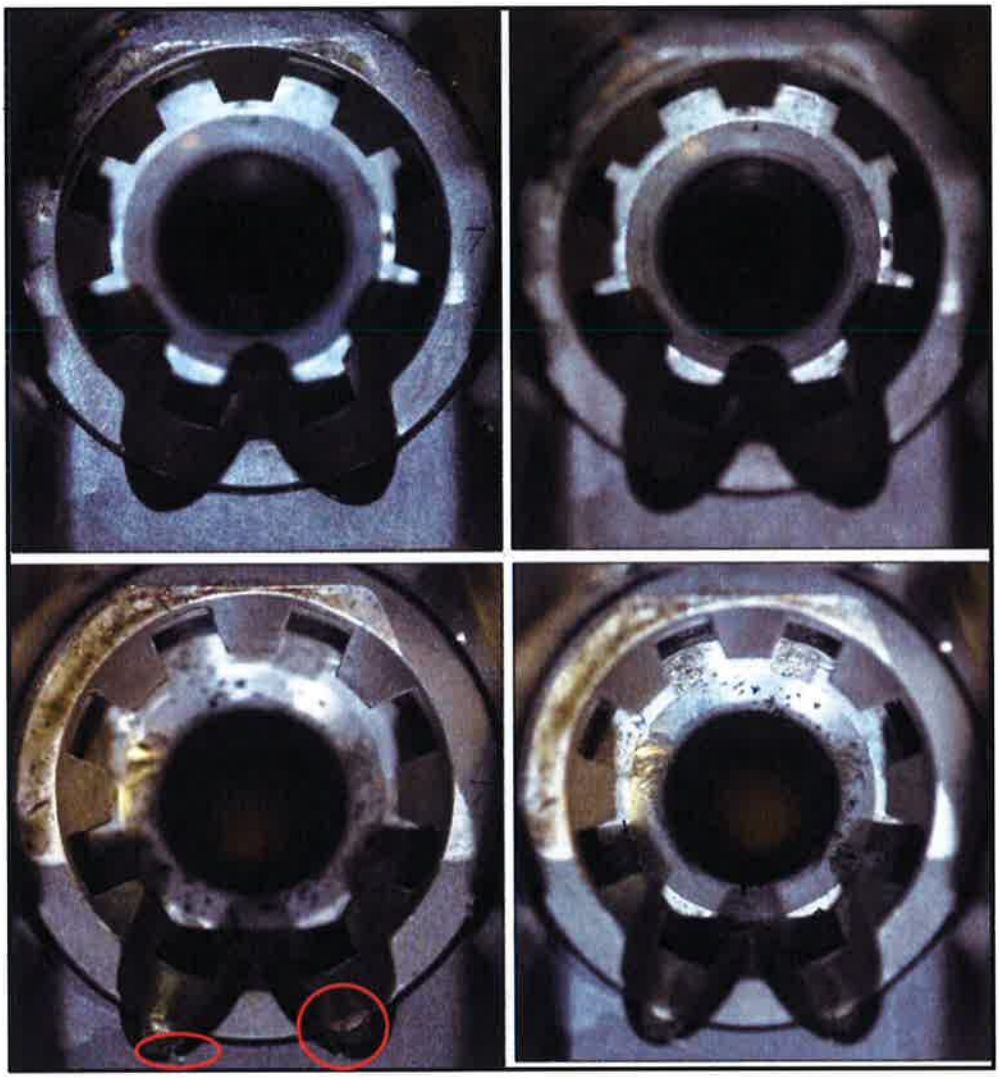


Figure 2.2-7. Pre- and post-test areas of the rear of the barrel and the feed ramps, M4A1 weapon C41-4.

(a) The feed ramps and rear of barrel before test (top) and after 9,600 rounds (bottom) of M4A1 weapon C41-4 firing M855A1 using vendor Bravo magazine. The lower left of the figure displays the wear on the feed ramps which leads to feeding malfunctions. This weapon showed the most amount of wear during the test for all of the weapons fired in the test.

(b) The difference of the feed ramp wear measurements of weapon C41-4 pre and post 9,600 rounds with vendor Bravo magazines is shown in Figure 2.2-8. This was the highest wear measurement in this area for all weapons tested.

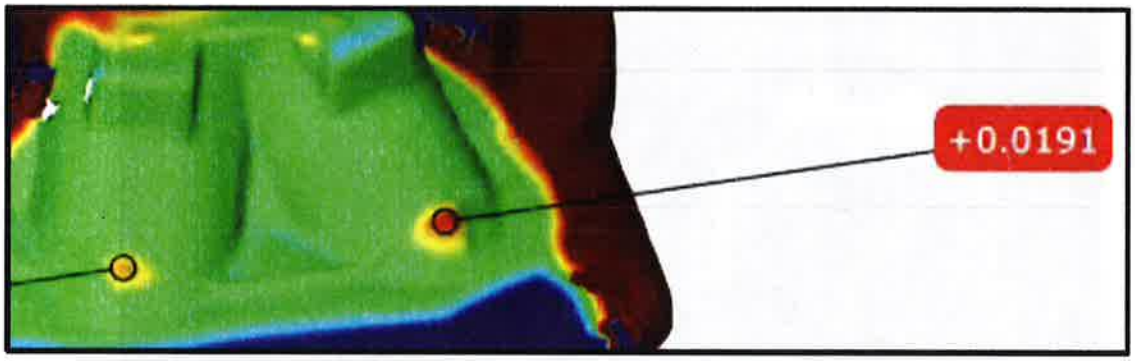


Figure 2.2-8. Weapon C41-4 feed ramp wear pre- and post-9,600 rounds with vendor Bravo magazines.

(c) The difference of the feed ramp wear measurements of all the weapons pre- and post-9,600 rounds is provided in Table 2.2-6. The measurements were taken by casting the feed ramp area with a casting metal and then laser scanning the casting. The scans were then properly aligned and the maximum difference calculated via software. The laser scans are provided in Appendix F.

TABLE 2.2-6. FEED RAMP WEAR MEASUREMENTS

WEAPON TYPE	WEAPON NO.	FEED RAMP WEAR, in.		MAGAZINE VENDOR
		LEFT	RIGHT	
M4A1	C41-1	0.0074	0.0068	Kilo
	C41-2	0.0032	0.0011	Lima
	C41-3	0.0011	0.0001	Alpha
	C41-4	0.0191	0.0138	Bravo
	C41-5	0.0062	0.0074	Delta
	C41-6	0.0134	0.0185	Hotel
	C41-7	0.0043	0.0042	Charlie
	C41-8	0.0016	0.0063	Echo
	C41-9	0.0029	0.0017	Foxtrot
	C41-10	0.0075	0.0118	Golf
	C41-11	0.0021	0.0039	India
	C41-12	0.0035	0.0018	Juliet
M16A4	T164-1	0.0073	0.0080	Kilo
	T164-2	0.0089	0.0066	Lima
	T164-3	0.0003	0.0014	Alpha
	T164-4	0.0151	0.0090	Bravo
	T164-5	0.0099	0.0065	Delta
	T164-6	0.0081	0.0097	Hotel

TABLE 2.2-6 (Cont)

WEAPON TYPE	WEAPON NO.	FEED RAMP WEAR, in.		MAGAZINE VENDOR
		LEFT	RIGHT	
M27	T27-1	0.0059	0.0097	Kilo
	T27-2	NA	NA	Lima
	T27-3	0.0063	0.0008	Alpha
	T27-4	0.0168	0.0077	Bravo
	T27-5	0.0051	0.0056	Delta
	T27-6	0.0029	0.0053	Hotel
	T27-7	0.0145	0.0105	Charlie
	T27-8	0.0021	0.0017	Echo
	T27-10	0.0012	0.0023	Foxtrot
	T27-11	0.0011	0.0016	Juliet

(4) The M27 weapon T27-4 was used with vendor Bravo magazines. The pre- and post-test areas of the rear of the barrel and the feed ramps are shown in Figure 2.2-9. Two focal planes at the same position had to be taken to show the rear of the barrel and the feed ramps in focus.

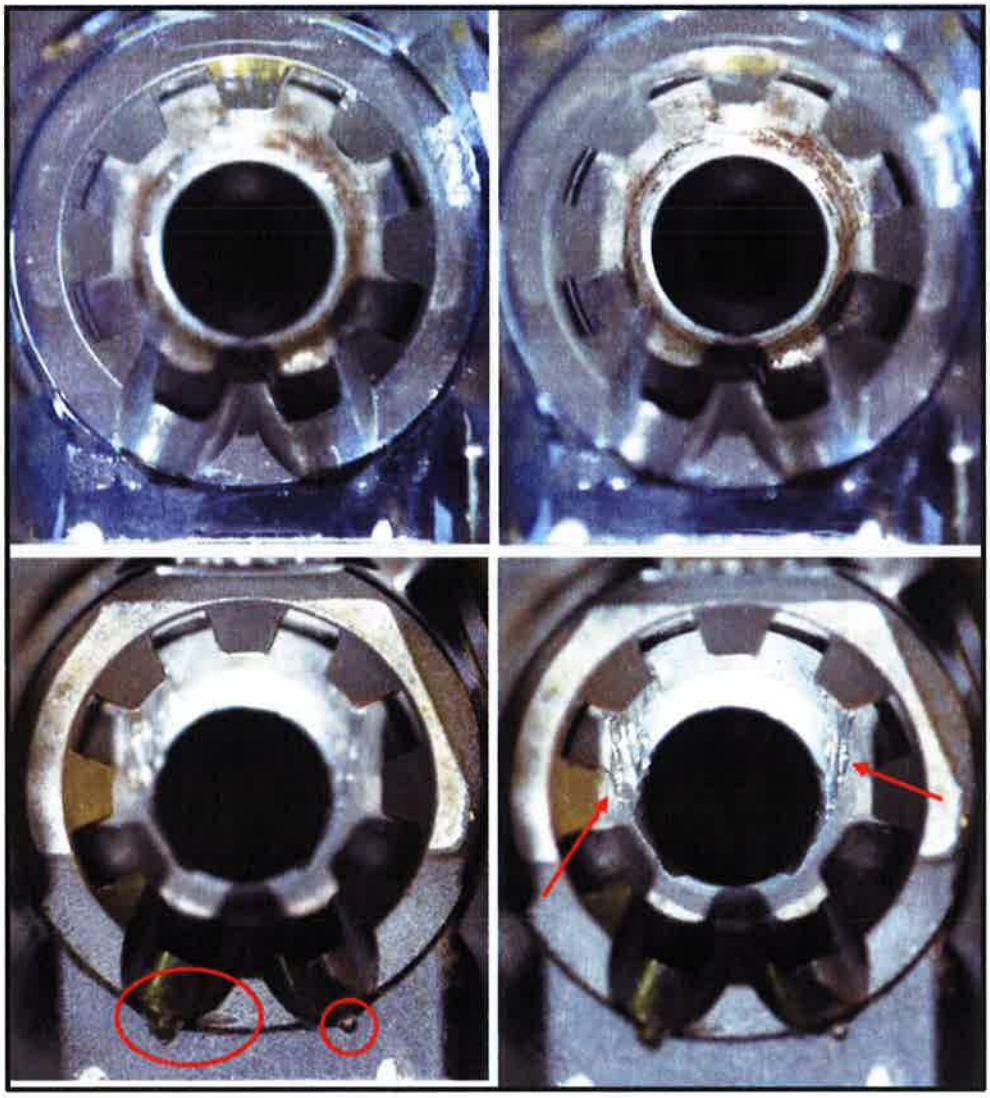


Figure 2.2-9. Pre- and post-test areas of the rear of the barrel and the feed ramps, M27 weapon T27-4.

(a) The feed ramps and rear of the barrel before test (top) and after 9,600 rounds (bottom) of M27 weapon T27-4 firing M855A1 using vendor Bravo magazine. The lower left of the figure displays the wear on the feed ramps which leads to feeding malfunctions. This weapon showed the most amount of wear during the test for all of the M27 weapons fired.

(b) The difference of the feed ramp wear measurements of weapon T27-4 pre- and post-9,600 rounds with vendor Bravo magazines is shown in Figure 2.2-10. This was the highest wear measurement in this area for M27 weapons.

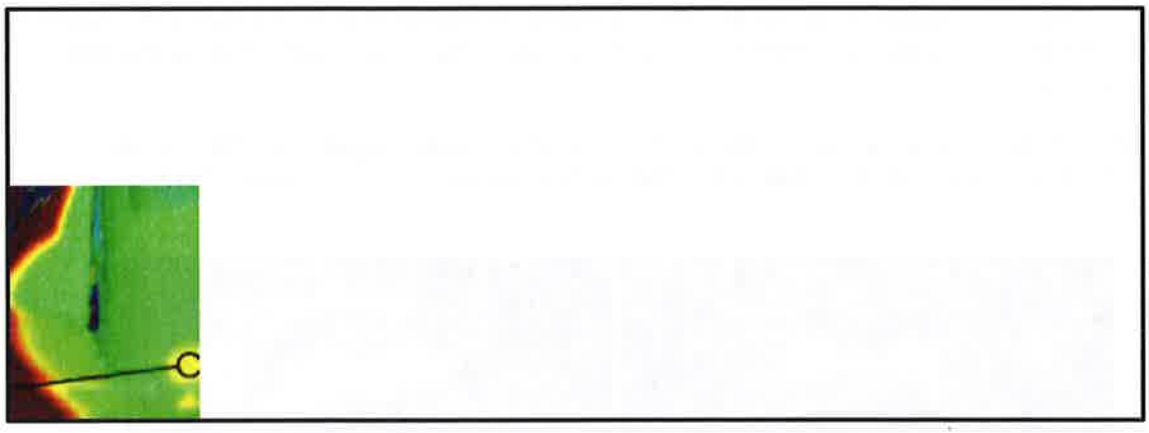


Figure 2.2-10. Weapon T27-4 feed ramp wear pre- and post-9,600 rounds with vendor Bravo magazines.

(5) The polymer used in the construction of the vendor Charlie magazine relaxed and caused high feed lip separation at the top of the magazine. The sides of the magazine body bowed outward. The increased feed lip separation presented the cartridges too high and led to increased FFD stoppages. In Figure 2.2-11, the arrows point to areas of the magazine body that are bending outward, these sides should be straight and parallel. Since the sides of the magazine have bent outward this causes increased feed lip separation (red line). When feed lip separation is too high it causes the cartridge to be presented too high, the top cartridge should be lower.

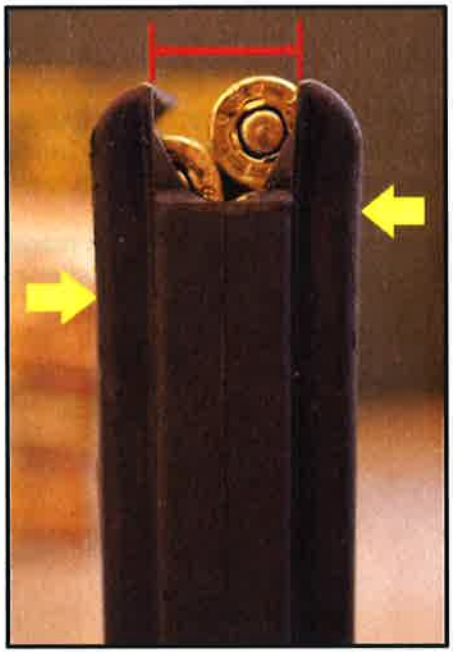


Figure 2.2-11. Vendor Charlie magazine.

(a) Due to the magazine issues this led to a higher amount of wear on the rear of the barrel, but the projectile tip was presented high enough to not present as much wear as the Bravo magazine vendor.

(b) The M4A1 weapon C41-7 was used with vendor Charlie magazines. The pre- and post-test areas of the rear of the barrel and the feed ramps are shown in Figure 2.2-12.

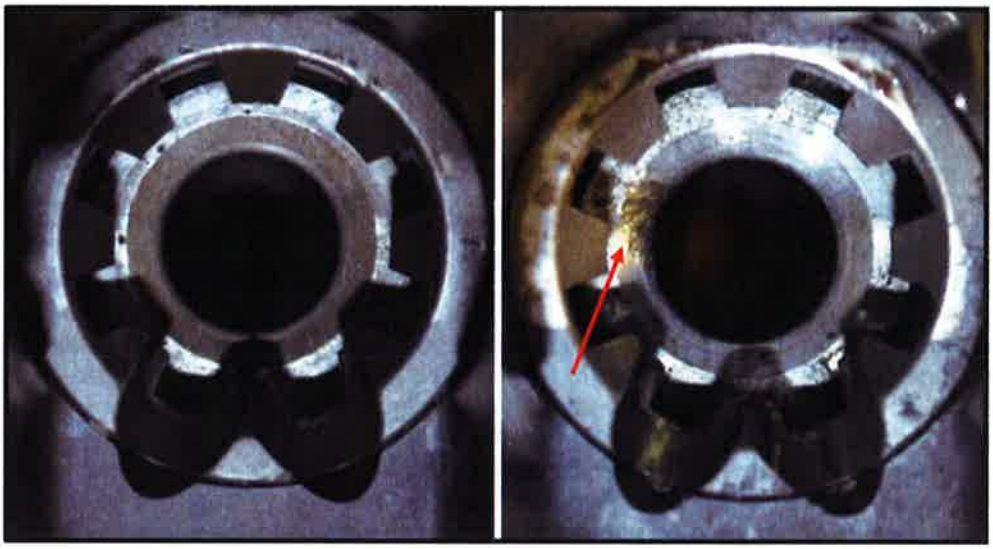


Figure 2.2-12. Pre- and post-test areas of the rear of the barrel and the feed ramps, M4A1 weapon C41-7.

(c) The feed ramps and rear of barrel before test (left) and after 9,600 rounds (right) of M4A1 weapon C41-7 firing M855A1 using magazine vendor Charlie. The right of the figure displays the wear patterns on the rear of the barrel.

(d) The M27 weapon T27-7 was used with vendor Charlie magazines. The pre- and post-test areas of the rear of the barrel and the feed ramps are shown in Figure 2.2-13.

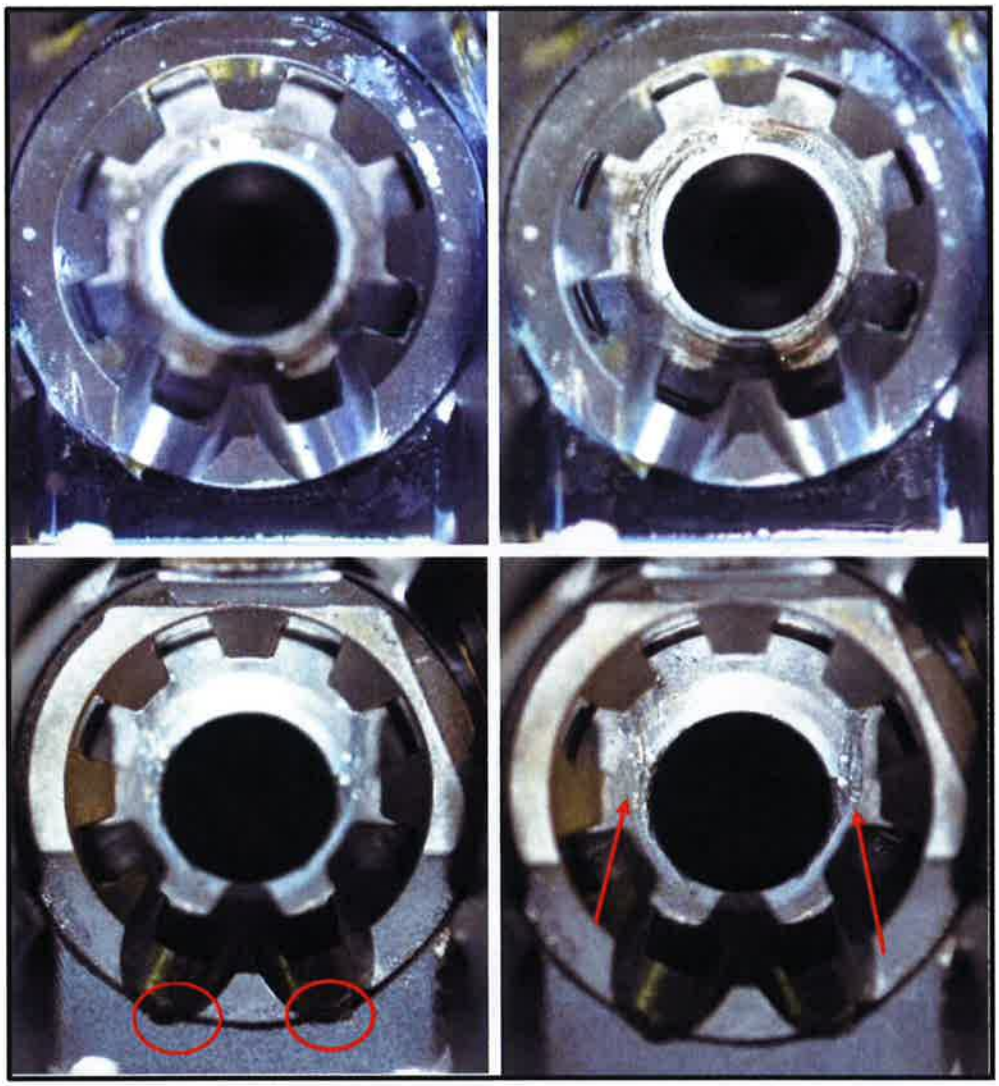


Figure 2.2-13. Pre- and post-test areas of the rear of the barrel and the feed ramps, M27 weapon T27-7.

(e) The feed ramps and rear of barrel before test (top, left to right) and after 9,600 rounds (bottom left to right) of M27 weapon T27-7 firing M855A1 using magazine vendor Charlie. The lower left of the figure displays the wear on the feed ramps which leads to feeding malfunctions.

i. At the other end of the performance spectrum, vendor Foxtrot, M4A1 weapon C41-9 and M27 weapon T27-11 made it through the test without a FFD BOB stoppage, no other magazine vendor that was tested on all weapon groups did this. The rear of the barrel after 9,600 rounds had no noticeable wear on the M4A1 or M27 weapon. This means the projectile was closer to the center of the bore when loading versus any other magazine vendor. The lack of visual wear and low feed ramp wear (Table 2.2-6) also shows that the tip of the projectile was high enough to not contact the aluminum upper receiver, which significantly reduces feed ramp wear and in turn stoppages. Contrast this with vendor Bravo, with very high feed ramp wear.

(1) The M27 is more sensitive to the projectile tip deviating from the bore during loading since the (b) of the M27 barrel (b) (3) (A) that the M4A1 barrel has. This allows the projectile tip to reach the center of the bore even if the projectile tip is not inside the bore during the loading operation. This is shown in Figure 2.2-14.

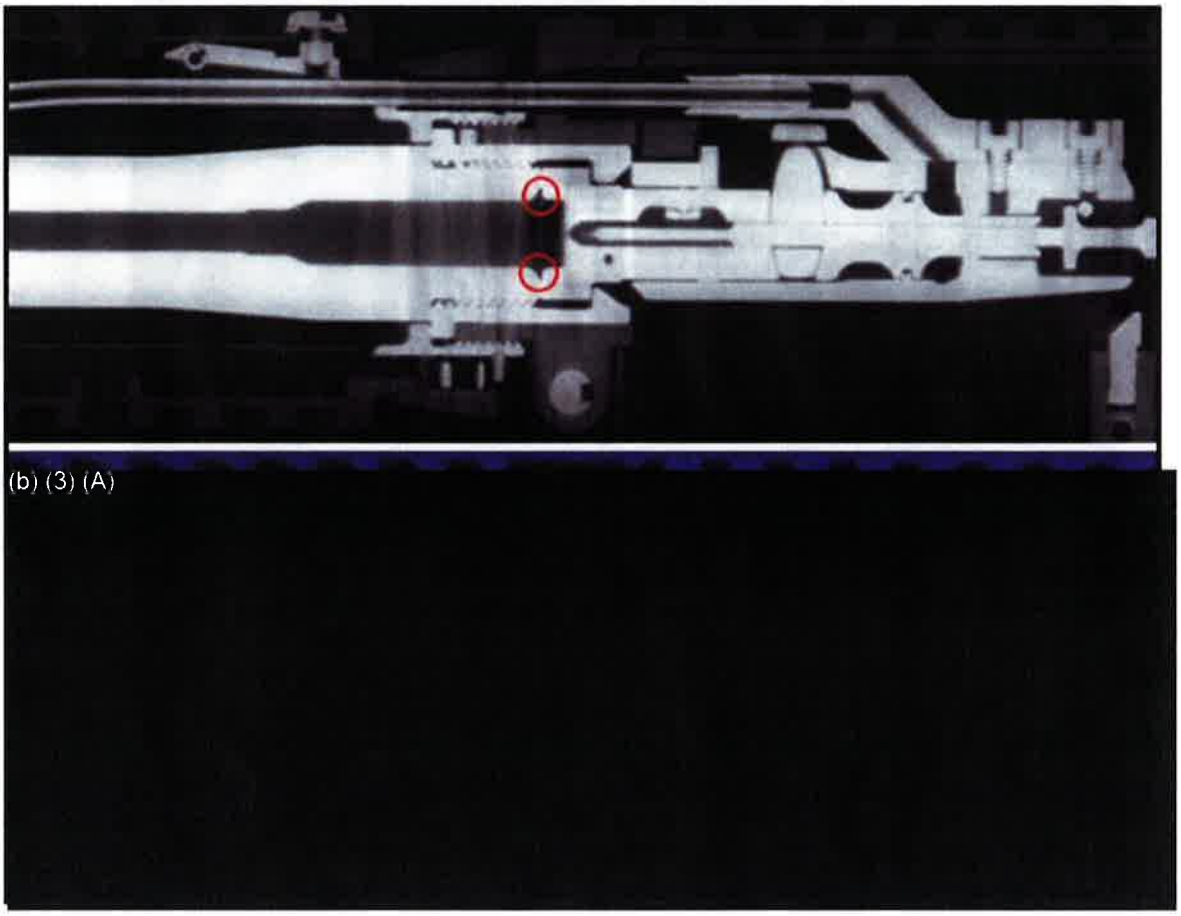


Figure 2.2-14. M4A1 barrel (top) versus M27 barrel (bottom).

(2) The feed ramps and rear of barrel before test (top, left to right) and after 9,600 rounds (bottom left to right) of M4A1 weapon C41-9 firing M855A1 using magazine vendor Foxtrot are shown in Figure 2.2-15.

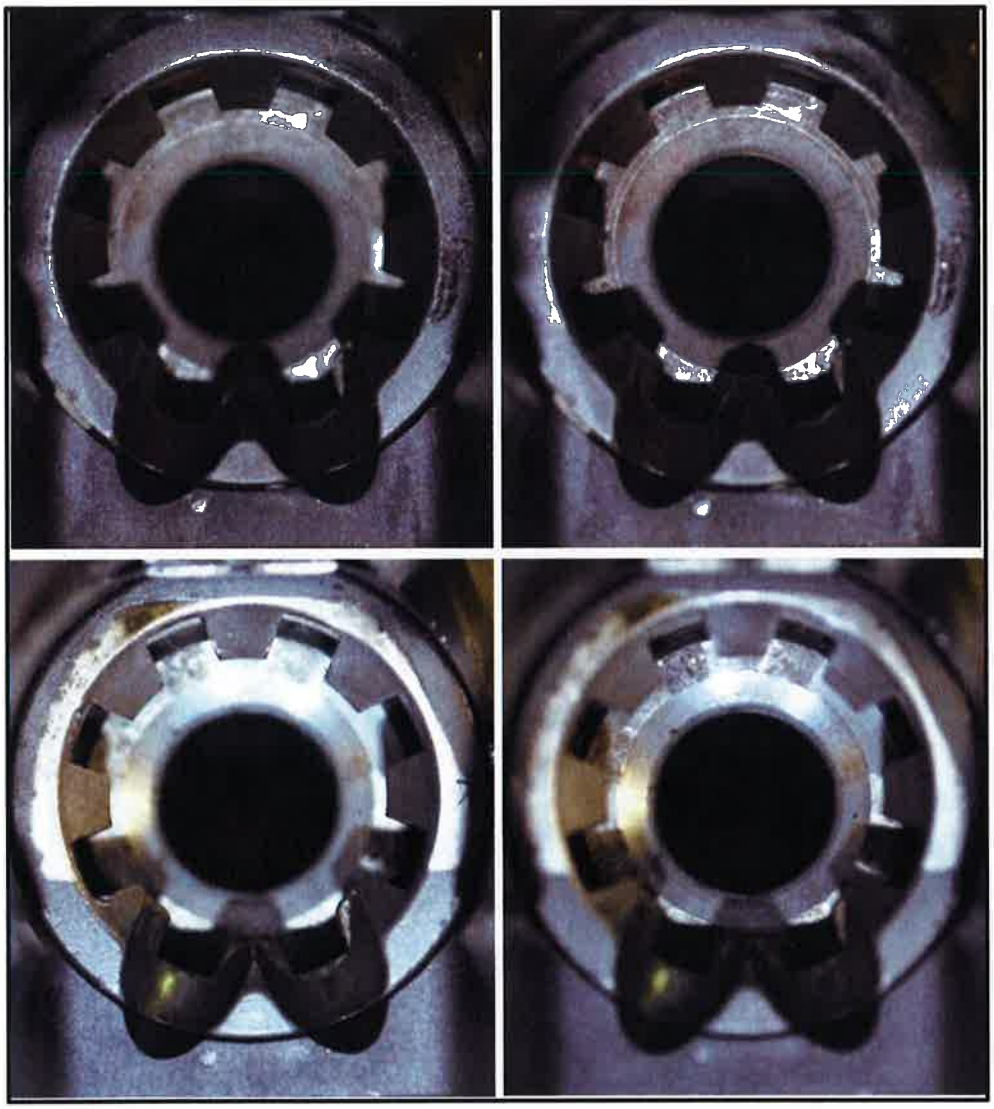


Figure 2.2-15. Pre- and post-test areas of the rear of the barrel and the feed ramps, M4A1 weapon C41-9.

(3) The feed ramps and rear of barrel before test (top, left to right) and after 9,600 rounds (bottom left to right) of M27 weapon T27-11 firing M855A1 using magazine vendor Foxtrot are shown in Figure 2.2-16.

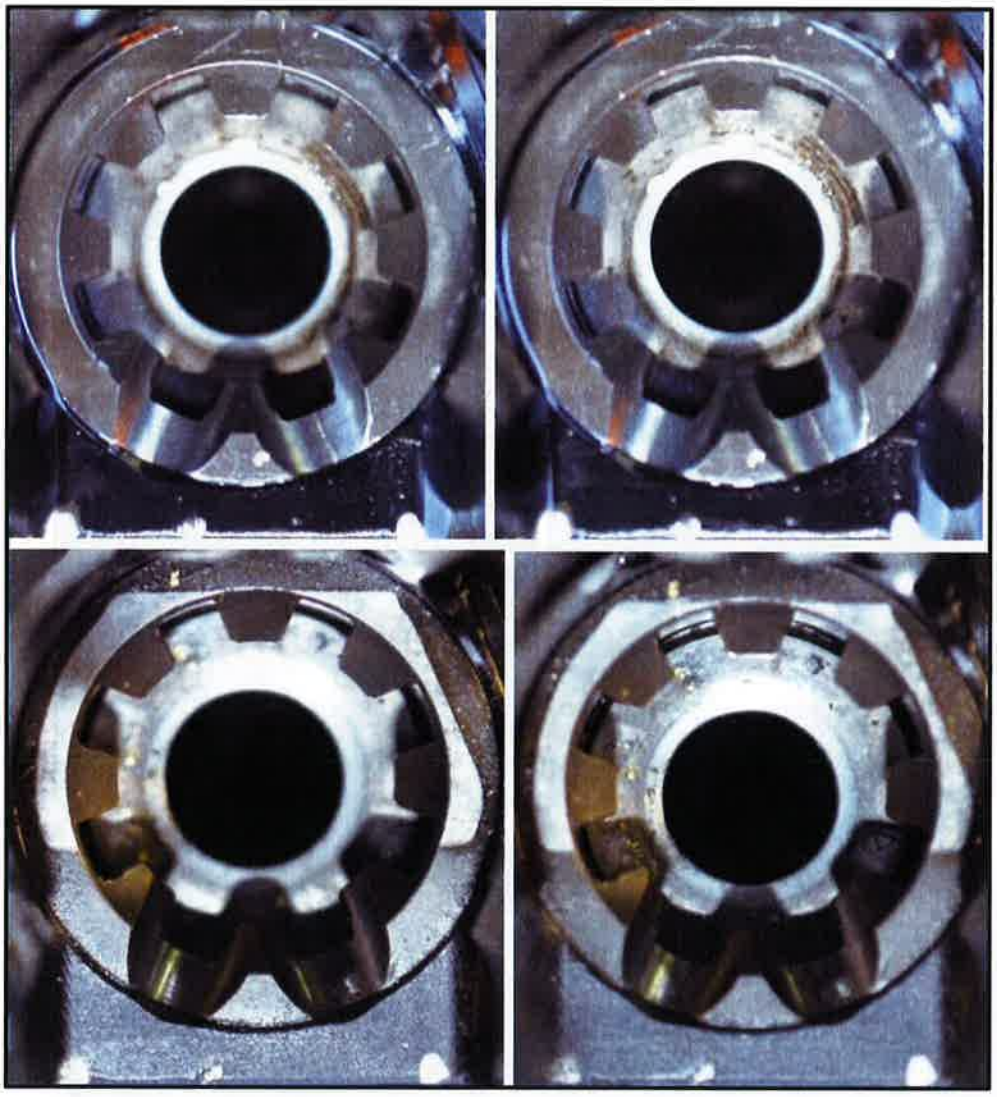


Figure 2.2-16. Pre- and post-test areas of the rear of the barrel and the feed ramps, M27 weapon T27-11.

j. Some stoppages were scored as system stoppages, meaning that the entire root cause was unknown without further exhaustive testing. A modified ramp angle excursion test was performed (para 2.3).

k. Due to the low sample size of one weapon per magazine type there is not a high confidence level of the results. One instance is that vendor Kilo performed better than vendor Lima when using M4A1 (Figure 2.2-4) and M27 (Figure 2.2-5). Previous testing with larger samples sizes has shown this to not be supported. Due to the fact that vendors Kilo and Lima were showing some unexpected trends, the customer authorized additional measuring of internal feeding geometry via CT X-ray scans (para 2.4).

2.3 MODIFIED FEED RAMP EXCURSION

2.3.1 Objective

The objective of this test was to prove that the feed ramp angle was the cause of reliability stoppages.

2.3.2 Criteria Compliance and Analysis

None. This test was performed to document technical performance.

2.3.3 Test Procedures and Findings

During reliability testing (para 2.2), some stoppages were scored as system stoppages, meaning that the entire root cause was unknown without further exhaustive testing. The feeding issues have to do with several factors; the primary ones being weapon geometry (such as feed ramp angle and magazine catch height), magazine geometry (the feeding angle that the cartridge is presented to the weapon feed ramp) and cartridge penetrator design (a sharper ogive and tougher material). To further prove this a M27 used in the Confirmatory Test of the M4A1 Carbine M855A1 Modified Magazine test (ATEC Project No. 2013-DT-ATC-M4CAR-F7255) (ref 10) was rebuilt for this test. With collaboration and permission from the United States Marine Corps (USMC), M27 weapon T27-2 had its feed ramp angle modified from (b) (3) (A) (when measured from centerline of the bore) (shown in Figs. 2.3-1 and 2.3-2). The weapon then fired 9,600 rounds. The result was the weapon had half the number of FFD stoppages firing the same ammunition and magazine type. A comparison of the number of stoppages between this test and the F7255 test is shown in Figure 2.3-3.

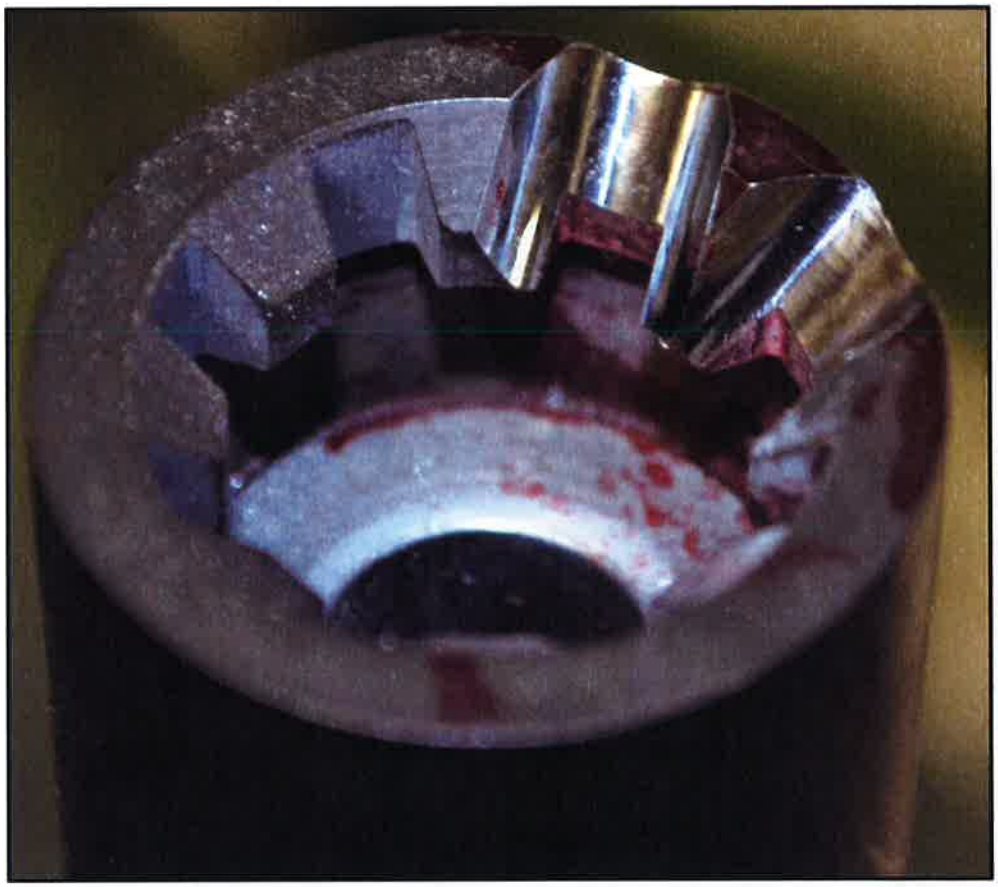


Figure 2.3-1. The barrel extension and barrel with the (b) machined feed ramps.

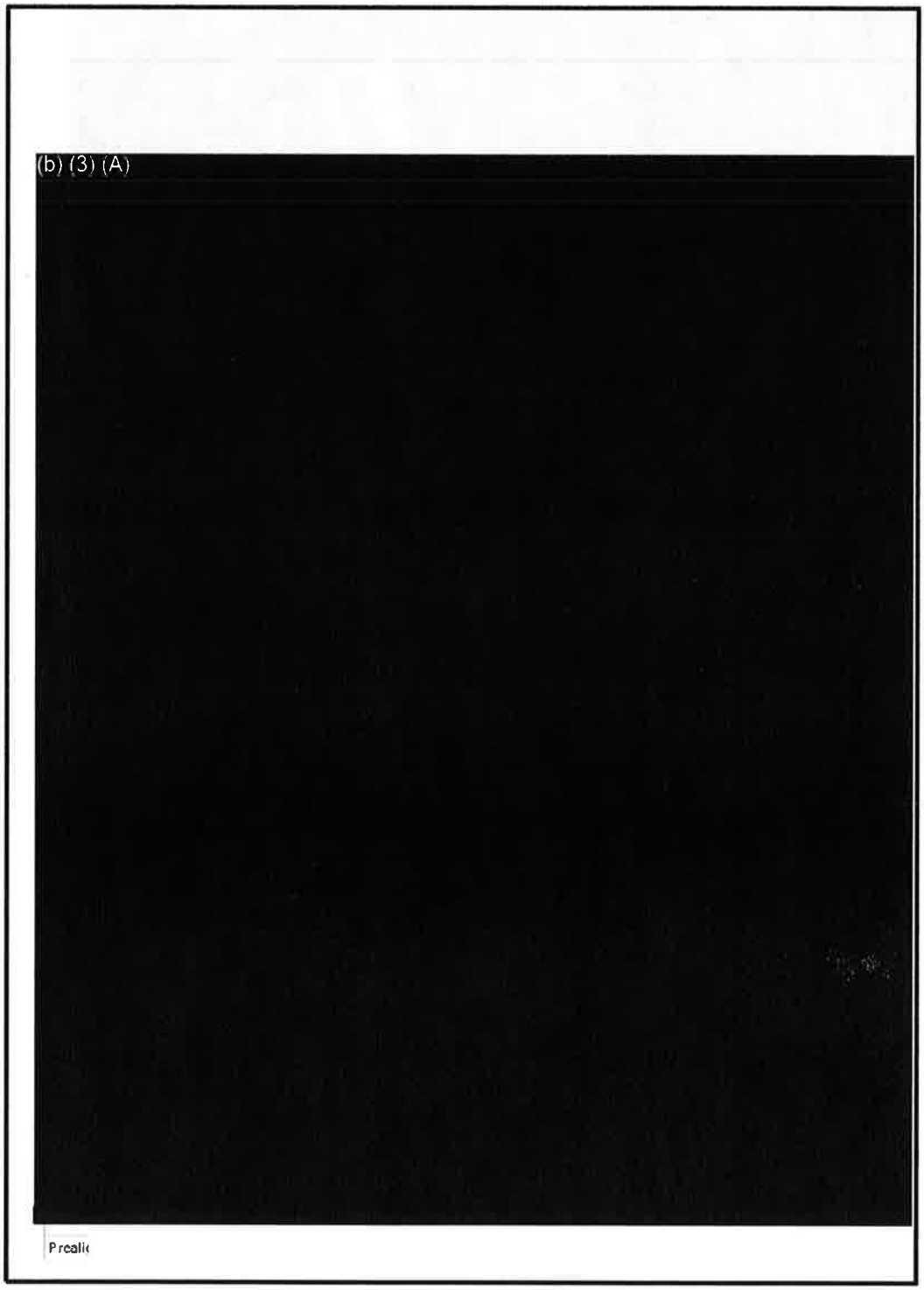


Figure 2.3-2. Laser scan image of the rear of the barrel extension after the feed ramps were machined at (b) .

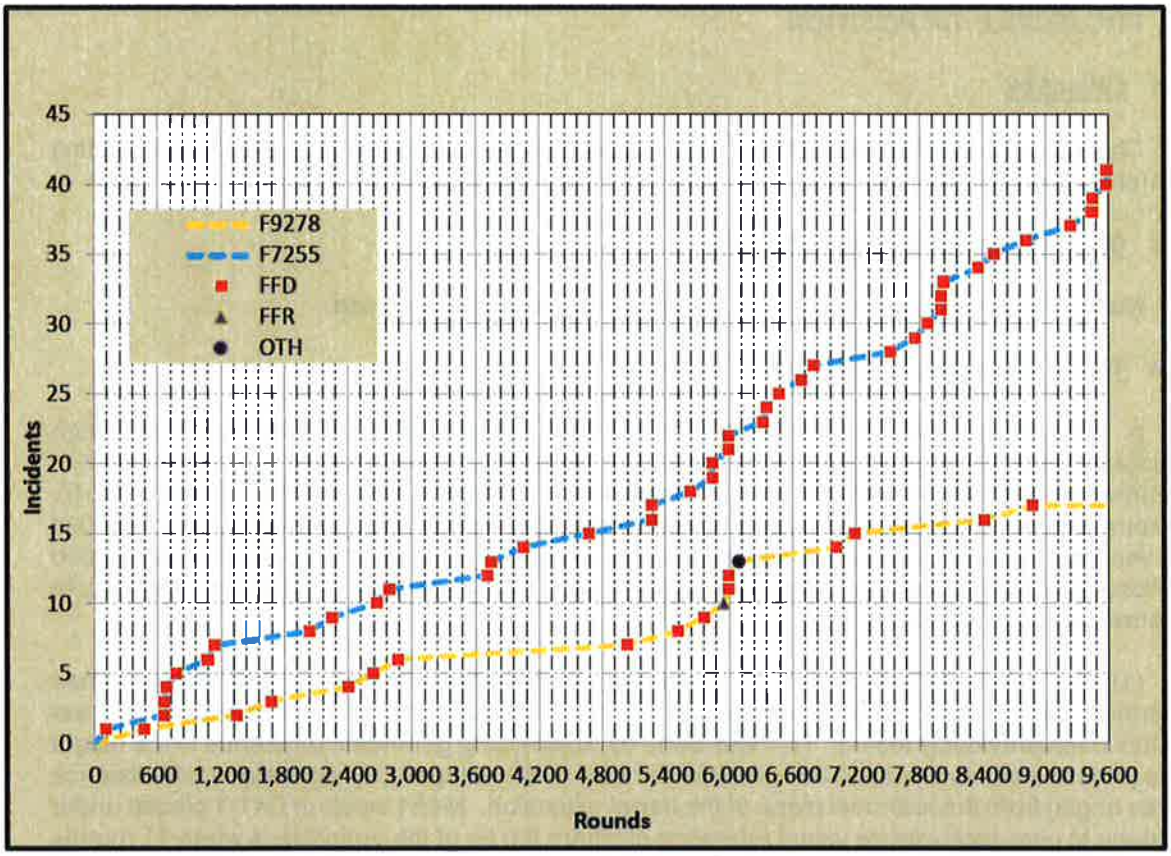


Figure 2.3-3. Stoppage comparison between the F7255 test and the F9278 test using M27 weapon T27-2.

2.4 PROJECTILE TIP POSITION

2.4.1 Objective

The objective of this test was to provide additional measurements of internal feeding geometry.

2.4.2 Criteria Compliance and Analysis

None. This test was performed to document technical performance.

2.4.3 Test Procedures and Findings

a. Due to the low sample size of one weapon per magazine type there is not a high confidence level of the results (Endurance testing para 2.2). One instance is that vendor Kilo performed better than vendor Lima when using M4A1 (Figure 2.2-4) and M27 (Figure 2.2-5). Previous testing with larger samples sizes has shown this to not be supported. Due to the fact that vendors Kilo and Lima were showing some unexpected trends, the customer authorized additional measuring of internal feeding geometry via CT X-ray scans. Further graphical results are provided in Appendix E.

(1) The primary reason was to show the performance difference of Kilo magazines performing better than Lima magazines since this goes against a much larger statistical data set that has been previously tested. This was done by determining geometric difference in the height of the projectile penetrator tip to the center of the bore of the weapon (x,y axis origin) and distance (Z-axis origin) from the rearmost plane of the barrel extension. M4A1 weapon C41-1 placed under the graph to give approximate visual reference of where the tip of the projectile is when 11 rounds are loaded in the magazine is shown in Figure 2.4-1. Eleven rounds in the magazine was used because the eleventh round is the lowest tip position in standard magazines. It is the worst case scenario between 0 to 30 rounds.

(2) Two M4A1 weapons (C41-1 and C41-2) and two M27 weapons (T27-2 and T27-14) were used in conjunction with the Kilo magazine (M27-1A) and one Lima magazine (M27-2A). The magazines that were used for this were two of the magazines (one from each vendor) that were completely CT scanned pre- and post-test. The primary configurations were oriented muzzle down (perpendicular to earth) to allow gravity to act on a loaded magazine and then the opposite orientation of muzzle up to allow gravity to act on the magazine in the opposite direction. The two orientations show the "play" in the magazine with a small force acting on it. The dimensions were measured by taking individual X-ray slices to determine the position of the tip of the projectile with respect to the back of the barrel extension and the center of the bore being the origin of the graphs.

(3) Figure 2.4-1 shows how the data point of "C41-1 (M4A1 assigned to Kilo magazines) using magazine M27-1A" (Kilo magazine used on the M27s, the first one in the firing order) - the reason this magazine was chosen is because there are complete pre- and post-test CT X-ray files on the magazine in case there was any discrepancy in the external geometry. The muzzle up orientation was used so that gravity is in effect pulling the magazine back in the magazine well, tilting the tip of the projectile down.

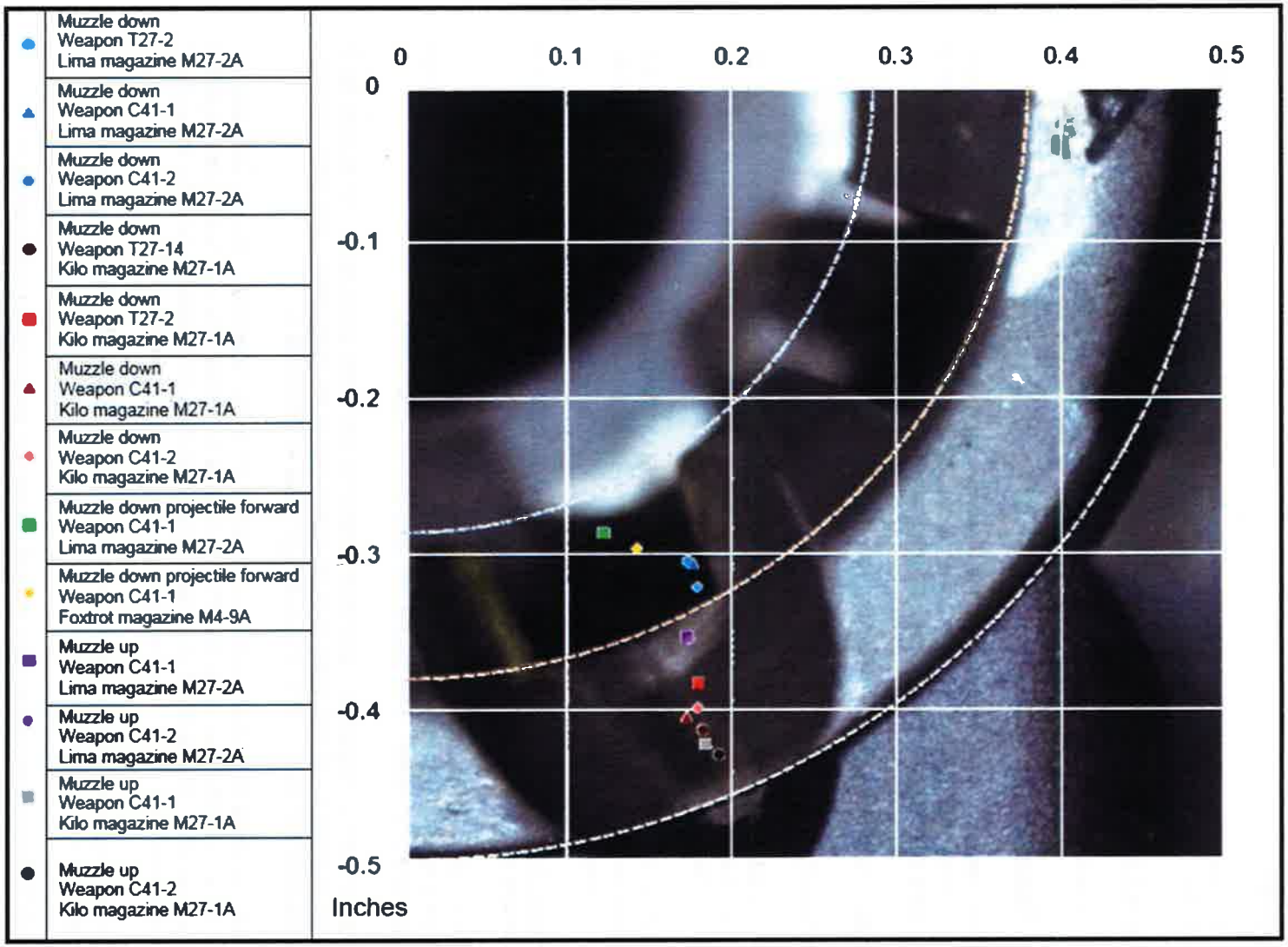


Figure 2.4-1. Calculated projectile tip impact location.

2.5 FINAL INSPECTION

2.5.1 Objective

The objective of this test was to document the final physical characteristics and appearance of the test items.

2.5.2 Criteria Compliance and Analysis

None. This test was performed to document technical performance.

2.5.3 Test Procedures and Findings

a. After testing was completed, the vendor magazines were visually inspected. Deficiencies were documented in TIRs (TIR index, Appendix B). The following physical inspections were performed on each vendor's magazines.

(1) Capacity. All magazines were loaded to full capacity.

(2) Fit and Retention.

(a) All empty magazines were inserted into M4A1/M16A4/M27 lower receiver. Each magazine was verified it fit into the lower receiver and could not be removed without activating the magazine release button.

(b) All fully loaded magazines were inserted into M4A1/M16A4/M27 lower receiver. Each magazine was verified it fit into the lower receiver and could not be removed without activating the magazine release button.

(3) Spring Force. Only magazines that were fired during the Endurance test (para 2.2), plus two replacement magazines per vendor were measured for spring force.

(a) For loading, magazines were held in an upright, vertical position. Dummy bullets (5.56-mm) were loaded into the magazine by using an Instron force gauge. The peak readings were recorded every 5th bullet. The results are provided in Appendix C.

(b) For unloading, magazines were held horizontal with bullet point down. An Instron force gauge with an extension rod was used to push bullets out of the magazine. The peak readings were recorded every 5th bullet. The results are provided in Appendix C.

(4) One magazine from each vendor underwent CT X-ray scanning. Magazines were CT X-ray scanned in 5-round increments from 0 to 30 rounds for a total of seven scans per magazine (using dummy bullets). These CT X-ray scans displayed magazine follower position throughout the loading process. The CT X-ray scans results are provided in Appendix D.

b. A final inspection of the support weapons (M4A1/M16A4/M27) was performed. The results are provided in Tables 2.5-1 through 2.5-3.

c. An NDT inspection was performed and the results are provided in Appendix A.

TABLE 2.5-1. FINAL MEASUREMENTS, M4A1

WEAPON NO.	FIRING PIN INDENT			FIRING PIN PROTRUSION	BARREL EROSION	HEADSPACE	DRIVE SPRING	HAMMER PIN	TRIGGER PIN	TRIGGER PULL, lb			AIR FLOW, psi
	in.												
C41-1	0.023	0.023	0.023	0.034	-22/32	1.4676	10.2	0.156	0.156	6.5	6.5	6.5	2.7
C41-2	0.021	0.020	0.020	0.033	-22/32	1.4686	10.7	0.156	0.155	5.5	5.5	5.5	2.6
C41-3	0.024	0.023	0.023	0.034	-24/32	1.4666	10.4	0.155	0.156	6.0	6.0	6.0	2.6
C41-4	0.019	0.020	0.021	0.030	-18/32	1.4676	10.5	0.156	0.156	6.5	6.5	7.0	2.6
C41-5	0.022	0.022	0.022	0.035	-18/32	1.4696	10.4	0.156	0.156	5.5	6.0	5.5	2.6
C41-6	0.022	0.022	0.021	0.035	-29/32	1.4656	10.5	0.156	0.156	6.0	5.5	6.0	2.5
C41-7	0.022	0.021	0.021	0.030	-20/32	1.4676	10.3	0.156	0.156	6.0	6.0	6.0	2.6
C41-8	0.020	0.021	0.021	0.031	-19/32	1.4676	10.2	0.157	0.157	6.0	5.5	5.5	2.6
C41-9	0.023	0.022	0.023	0.033	-25/32	1.4686	10.4	0.157	0.157	5.5	5.5	6.0	2.6
C41-10	0.021	0.021	0.020	0.034	-31/32	1.4696	10.2	0.156	0.156	6.5	6.5	6.5	2.5
C41-11	0.023	0.022	0.022	0.031	-19/32	1.4676	10.4	0.156	0.156	6.0	6.0	6.0	2.6
C41-12	0.020	0.019	0.020	0.032	-8/32	1.4696	10.4	0.156	0.156	6.0	6.0	6.0	2.6

TABLE 2.5-2. FINAL MEASUREMENTS, M16A4

WEAPON NO.	FIRING PIN INDENT			FIRING PIN PROTRUSION	BARREL EROSION	HEADSPACE	DRIVE SPRING	HAMMER PIN	TRIGGER PIN	TRIGGER PULL, lb			AIR FLOW, psi
	in.												
T164-1	0.023	0.023	0.023	0.034	4/32	1.4666	12.6	0.156	0.157	7.0	7.0	7.0	1.7
T164-2	0.021	0.021	0.022	0.032	5/32	1.4666	12.2	0.156	0.155	7.0	7.0	7.0	1.7
T164-3	0.024	0.024	0.024	0.032	-8/32	1.4666	12.3	0.156	0.157	7.0	7.0	7.0	1.7
T164-4	0.021	0.021	0.021	0.031	3/32	1.4666	12.2	0.156	0.156	7.0	7.0	7.0	1.7
T164-5	0.022	0.023	0.022	0.033	4/32	1.4676	12.3	0.156	0.156	7.0	7.0	8.0	1.7
T164-6	0.020	0.020	0.020	0.032	4/32	1.4696	12.1	0.156	0.156	7.0	7.0	7.0	1.7

TABLE 2.5-3. FINAL MEASUREMENTS, M27

WEAPON NO.	FIRING PIN				BARREL EROSION		HEADSPACE	DRIVE SPRING	HAMMER PIN	TRIGGER PIN	TRIGGER PULL, lb		
	INDENT			PROTRUSION	STD	H&K							
	in.												
T27-1	0.020	0.020	0.020	0.038	5/32	12/32	1.4656	11.7	0.156	0.156	6.0	6.0	6.0
T27-2	0.016	0.016	0.016	0.039	9/32	13/32	1.4646T	11.7	0.157	0.157	6.0	6.5	6.0
T27-3	0.021	0.020	0.020	0.040	8/32	12/32	1.4646T	11.4	0.156	0.156	6.5	6.0	6.5
T27-4	0.020	0.020	0.021	0.039	-6/32	11/32	1.4646T	11.4	0.156	0.156	6.0	6.0	6.0
T27-5	0.020	0.021	0.021	0.040	-7/32	8/32	1.4646	11.2	0.157	0.157	6.0	6.0	6.0
T27-6	0.020	0.019	0.019	0.040	-6/32	11/32	1.4646T	11.4	0.156	0.156	6.0	6.0	6.0
T27-7	0.019	0.019	0.019	0.040	-5/32	11/32	1.4646	11.2	0.156	0.156	6.0	6.0	6.0
T27-8	0.020	0.021	0.020	0.040	-6/32	11/32	1.4646	11.2	0.156	0.156	6.5	6.5	6.5
T27-10	0.020	0.020	0.020	0.040	1/32	12/32	1.4646T	11.5	0.156	0.156	6.5	6.0	6.0
T27-11	0.019	0.018	0.019	0.040	-5/32	11/32	1.4646T	11.3	0.157	0.157	6.5	6.5	6.5

SECTION 3. APPENDIXES

APPENDIX A. TEST DATA

USAATC Memo 750-1

DATE: 7/1/14

NONDESTRUCTIVE TEST INSPECTION

ITEM:	SN:	MODEL:	INSPECTION STATUS: BFAPG	ENGINEER: (b) (6)
Carbine	See Below	M4A1, 5.56mm	Rounds: EFC TOTAL: 0	BRANCH: Small Arms Test BR
			OTHER: Int Magazine Test	WO: 15272.2

METHOD OF INSPECTION

MAGNETIC PARTICLE: WET XX DRY BLACKLIGHT BORESCOPE AMP: CONDUCTOR CONTACT COIL XX

MAGNETIC RECORDING BORESCOPE: ULTRASONICS: EDDY CURRENT: PENETRANT:

OTHER COMPONENTS INSPECTED

1. Barrel
2. Bolt
3. Bolt Carrier
4. Cam Pin

SERVICEABLE XXX
UNSERVICEABLE
HAZARDOUS

REMARKS

1. Four components for each weapon were received for magnetic particle inspection. The magnetic particle inspection was conducted in accordance with ATC-NDT-1062.

2.Inspection was conducted using magnetic particle inspection station SN: 89624. Calibration due 7/29/2014.

3. The weapon serial numbers are 10588388, 10588390, 10588393, 10588659, 10588660, 10588861, 10592419, W281627, W282385, W499818 and W499994.

4. No discontinuities indicative of a crack pattern or other defects were noted.

STEAP-MT Form 302, 1 Mar 76

APPROVED BY: (b) (6)

(b) (6) [redacted]

INSPECTED BY: (b) (6) [redacted]

(b) (6) [redacted]

USAATC Memo 750-1

DATE: 6/30/14 NONDESTRUCTIVE TEST INSPECTION

ITEM:	SN:	MODEL:	INSPECTION STATUS: BFAPG	ENGINEER: (b) (6)
Rifle (T164-(1-6))	See Below	M16A4, 5.56mm	Rounds: EFC TOTAL: 0	BRANCH: Small Arms Test BR
			OTHER: Int Magazine Test	WO: 14360.2

METHOD OF INSPECTION

MAGNETIC PARTICLE: WET XX DRY BLACKLIGHT BORESCOPE AMP: CONDUCTOR CONTACT COIL XX

MAGNETIC RECORDING BORESCOPE: ULTRASONICS: EDDY CURRENT: PENETRANT:

OTHER COMPONENTS INSPECTED	
1. Barrel	SERVICEABLE XXX
2. Bolt	UNSERVICEABLE
3. Bolt Carrier	HAZARDOUS
4. Cam Pin	

REMARKS

1. Four components for each weapon were received for magnetic particle inspection. Inspections were conducted using magnetic particle horizontal machine SN 89624, Calibration due 7/29/2014

2. Magnetic particle inspection was conducted in accordance with written procedure ATC-NDT- 1062.

3. The following weapon serial/ATC numbers were inspected; 10514979 (T164-1), 10515097 (T164-2), 10515188 (T164-3), 10515213 (T164-4), 10515266 (T164-5), 10515284 (T164-6).

4. No discontinuities indicative of a crack pattern or other defects were noted.

STEAP-MT Form 302, 1 Mar 76

APPROVED BY: (b) (6)

(b) (6)

INSPECTED BY: (b) (6)

(b) (6)

USAATC Memo 750-1

DATE: 6/30/14 NONDESTRUCTIVE TEST INSPECTION

ITEM:	SN:	MODEL:	INSPECTION STATUS: BFAPG	ENGINEER: [redacted]
IAR (T27- (1-12)	See Below	M27, 5.56mm	Rounds: EFC TOTAL: 0	BRANCH: Small Arms Test BR
			OTHER: Int Magazine Test	WO: 14360.2

METHOD OF INSPECTION

MAGNETIC PARTICLE: WET XX DRY BLACKLIGHT BORESCOPE AMP: CONDUCTOR CONTACT COIL XX

MAGNETIC RECORDING BORESCOPE: ULTRASONICS: EDDY CURRENT: PENETRANT:

OTHER COMPONENTS INSPECTED

1. Barrel
2. Bolt
3. Bolt Carrier
4. Cam Pin

SERVICEABLE XXX
UNSERVICEABLE
HAZARDOUS

REMARKS

1. Four components for each weapon were received for magnetic particle inspection. Inspections were conducted using magnetic particle horizontal machine SN 89624, Calibration due 7/29/2014

2. Magnetic particle inspection was conducted in accordance with written procedure ATC-NDT- 1062.

3. The following weapon serial/ATC numbers were inspected; 172-003750 (T27-1), 172-003777 (T27-2), 172-006441 (T27-3), 172-006442 (T27-4), 172-006596 (T27-5), 172-006597 (T27-6), 172-006598 (T27-7), 172-006599 (T27-8), 172-006601 (T27-9), 172-006603 (T27-10), 172-006605 (T27-11), 172-006606 (T27-12).

4. No discontinuities indicative of a crack pattern or other defects were noted.

STEAP-MT Form 302, 1 Mar 76

APPROVED BY: (b) (6)

(b) (6)

INSPECTED BY: (b) (6)

(b) (6)

TABLE A-2.2-1. ENDURANCE MEASUREMENTS, 1,200 ROUNDS

WEAPON TYPE	WEAPON NO.	HEADSPACE	FIRING PIN PROTRUSION	BARREL EROSION	
				STD	H&K
		in.			
M4A1	C41-1	1.4686	0.034	13/32	
	C41-2	1.4676	0.032	13/32	
	C41-3	1.4686	0.031	12/32	
	C41-4	1.4686	0.030	11/32	
	C41-5	1.4686	0.033	13/32+	
	C41-6	1.4646	0.034	12/32+	
	C41-7	1.4666	0.029	12/32+	
	C41-8	1.4666	0.030	13/32	
	C41-9	1.4686	0.034	13/32	
	C41-10	1.4676	0.032	12/32	
	C41-11	1.4676	0.033	12/32+	
	C41-12	1.4656	0.030	13/32	
M16A4	T164-1	1.4666	0.033	11/32	
	T164-2	1.4666	0.031	11/32+	
	T164-3	1.4666	0.031	6/32	
	T164-4	1.4666	0.030	11/32+	
	T164-5	1.4676	0.032	12/32	
	T164-6	1.4696	0.030	12/32	
M27	T27-1	1.4646T	0.037	5/32	12/32
	T27-2	1.4646T	0.058	12/32	13/32
	T27-3	1.4646T	0.038	10/32	12/32
	T27-4	1.4646T	0.038	-4/32	11/32
	T27-5	1.4646T	0.038	-5/32	9/32
	T27-6	1.4646T	0.038	4/32	12/32
	T27-7	1.4646	0.037	6/32	12/32
	T27-8	1.4646T	0.038	-5/32	12/32
	T27-10	1.4646T	0.037	5/32	12/32
	T27-11	1.4646T	0.038	-2/32	12/32

TABLE A-2.2-2. ENDURANCE MEASUREMENTS, 2,400 ROUNDS

WEAPON TYPE	WEAPON NO.	HEADSPACE	FIRING PIN PROTRUSION	BARREL EROSION	
				STD	H&K
		in.			
M4A1	C41-1	1.4686	0.034	5/32+	
	C41-2	1.4676	0.032	4/32+	
	C41-3	1.4676	0.031	3/32	
	C41-4	1.4676	0.030	3/32	
	C41-5	1.4686	0.034	7/32	
	C41-6	1.4646	0.034	4/32	
	C41-7	1.4676	0.029	4/32	
	C41-8	1.4666	0.031	6/32	
	C41-9	1.4686	0.033	5/32+	
	C41-10	1.4676	0.032	4/32	
	C41-11	1.4676	0.033	7/32	
	C41-12	1.4656	0.029	8/32	
M16A4	T164-1	1.4666	0.033	4/32+	
	T164-2	1.4666	0.031	6/32+	
	T164-3	1.4666	0.031	-7/32	
	T164-4	1.4666	0.030	4/32	
	T164-5	1.4676	0.032	5/32	
	T164-6	1.4696	0.031	4/32	
M27	T27-1	1.4646	0.037	9/32+	12/32
	T27-2	1.4646T	0.038	11/32	13/32
	T27-3	1.4646T	0.039	10/32	12/32
	T27-4	1.4646T	0.038	-6/32	11/32
	T27-5	1.4646T	0.037	-8/32	8/32+
	T27-6	1.4646T	0.038	7/32	11/32
	T27-7	1.4646	0.038	4/32+	12/32
	T27-8	1.4646T	0.039	-7/32	11/32+
	T27-10	1.4646T	0.038	3/32	12/32
	T27-11	1.4646	0.039	-2/32	12/32

TABLE A-2.2-3. ENDURANCE MEASUREMENTS, 4,800 ROUNDS

WEAPON TYPE	WEAPON NO.	HEADSPACE	FIRING PIN PROTRUSION	BARREL EROSION	
				STD	H&K
		in.			
M4A1	C41-1	1.4696	0.034	-4/32	
	C41-2	1.4676	0.033	-6/32	
	C41-3	1.4686	0.032	-8/32	
	C41-4	1.4686	0.030	-5/32	
	C41-5	1.4686	0.034	-1/32	
	C41-6	1.4646	0.034	-7/32	
	C41-7	1.4676	0.029	-6/32	
	C41-8	1.4666	0.032	-3/32	
	C41-9	1.4696	0.035	-5/32	
	C41-10	1.4686	0.033	-9/32	
	C41-11	1.4676	0.033	-4/32	
	C41-12	1.4666	0.030	2/32	
M27	T27-1	1.4646	0.036	8/32+	11/32
	T27-2	1.4646T	0.039	10/32	13/32
	T27-3	1.4646T	0.039	9/32	12/32
	T27-4	1.4646T	0.039	-6/32	11/32
	T27-5	1.4646T	0.040	-7/32	9/32
	T27-6	1.4646T	0.039	6/32+	12/32
	T27-7	1.4646	0.039	6/32+	11/32
	T27-8	1.4646T	0.039	-7/32	11/32
	T27-10	1.4646T	0.040	4/32	12/32
	T27-11	1.4646	0.040	-2/32	11/32

TABLE A-2.2-4. ENDURANCE MEASUREMENTS, 6,000 ROUNDS

WEAPON TYPE	WEAPON NO.	HEADSPACE	FIRING PIN PROTRUSION	BARREL EROSION	
				STD	H&K
		in.			
M4A1	C41-1	1.4696	0.035	-9/32	
	C41-2	1.4676	0.033	-10/32	
	C41-3	1.4686	0.033	-11/32	
	C41-4	1.4686	0.031	-8/32	
	C41-5	1.4686	0.035	-5/32	
	C41-6	1.4656	0.035	-12/32	
	C41-7	1.4686	0.030	-10/32	
	C41-8	1.4676	0.032	-8/32	
	C41-9	1.4696	0.035	-8/32	
	C41-10	1.4686	0.034	-13/32	
	C41-11	1.4676	0.034	-7/32	
	C41-12	1.4666	0.031	0/32	
M27	T27-1	1.4646	0.038	8/32+	12/32
	T27-2	1.4646T	0.039	11/32	13/32
	T27-3	1.4646T	0.040	10/32	12/32
	T27-4	1.4646T	0.039	-5/32	12/32
	T27-5	1.4646T	0.040	-7/32	8/32
	T27-6	1.4646T	0.040	6/32	12/32
	T27-7	1.4646	0.039	6/32+	11/32
	T27-8	1.4646T	0.040	11/32	11/32
	T27-10	1.4646T	0.040	6/32	12/32
	T27-11	1.4646	0.040	-2/32	11/32+

TABLE A-2.2-5. ENDURANCE MEASUREMENTS, 7,200 ROUNDS

WEAPON TYPE	WEAPON NO.	HEADSPACE	FIRING PIN PROTRUSION	BARREL EROSION	
		in.		STD	H&K
M4A1	C41-1	1.4696	0.035	-14/32	
	C41-2	1.4676	0.033	-15/32	
	C41-3	1.4696	0.033	-15/32	
	C41-4	1.4686	0.031	-12/32	
	C41-5	1.4696	0.035	-9/32	
	C41-6	1.4656	0.035	-18/32	
	C41-7	1.4666	0.029	-13/32	
	C41-8	1.4676	0.031	-11/32	
	C41-9	1.4696	0.035	-15/32	
	C41-10	1.4686	0.034	-20/32	
	C41-11	1.4666	0.031	-11/32	
	C41-12	1.4666	0.032	-2/32	
M27	T27-1	1.4646	0.038	8/32	12/32
	T27-2	1.4646T	0.039	10/32	13/32
	T27-3	1.4646T	0.040	8/32	12/32
	T27-4	1.4646T	0.039	-6/32	11/32+
	T27-5	1.4646T	0.040	-7/32	8/32
	T27-6	1.4646T	0.039	6/32	11/32+
	T27-7	1.4646	0.039	-4/32	11/32
	T27-8	1.4646T	0.040	-7/32	11/32
	T27-10	1.4646T	0.040	5/32	12/32
	T27-11	1.4646	0.040	-4/32	11/32+

TABLE A-2.2-6. ENDURANCE MEASUREMENTS, 8,400 ROUNDS

WEAPON TYPE	WEAPON NO.	HEADSPACE	FIRING PIN PROTRUSION	BARREL EROSION	
				STD	H&K
		in.			
M4A1	C41-1	1.4706	0.035	-18/32	
	C41-2	1.4686	0.033	-19/32	
	C41-3	1.4666	0.033	-17/32	
	C41-4	1.4696	0.029	-15/32	
	C41-5	1.4696	0.030	-15/32	
	C41-6	1.4656	0.035	-24/32	
	C41-7	1.4676	0.030	-16/32	
	C41-8	1.4676	0.031	-15/32	
	C41-9	1.4706	0.036	-20/32	
	C41-10	1.4686	0.034	-25/32	
	C41-11	1.4676	0.031	-16/32	
	C41-12	1.4666	0.031	-4/32	
M27	T27-1	1.4646	0.038	7/32+	12/32
	T27-2	1.4646T	0.039	9/32	12/32
	T27-3	1.4646T	0.039	5/32	12/32
	T27-4	1.4646T	0.039	-6/32	11/32+
	T27-5	1.4646	0.040	-7/32	8/32
	T27-6	1.4646T	0.040	3/32	12/32
	T27-7	1.4656	0.039	-2/32	11/32
	T27-8	1.4646	0.040	-6/32	11/32
	T27-10	1.4646T	0.040	2/32+	12/32
	T27-11	1.4646	0.040	-4/32	11/32

TABLE A-2.2-7. CLASS I/EFF FAILURE MODES FOR M4A1 WEAPONS

MAGAZINE	MALFUNCTION TYPE	MALFUNCTION CAUSE	VENDOR/WEAPON NO. ALPHA (C41-3)	BRAVO (C41-4)	CHARLIE (C41-7)	DELTA (C41-5)	ECHO (C41-8)	FOXTROT (C41-9)	GOLF (C41-10)	HOTEL (C41-6)	INDIA (C41-11)	JULIET (C41-12)	KILO (C41-1)	LIMA (C41-2)
AMMUNITION														
C-1	FFR	LI	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA
MAGAZINE														
B	FBR	NA	-	-	-	-	-	-	8	-	1	-	-	-
C			-	-	-	-	-	-	9	-	9	-	-	-
D			-	-	-	-	-	-	5	-	6	-	-	-
A	FF2	NA	-	-	3	-	-	-	-	-	-	-	-	-
A	FFD	BLE	-	-	-	-	-	-	1	-	-	-	-	-
B		BOB	-	4	-	-	-	-	-	-	-	-	-	-
C			-	2	-	-	-	-	-	-	-	-	-	-
D			-	2	1	-	-	-	-	1	-	-	-	-
A	OTH	NA	-	-	1	-	-	-	-	-	-	-	-	-
WEAPON														
B	FEJ	NA	-	-	-	-	-	-	-	-	-	-	-	2
D	FFD	BOB	-	-	3	-	-	-	-	-	-	-	-	-
C	FXT	NA	-	-	-	1	-	-	-	-	-	-	-	-
D			-	-	-	-	-	-	-	-	-	-	-	1
SYSTEM														
D	FFD	BLE	1	-	-	-	-	-	-	-	-	-	-	-
OVERALL														
B	FBR	NA	-	-	-	-	-	-	8	-	1	-	-	-
C			-	-	-	-	-	-	9	-	9	-	-	-
D			-	-	-	-	-	-	5	-	6	-	-	-
B	FEJ	NA	-	-	-	-	-	-	-	-	-	-	-	2
A	FF2	NA	-	-	3	-	-	-	-	-	-	-	-	-
A	FFD	BLE	-	-	-	-	-	-	1	-	-	-	-	-
B		BOB	-	4	-	-	-	-	-	-	-	-	-	-
C			-	2	-	-	-	-	-	-	-	-	-	-
D		BLE	1	-	-	-	-	-	-	-	-	-	-	-
D		BOB	-	2	4	-	-	-	-	1	-	-	-	-
C-1	FFR	LI	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA
C	FXT	NA	-	-	-	1	-	-	-	-	-	-	-	-
D			-	-	-	-	-	-	-	-	-	-	-	1
A	OTH	NA	-	-	1	-	-	-	-	-	-	-	-	-
		Overall	1	8	8	1	0	0	24	1	16	-	-	3

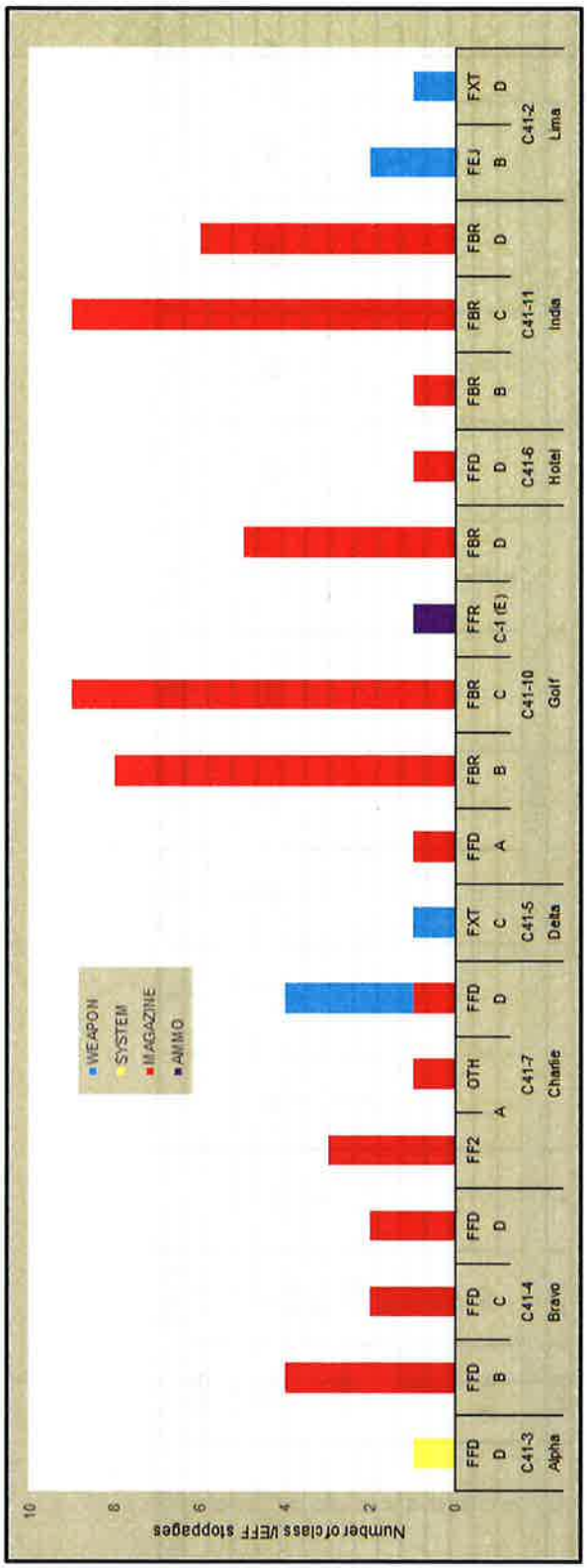


Figure A-2.2-1. Class I/EFF failure modes for M4A1 weapons.

TABLE A-2.2-8. CLASS III/EFF FAILURE MODES FOR M4A1 WEAPONS

MAGAZINE	MALFUNCTION TYPE	MALFUNCTION CAUSE	VENDOR/WEAPON NO. ALPHA (C41-3)	BRAVO (C41-4)	CHARLIE (C41-7)	DELTA (C41-5)	ECHO (C41-8)	FOXTROT (C41-9)	GOLF (C41-10)	HOTEL (C41-6)	INDIA (C41-11)	JULIET (C41-12)	KILO (C41-1)	LIMA (C41-2)
MAGAZINE														
B	OTH	NA	-	-	-	-	-	-	1	-	-	-	-	-
C			-	-	-	-	-	-	1	-	-	-	-	-
WEAPON														
B	FRA	NA	1	-	-	-	-	-	-	-	-	-	1	-
C			-	-	1	-	1	-	-	-	1	-	-	-
D			-	1	-	-	-	1	-	-	-	1	-	-
A	OTH	NA	-	-	-	-	-	-	-	1	-	-	-	-
D			-	-	-	-	-	-	-	-	1	-	-	-
OVERALL														
B	FRA	NA	1	-	-	-	-	-	-	-	-	-	1	-
C			-	-	1	-	1	-	-	-	1	-	-	-
D			-	1	-	-	-	1	-	-	-	1	-	-
A	OTH	NA	-	-	-	-	-	-	-	1	-	-	-	-
B			-	-	-	-	-	-	1	-	-	-	-	-
C			-	-	-	-	-	-	1	-	-	-	-	-
D			-	-	-	-	-	-	-	-	1	-	-	-
		Overall	1	1	1	-	1	1	2	1	2	1	1	-

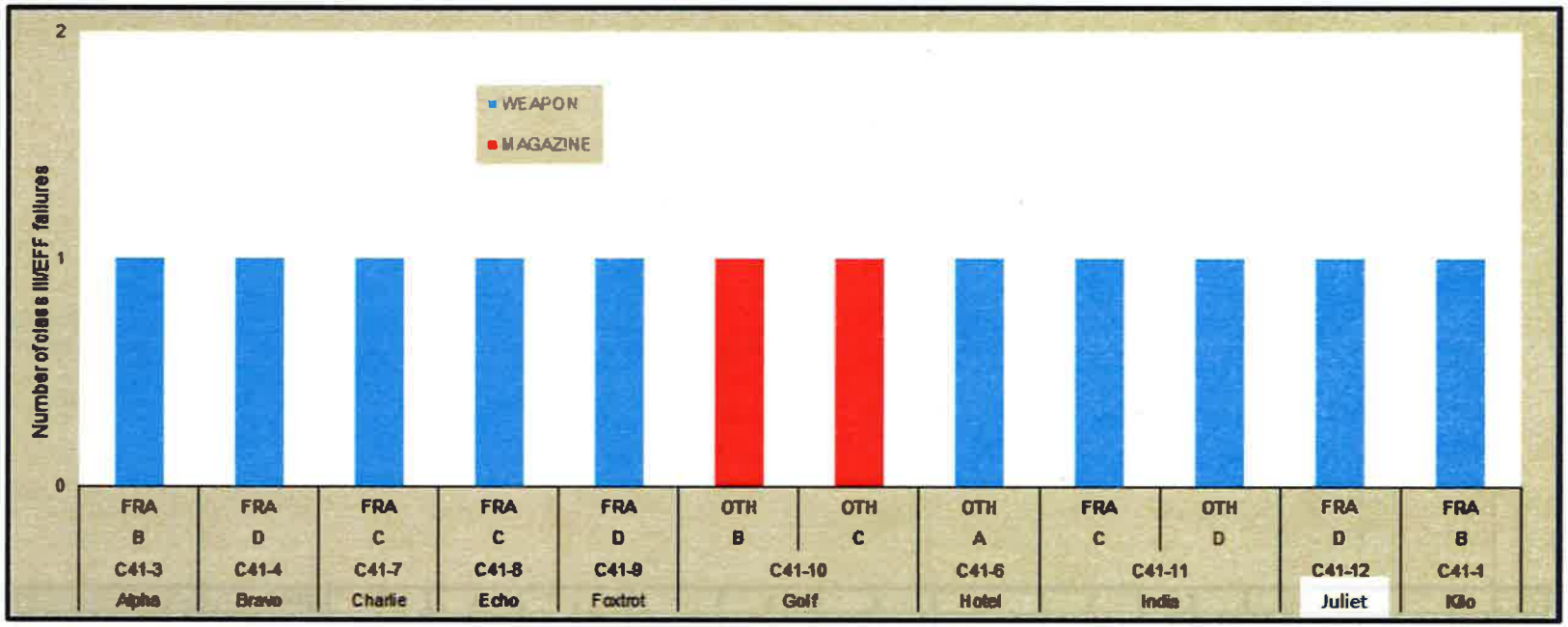


Figure A-2.2-2. Class III/EFF failure modes for M4A1 weapons.

TABLE A-2.2-9. CLASS I/EFF FAILURE MODES FOR M16A4 WEAPONS

MAGAZINE	MALFUNCTION TYPE	MALFUNCTION CAUSE	VENDOR/WEAPON NO. ALPHA (T164-3)	BRAVO (T164-4)	CHARLIE (2T164-1)	DELTA (T164-5)	ECHO (2T164-2)	FOXTROT (2T164-3)	GOLF (2T164-4)	HOTEL (T164-6)	INDIA (2T164-5)	JULIET (2T164-6)	KILO (T164-1)	LIMA (T164-2)
MAGAZINE														
B	FBR	NA	-	-	-	-	-	-	1	-	-	-	-	-
D			-	-	-	-	-	-	-	-	1	-	-	-
B	FF2	NA	-	-	-	-	-	-	-	1	-	-	-	-
WEAPON														
A	FFD	BOB	-	2	-	-	-	-	-	-	-	-	-	-
D		NA	-	-	-	-	-	-	1	-	-	-	-	-
A	FTC	BLE	-	-	-	-	-	-	-	-	-	-	-	1
OVERALL														
B	FBR	NA	-	-	-	-	-	-	1	-	-	-	-	-
D			-	-	-	-	-	-	-	-	1	-	-	-
B	FF2	NA	-	-	-	-	-	-	-	1	-	-	-	-
A	FFD	BOB	-	2	-	-	-	-	-	-	-	-	-	-
D		NA	-	-	-	-	-	-	1	-	-	-	-	-
A	FTC	BLE	-	-	-	-	-	-	-	-	-	-	-	1
Overall			-	2	-	-	-	-	2	1	1	-	-	1

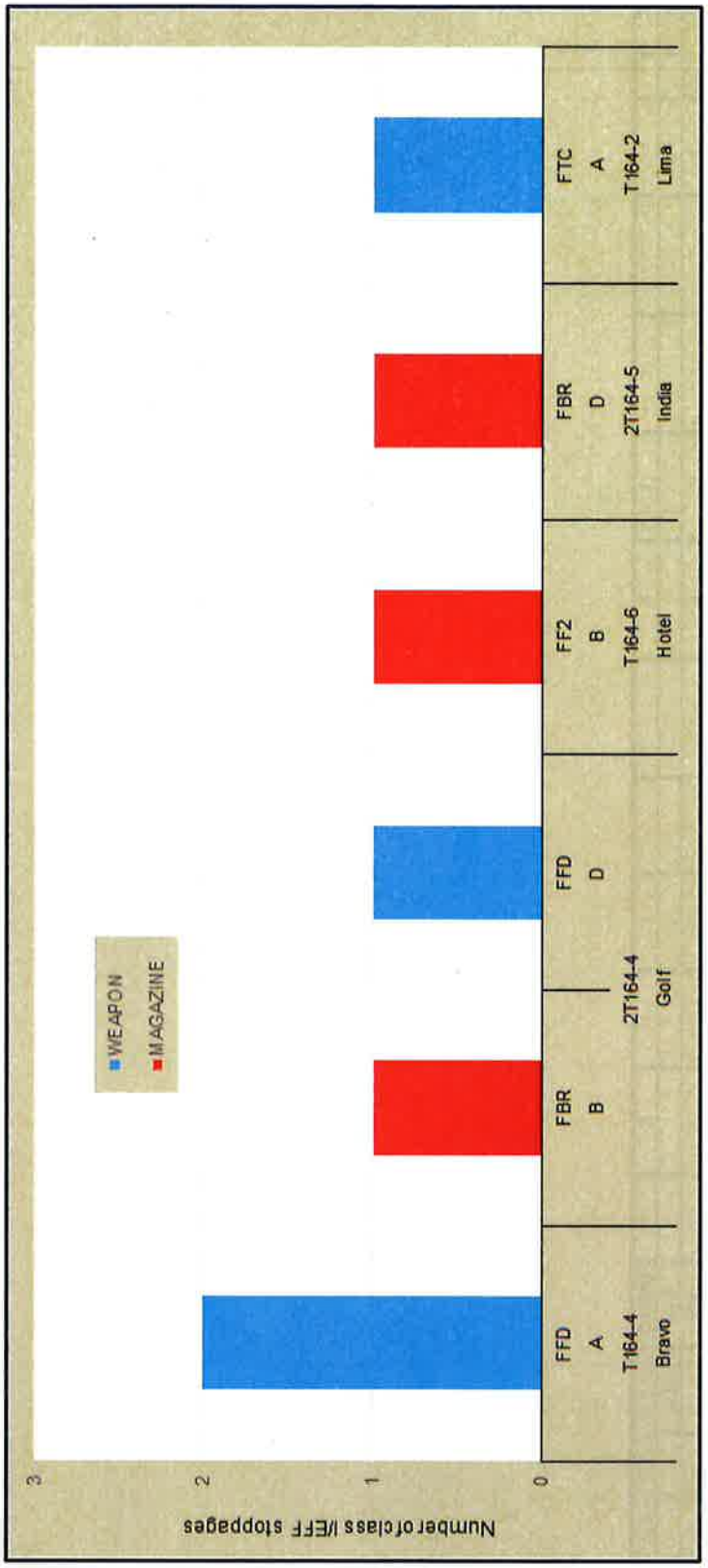


Figure A-2.2-3. Class I/EFF failure modes for M16A4 weapons.

TABLE A-2.2-10. CLASS I/EFF FAILURE MODES FOR M27 WEAPONS

MAGAZINE	MALFUNCTION TYPE	MALFUNCTION CAUSE	VENDOR/WEAPON NO. ALPHA (T27-3)	BRAVO (T27-4)	CHARLIE (T27-7)	DELTA (T27-5)	ECHO (T27-8)	FOXTROT (T27-11)	HOTEL (T27-6)	JULIET (T27-10)	KILO (T27-1)	LIMA (T27-2)
AMMUNITION												
A	FFR	LI	-	-	-	-	-	-	-	1	-	-
B			-	-	-	-	-	1	-	-	-	-
C			-	-	-	-	-	-	-	2	-	1
MAGAZINE												
C	FF2	NA	-	-	3	-	-	-	-	-	-	-
D			-	1	-	-	-	-	-	-	-	-
A	FFD	BOB	-	7	4	-	-	-	-	1	-	1
B			1	-	3	-	-	-	-	1	-	-
B-1			NA	1	NA	NA	NA	NA	NA	NA	NA	NA
C			-	1	-	-	-	-	-	-	-	-
C-1			NA	5	4	NA	NA	NA	NA	NA	NA	NA
D			-	11	2	-	-	-	-	1	-	2
D-1			NA	NA	NA	NA	NA	NA	NA	NA	NA	1
B	FSR	NA	-	-	-	-	-	-	-	1	-	-
D			-	-	1	-	-	-	-	-	-	-
WEAPON												
A	FFD	BLE	-	-	-	-	-	1	-	-	-	-
A		BOB	-	2	6	-	-	-	-	2	-	1
B			-	18	7	-	-	-	-	2	-	1
C		BLE	-	1	-	-	-	-	-	-	-	-
C		BOB	2	7	10	1	-	-	-	2	1	-
C-1			NA	-	1	NA	NA	NA	NA	NA	NA	NA
D			-	2	5	-	1	-	1	1	2	5
D-1			NA	NA	NA	NA	NA	NA	NA	NA	NA	1
B	FFR	LI	-	-	-	-	-	-	-	-	2	-
D			-	-	1	-	-	-	-	-	-	-
C	FSR	NA	-	-	-	-	-	-	-	-	1	-
SYSTEM												
A	FFD	BOB	-	4	-	-	-	-	-	-	-	-
B-1			-	1	-	-	-	-	-	-	-	-
C			-	6	-	-	-	-	-	-	-	-
C		BLE	-	1	-	-	-	-	-	-	-	-
C	FTC	BLE	-	-	-	-	-	-	-	1	-	-
D	FFD	BOB	-	1	-	-	-	-	-	-	-	-

TABLE A-2.2-10 (Cont)

MAGAZINE	MALFUNCTION TYPE	MALFUNCTION CAUSE	VENDOR/WEAPON NO. ALPHA (T27-3)	BRAVO (T27-4)	CHARLIE (T27-7)	DELTA (T27-5)	ECHO (T27-8)	FOXTROT (T27-11)	HOTEL (T27-6)	JULIET (T27-10)	KILO (T27-1)	LIMA (T27-2)
OVERALL												
C	FF2	NA	-	-	3	-	-	-	-	-	-	-
D			-	1	-	-	-	-	-	-	-	-
A	FFD	BLE	-	-	-	-	-	1	-	-	-	-
A		BOB	-	13	10	-	-	-	-	3	-	2
B			1	18	10	-	-	-	-	3	-	1
B-1			NA	2	NA	NA	NA	NA	NA	NA	NA	NA
C		BLE	-	2	-	-	-	-	-	-	-	-
C		BOB	2	14	10	1	-	-	-	2	1	-
C-1			NA	5	5	NA	NA	NA	NA	NA	NA	NA
D			-	14	7	-	1	-	1	2	2	7
D-1			NA	NA	NA	NA	NA	NA	NA	NA	NA	2
A	FFR	LI	-	-	-	-	-	-	-	1	-	-
B			-	-	-	-	-	1	-	-	2	-
C			-	-	-	-	-	-	-	2	-	1
D			-	-	1	-	-	-	-	-	-	-
B	FSR	NA	-	-	-	-	-	-	-	1	-	-
C			-	-	-	-	-	-	-	-	1	-
D			-	-	1	-	-	-	-	-	-	-
C	FTC	BLE	-	-	-	-	-	-	-	1	-	-
Overall			3	69	47	1	1	2	1	15	6	13

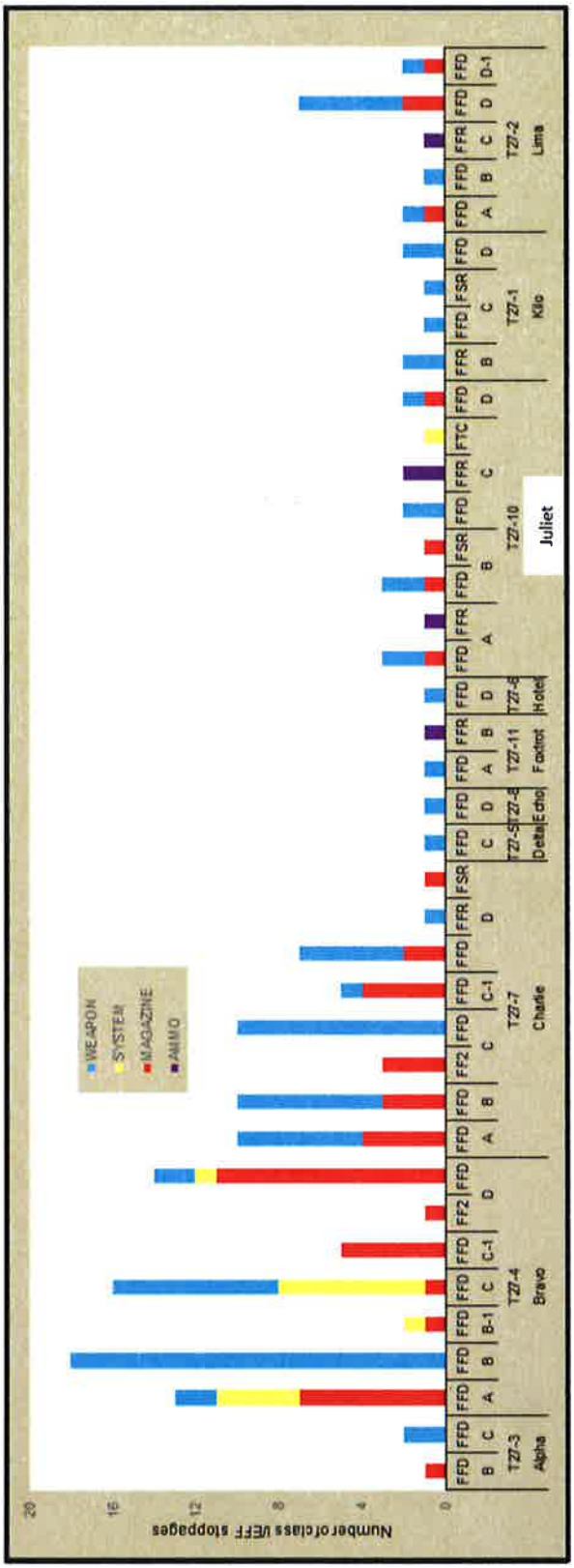


Figure A-2.2-4. Class I/EFF failure modes for M27 weapons.

TABLE A-2.2-11. CLASS III/EFF FAILURE MODES FOR M27 WEAPONS

MAGAZINE	MALFUNCTION TYPE	MALFUNCTION CAUSE	VENDOR/WEAPON NO. ALPHA (T27-3)	BRAVO (T27-4)	CHARLIE (T27-7)	DELTA (T27-5)	ECHO (T27-8)	FOXTROT (T27-11)	HOTEL (T27-6)	JULIET (T27-10)	KILO (T27-1)	LIMA (T27-2)
MAGAZINE												
B	OTH	NA	-	1	-	-	-	-	-	-	-	-
C			-	1	1	-	-	-	-	-	-	-
D			-	-	-	-	-	-	-	-	-	1
WEAPON												
A	FRA	NA	1	-	-	-	-	-	-	-	-	-
C			-	-	-	-	-	1	-	-	-	-
C-1			NA	-	1	NA	NA	NA	NA	NA	NA	NA
OVERALL												
A	FRA	NA	1	-	-	-	-	-	-	-	-	-
C			-	-	-	-	-	1	-	-	-	-
C-1			NA	-	1	NA	NA	NA	NA	NA	NA	NA
B	OTH	NA	-	1	-	-	-	-	-	-	-	-
C			-	1	1	-	-	-	-	-	-	-
D			-	-	-	-	-	-	-	-	-	1
Overall			1	2	2	-	-	1	-	-	-	1

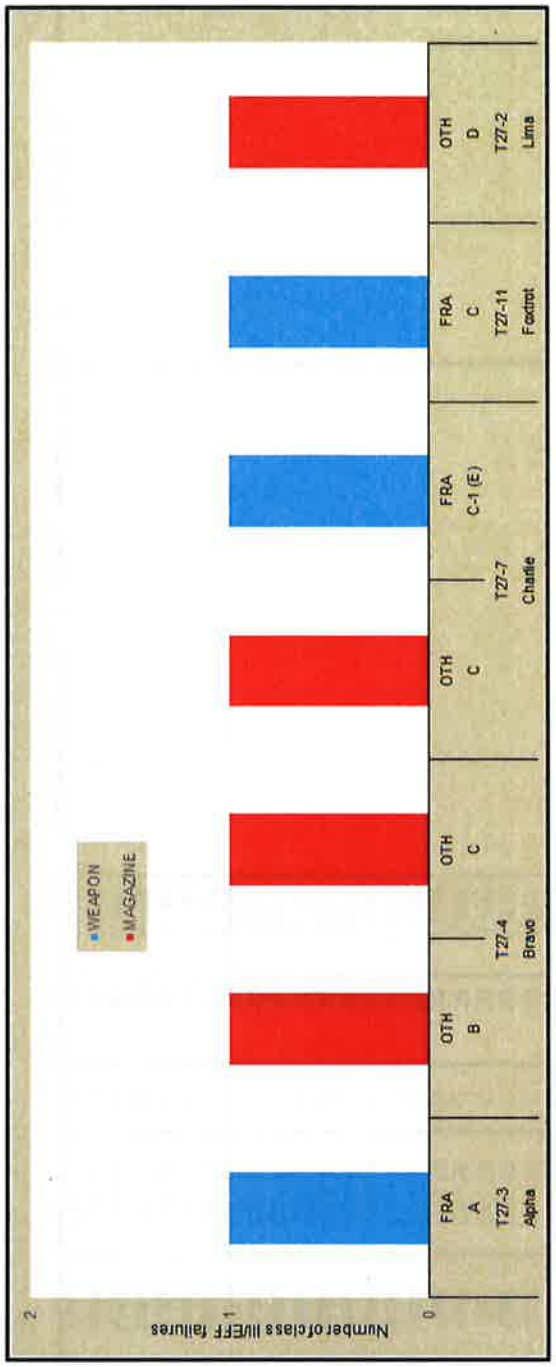


Figure A-2.2-5. Class III/EFF failure modes for M27 weapons.

TABLE A-2.2-12. SUMMARY OF FAILURE MODES FOR M4A1 WEAPONS

SEQUENCE NO.	VENDOR	WEAPON NO.	MAGAZINE NO.	MAGAZINE ROUND	SUBTEST ROUND	MALFUCTION TYPE/DESCRIPTION	FD/SC SCORE/ CORRECTIVE ACTION
M4A1							
105 489	Golf Bravo	C41-10 C41-4	A B	1 21	1 1,851	FFD. The magazine was feeding low into the weapon, which caused the tip of the projectile to get caught on the top front of the magazine and the feed ramp in the upper receiver. Note: the feed ramps in this weapon showed more wear than any other magazine vendor across M4A1 weapons.	Class I/EFF. The round was replaced and fired successfully (Charged to magazine).
7	Golf	C41-10	D	30	240	FBR. The bolt failed to lock to the rear after the last round in the magazine was fired.	Class I/EFF. The bolt was pulled back manually to the locked position (Charged to magazine).
109	Golf	C41-10	D	30	360		
215	Golf	C41-10	D	30	1,200		
563	Golf	C41-10	B	30	1,980		
567	Golf	C41-10	D	30	2,400		
853	Golf	C41-10	B	30	3,180		
1140	Golf	C41-10	B	30	3,780		
1144	Golf	C41-10	B	30	4,140		
1147	Golf	C41-10	C	30	4,290		
1149	Golf	C41-10	B	30	4,380		
1150	Golf	C41-10	C	30	4,410		
1153	Golf	C41-10	C	30	4,650		
1155	Golf	C41-10	C	30	4,770		
1438	Golf	C41-10	B	30	5,100		
1440	Golf	C41-10	B	30	5,220		
1442	Golf	C41-10	B	30	5,340		
1452	Golf	C41-10	C	30	5,970		
1740	Golf	C41-10	C	30	6,210		
1742	Golf	C41-10	C	30	6,330		
1744	Golf	C41-10	C	30	6,450		
1748	Golf	C41-10	C	30	6,690		
2066	Golf	C41-10	D	30	7,680		
219	India	C41-11	D	30	480		
570	India	C41-11	C	30	1,290		
573	India	C41-11	C	30	1,530		
859	India	C41-11	C	30	2,490		
861	India	C41-11	C	30	2,610		
865	India	C41-11	B	30	2,700		
863	India	C41-11	C	30	2,850		
870	India	C41-11	C	30	3,090		
874	India	C41-11	C	30	3,450		
875	India	C41-11	D	30	3,480		
1164	India	C41-11	C	30	4,290		
1166	India	C41-11	C	30	4,410		
1168	India	C41-11	D	30	4,560		
1759	India	C41-11	D	30	6,360		
2078	India	C41-11	D	30	7,560		
2085	India	C41-11	D	30	8,160		

TABLE A-2.2-12 (Cont)

SEQUENCE NO.	VENDOR	WEAPON NO.	MAGAZINE NO.	MAGAZINE ROUND	SUBTEST ROUND	MALFUCTION TYPE/DESCRIPTION	FD/SC SCORE/ CORRECTIVE ACTION
				M4A1			
473	Alpha	C41-3	D	1	1,651	FFD. Before the stoppage could be observed by the test officer, the scissor mount was bumped and the round fully chambered.	Class I/EFF. The round was reloaded and fired successfully (Charged to system).
869	India	C41-11	D	30	3,000	Other. The spring in the sear assembly was noted deformed and displaced during scheduled wipe and lube.	Class III/EFF. The sear assembly (P/N 8448595) was replaced (Charged to weapon).
812	Charlie	C41-7	D	14	3,104	FFD. The bolt overrode the base of the cartridge and damaged the side of the cartridge case due to being pinched between the lugs of the bolt and the lugs of the barrel extension. The round was stubbed on the rear of the barrel.	Class I/EFF. The round was replaced and fired successfully (Charged to weapon).
817	Charlie	C41-7	D	5	3,455		
819	Charlie	C41-7	D	3	3,573		
815	Charlie	C41-7	A	1	3,241	FF2. The double feed occurred on rounds 1 and 2.	Class I/EFF. The bolt was pulled to the rear and the stoppage was cleared (Charged to magazine).
1705	Charlie	C41-7	A	1	6,721		
2031	Charlie	C41-7	A	1	7,921		
1337	Lima	C41-2	B	2	5,072	FEJ. The mouth of the spent cartridge was outside of the ejection port (stove pipe) causing the bolt to cease its forward motion.	Class I/EFF. The stoppage was cleared (Charged to weapon).
1338	Lima	C41-2	B	25	5,095		
1369	Bravo	C41-4	D	19	5,629	FFD. The magazine was feeding low into the weapon, which caused the tip of the projectile to get caught on the feed ramp in the upper receiver.	Class I/EFF. The round was replaced and fired successfully (Charged to magazine).
1373	Bravo	C41-4	B	23	5,933		
1447	Golf	C41-10	B	30	5,700	FBR. The bolt failed to lock to the rear after the last round in the magazine was fired.	Dependent malfunction. Linked to sequence 1450 and 1754 for corrective action (Charged to magazine).
1449	Golf	C41-10	B	30	5,820		
1752	Golf	C41-10	C	30	7,050		
1450	Golf	C41-10	B	30	5,820	Other. Due to multiple failures of the bolt to lock to the rear when using magazine B/C.	Class III/EFF. Magazine was replaced with a spare magazine (Charged to magazine).
1754	Golf	C41-10	C	30	7,170		
1984	Bravo	C41-4	C	23	7,283	FFD. The bolt overrode the base of the cartridge and damaged the side of the cartridge case due to being pinched between the lugs of the bolt and the lugs of the barrel extension. The round was stubbed on the rear of the barrel.	Class I/EFF. The round was replaced and fired successfully (Charged to magazine).
2277	Bravo	C41-4	C	23	8,483		
2286	Bravo	C41-4	B	21	9,051		
2287	Bravo	C41-4	D	21	9,111		
2292	Bravo	C41-4	B	25	9,535		
1701	Charlie	C41-7	D	5	6,575		
1688	Hotel	C41-6	D	5	6,575		
2062	Golf	C41-10	C-1	24	7,284	FFR. The primer was struck but the round did not fire and the primer indentation was not deep enough by visual inspection. The cartridge case was deformed at the bottle neck and would not allow the round to fully chamber. The energy of the hammer was used to slide the bolt carrier forward and did not leave enough energy to properly strike the firing pin.	Class I/EFF. The round was replaced (Charged to ammunition).

TABLE A-2.2-12 (Cont)

SEQUENCE NO.	VENDOR	WEAPON NO.	MAGAZINE NO.	MAGAZINE ROUND	SUBTEST ROUND	MALFUCTION TYPE/DESCRIPTION	FD/SC SCORE/ CORRECTIVE ACTION
			M4A1				
1970	Alpha	C41-3	B	10	7,360	FTC. Bolt lug(s) broke off of the bolt.	Dependent malfunction. Linked to sequence number 1971, 2281, 1708, 1722, 2355, 1769, 2393, and 2242, respectively for corrective action (Charged to weapon).
2280	Bravo	C41-4	D	4	8,734		
1707	Charlie	C41-7	C	14	6,914		
1721	Echo	C41-8	C	22	6,922		
2354	Foxtrot	C41-9	D	21	9,351		
1768	India	C41-11	C	12	7,152		
2392	Juliet	C41-12	D	10	9,460		
2241	Kilo	C41-1	B	8	8,678		
1971	Alpha	C41-3	B	10	7,360	FRA. The broken bolt lug (s) was stuck between the bolt carrier and the ejection port of the upper receiver	Class III/EFF. The bolt assembly (PN 13004787) was replaced (Charged to weapon).
2281	Bravo	C41-4	D	30	8,760		
1708	Charlie	C41-7	C	14	6,914		
1722	Echo	C41-8	C	22	6,922		
2355	Foxtrot	C41-9	D	21	9,351		
1769	India	C41-11	C	12	7,152		
2393	Juliet	C41-12	D	30	9,480		
2242	Kilo	C41-1	B	8	8,678		
1972	Alpha	C41-3	B	10	7,360	Other. Fire control selector was observed loose.	NEFF. The fire control selector was tightened (Charged to weapon).
1957	Lima	C41-2	D	1	7,531	FXT. The weapon failed to extract the spent cartridge out of the chamber. As the weapon attempted to feed the next round the projectile stubbed on the back of the barrel because it could not be chambered due to the empty cartridge case remaining in the chamber. This caused a failure to feed on the second round.	Class I/EFF. The round was replaced (Charged to weapon).
2296	Delta	C41-5	C	2	8,582		
1958	Lima	C41-2	D	2	7,532	FFD. The bolt overrode the base of the cartridge and damaged the side of the cartridge case due to being pinched between the lugs of the bolt and the lugs of the barrel extension. The round was stubbed on the rear of the barrel.	Dependent malfunction. Linked to sequence number 1957 and 2296, respectively for corrective action (Charged to weapon).
2250	Delta	C41-5	C	3	8,583		
2016	Hotel	C41-6	A	5	7,925	IFR. With the weapon selected to semi-automatic mode, the weapon fired two rounds with one trigger pull. No stoppage occurred and firing continued.	Dependent malfunction. Linked to sequence number 2308 for corrective action (Charged to weapon).
2018	Hotel	C41-6	C	14	8,114		
2020	Hotel	C41-6	A	10	8,170		
2033	Charlie	C41-7	A	1	8,041	Other. Round popped out of the magazine.	Class I/EFF. The round was reloaded (Charged to weapon).
2308	Hotel	C41-6	A	0	8,400	Other. The weapon was discovered to be double firing.	Class III/EFF. The hammer (P/N 8448612) was replaced (Charged to weapon).

TABLE A-2.2-13. SUMMARY OF FAILURE MODES FOR M16A4 WEAPONS

SEQUENCE NO.	VENDOR	WEAPON NO.	MAGAZINE NO.	MAGAZINE ROUND	SUBTEST ROUND	MALFUCTION TYPE/DESCRIPTION	FD/SC SCORE/ CORRECTIVE ACTION
M16A4							
406 429	Golf India	2T164-4 2T164-5	B D	30 30	60 960	FBR. The bolt failed to lock to the rear after the last round in the magazine was fired.	Class I/EFF. The bolt was pulled back manually to the locked position (Charged to magazine).
36	Hotel	T164-6	B	1	511	FF2. The double feed occurred on rounds 1 and 2.	Class I/EFF. The stoppage was cleared (Charged to magazine).
46	Lima	T164-2	A	2	722	FTC. The bolt lacked sufficient energy to fully chamber the round from the magazine because of drag between the bolt and the second round of the magazine.	Class I/EFF. The round was replaced (Charged to magazine).
59 61	Bravo Bravo	T164-4 T164-4	A A	22 25	742 865	FFD. The cartridge was almost completely stripped from the magazine when the tip of the projectile was arrested by contacting the rear of the barrel, outside of the bore.	Class I/EFF. The stoppage was cleared and the round was replaced (Charged to weapon).
417	Golf	2T164-4	D	29	1,199	FXT. The spent cartridge did not extract from the chamber. This caused a stoppage on the following round.	Dependent failure. Linked to sequence 418 for corrective action (Charged to weapon).
418	Golf	2T164-4	D	30	1,200	FFD. This stoppage was due to the failure to extract on the previous round. The bolt cycled to the rear and picked up another round while an empty cartridge case was still in the chamber.	Class I/EFF. The spent cartridge case was removed and the round was replaced (Charged to weapon).

TABLE A-2.2-14. SUMMARY OF FAILURE MODES FOR M27 WEAPONS

SEQUENCE NO.	VENDOR	WEAPON NO.	MAGAZINE NO.	MAGAZINE ROUND	SUBTEST ROUND	MALFUCTION TYPE/DESCRIPTION	FD/SC SCORE/ CORRECTIVE ACTION
M27							
239	Kilo	T27-1	C	2	62	FSR. The magazine slid down away from the bolt carrier which caused the top round in the magazine to be low for the bolt to push forward. The magazine slid down due to the magazine catch from the weapon had resistance and was not fully inserted into the hole in the magazine. The magazine slid down the magazine well because it was not properly secured by the weapon. The magazine did not completely fall out of the magazine well due to the tight tolerances of the M27 magazine well.	Class I/EFF. The magazine was reinserted into the weapon and the round loaded and fired successfully (Charged to weapon).
324	Charlie	T27-7	D	26	836	FSR. The tips of the ammunition had carved a groove into the front of the magazine. The tips of the projectiles were stuck inside the magazine, causing the cartridge to not be presented high enough for the bolt to strip the round.	Class I/EFF. The magazine was reinserted into the weapon and the round loaded and fired successfully (Charged to magazine).
272	Alpha	T27-3	C	30	810	FFD. The bolt overrode the base of the cartridge and damaged the side of the cartridge case due to being pinched between the lugs of the bolt and the lugs of the barrel extension. The round was stubbed on the rear of the barrel.	Class I/EFF. The round was replaced and fired successfully (Charged to weapon).
1518	Alpha	T27-3	C	30	5,730		
285	Bravo	T27-4	B	15	765		
289	Bravo	T27-4	B	15	1,125		
931	Bravo	T27-4	B	20	2,450		
933	Bravo	T27-4	B	23	2,573		
934	Bravo	T27-4	B	25	2,575		
935	Bravo	T27-4	C	30	2,610		
937	Bravo	T27-4	B	16	2,686		
940	Bravo	T27-4	C	23	2,963		
944	Bravo	T27-4	B	23	3,173		
948	Bravo	T27-4	C	23	3,563		
1222	Bravo	T27-4	B	27	3,777		
1228	Bravo	T27-4	B	25	4,255		
1230	Bravo	T27-4	B	23	4,373		
1231	Bravo	T27-4	D	29	4,439		
1233	Bravo	T27-4	B	26	4,496		
1234	Bravo	T27-4	C	24	4,524		
1235	Bravo	T27-4	D	29	4,559		
1238	Bravo	T27-4	A	17	4,697		
1525	Bravo	T27-4	C	23	5,123		
1528	Bravo	T27-4	A	29	5,309		
1531	Bravo	T27-4	B	24	5,454		
1532	Bravo	T27-4	B	27	5,457		
1534	Bravo	T27-4	C	27	5,607		
1538	Bravo	T27-4	B	23	5,933		
1539	Bravo	T27-4	B	27	5,937		
326	Charlie	T27-7	C	2	902		
327	Charlie	T27-7	C	4	904		

TABLE A-2.2-14 (Cont)

SEQUENCE NO.	VENDOR	WEAPON NO.	MAGAZINE NO.	MAGAZINE ROUND	SUBTEST ROUND	MALFUCTION TYPE/DESCRIPTION	FD/SC SCORE/ CORRECTIVE ACTION
			M27				
329	Charlie	T27-7 -	B	2	992	FFD. The bolt overrode the base of the cartridge and damaged the side of the cartridge case due to being pinched between the lugs of the bolt and the lugs of the barrel extension. The round was stubbed on the rear of the barrel.	Class I/EFF. The round was replaced and fired successfully (Charged to weapon).
330	Charlie	T27-7	C	17	1,037		
975	Charlie	T27-7	C	4	2,464		
976	Charlie	T27-7	C	18	2,478		
980	Charlie	T27-7	C	2	2,822		
987	Charlie	T27-7	A	2	3,242		
1269	Charlie	T27-7	B	4	3,754		
1274	Charlie	T27-7	C	3	4,143		
1275	Charlie	T27-7	C	7	4,147		
1280	Charlie	T27-7	D	2	4,532		
1282	Charlie	T27-7	C	4	4,624		
1566	Charlie	T27-7	A	6	4,806		
1569	Charlie	T27-7	B	4	4,954		
1570	Charlie	T27-7	D	21	5,031		
1572	Charlie	T27-7	C-1	3	5,103		
1575	Charlie	T27-7	D	5	5,375		
1578	Charlie	T27-7	D	4	5,494		
1249	Delta	T27-5	C	16	4,516		
1591	Echo	T27-8	D	13	5,503		
306	Hotel	T27-6	D	1	331		
1602	Juliet	T27-10	D	4	5,374		
1605	Juliet	T27-10	B	8	5,438		
1913	Juliet	T27-10	A	11	6,251		
1914	Juliet	T27-10	C	25	6,325		
1918	Juliet	T27-10	B	2	6,512		
1919	Juliet	T27-10	C	2	6,542		
1923	Juliet	T27-10	A	6	6,606		
1480	Kilo	T27-1	C	30	5,010		
1785	Kilo	T27-1	D	28	6,238		
255	Lima	T27-2	D	19	469		
906	Lima	T27-2	D	24	2,634		
909	Lima	T27-2	D	22	2,872		
1493	Lima	T27-2	D	18	5,028		
1499	Lima	T27-2	D	20	5,510		
1807	Lima	T27-2	B	21	7,011		
1809	Lima	T27-2	D-1	20	7,190		

TABLE A-2.2-14 (Cont)

SEQUENCE NO.	VENDOR	WEAPON NO.	MAGAZINE NO.	MAGAZINE ROUND	SUBTEST ROUND	MALFUCTION TYPE/DESCRIPTION	FD/SC SCORE/ CORRECTIVE ACTION
M27							
636	Bravo	T27-4	B	27	1,257	FFD. The bolt overrode the base of the cartridge and damaged the side of the cartridge case due to being pinched between the lugs of the bolt and the lugs of the barrel extension.	Class I/EFF. The stoppage was cleared, the round was replaced and fired successfully (Charged to weapon).
641	Bravo	T27-4	C	29	1,769		
645	Bravo	T27-4	B	27	1,977		
647	Bravo	T27-4	B	25	2,095		
676	Charlie	T27-7	A	2	1,202		
677	Charlie	T27-7	B	14	1,244		
678	Charlie	T27-7	B	18	1,248		
679	Charlie	T27-7	D	21	1,311		
681	Charlie	T27-7	A	4	1,324		
682	Charlie	T27-7	B	6	1,356		
683	Charlie	T27-7	B	17	1,367		
691	Charlie	T27-7	A	3	2,043		
695	Charlie	T27-7	C	1	2,341		
602	Kilo	T27-1	D	24	1,914		
610	Lima	T27-2	A	19	1,339		
613	Lima	T27-2	D	22	1,672		
621	Lima	T27-2	D	22	2,392		
694	Charlie	T27-7	C	1	2,341	FF2. The double feed occurred on rounds 1 and 2. The bolt face caught both rounds from the magazine	Class I/EFF. The bolt was pulled to the rear and the stoppage was cleared (Charged to weapon).
1018	Foxtrot	T27-11	A	24	2,544	FFD. The bolt carrier completely closed; however, the bolt took several seconds to chamber the round.	Class I/EFF. The bolt cycled by the charging handle and still had the resistance. The magazine was reinserted. Once chambered the round fired successfully (Charged to weapon).
892	Kilo	T27-1	B	14	2,564	FFR. The primer was struck but the round did not fire. From visual inspection it appeared that the primer indent was not deep enough.	Class I/EFF. The round was reloaded and fired successfully (Charged to weapon).
896	Kilo	T27-1	B	30	2,940		
984	Charlie	T27-7	D	22	3,112	FFR. The primer was struck but the round did not fire.	Class I/EFF. The round was reloaded and fired successfully (Charged to weapon).
990	Charlie	T27-7	C	1	3,541	FF2. The double feed occurred on rounds 1 and 2 because the top round presented too high in the magazine due to the magazine experiencing significant feed lip separation.	Class I/EFF. The bolt was pulled to the rear and the stoppage was cleared (Charged to magazine).
1266	Charlie	T27-7	C	1	3,661		
1267	Charlie	T27-7	C	30	3,690	Other. Prior to loading magazine into the weapon, it was noted that when the magazine was sitting on top of the brass catcher, the first round would pop out.	NEFF. The round was manually loaded back into the magazine (Charged to magazine).
1271	Charlie	T27-7	A	4	3,844	FFD. The bolt overrode the base of the cartridge and damaged the side of the cartridge case due to being pinched between the lugs of the bolt and the lugs of the barrel extension. The round was stubbed on the rear of the barrel.	Class I/EFF. The round was positioned at approximately an 80 degree angle. The stoppage was cleared, the round was replaced and fired successfully (Charged to weapon).

TABLE A-2.2-14 (Cont)

SEQUENCE NO.	VENDOR	WEAPON NO.	MAGAZINE NO.	MAGAZINE ROUND	SUBTEST ROUND	MALFUCTION TYPE/DESCRIPTION	FD/SC SCORE/ CORRECTIVE ACTION
				M27			
1825	Bravo	T27-4	B	2	6,152	FFD. The bolt overrode the base of the cartridge and damaged the side of the cartridge case due to being pinched between the lugs of the bolt and the lugs of the barrel extension. The round was stubbed on the rear of the barrel.	Dependent malfunction. Linked to sequence number 1797 and 1831 (Charged to magazine).
1826	Bravo	T27-4	B	5	6,155		
1827	Bravo	T27-4	B	13	6,163		
1828	Bravo	T27-4	B	17	6,167		
1829	Bravo	T27-4	B	19	6,169		
1830	Bravo	T27-4	B	27	6,177		
2149	Bravo	T27-4	C	26	7,646		
2156	Bravo	T27-4	C	26	8,006		
1502	Lima	T27-2	D	22	5,752		
1506	Lima	T27-2	D	21	5,991		
1507	Lima	T27-2	D	23	5,993		
1931	Foxtrot	T27-11	B	6	6,156	FFR. The primer was struck but the round did not fire and the primer indentation was not deep enough by visual inspection. The cartridge case was deformed at the bottle neck and would not allow the round to fully chamber. The energy of the hammer was used to slide the bolt carrier forward and did not leave enough energy to properly strike the firing pin.	Class I/EFF. The round was replaced and fired successfully (Charged to ammo).
1304	Juliet	T27-10	A	16	4,216		
1916	Juliet	T27-10	C	26	6,446		
2224	Juliet	T27-10	C	30	8,370		
1505	Lima	T27-2	C	8	5,948		
1831	Bravo	T27-4	B	30	6,180	Other. Multiple failure to feed stoppages occurred due to the bolt being over the base of the cartridge.	Class III/EFF. Magazine was replaced with a spare magazine (Charged to magazine).
2157	Bravo	T27-4	C	30	8,010		
1567	Charlie	T27-7	C	30	4,890		
1797	Lima	T27-2	D	0	6,090		
1833	Bravo	T27-4	A	15	6,255	FFD. The bolt overrode the base of the cartridge and damaged the side of the cartridge case due to being pinched between the lugs of the bolt and the lugs of the barrel extension. The round was stubbed on the rear of the barrel.	Class I/EFF. The round was replaced and fired successfully (Charged to system).
1834	Bravo	T27-4	A	17	6,257		
1835	Bravo	T27-4	A	25	6,265		
1836	Bravo	T27-4	B-1	25	6,295		
1837	Bravo	T27-4	D	23	6,353		
1839	Bravo	T27-4	A	10	6,370		
1840	Bravo	T27-4	C	25	6,445		
1843	Bravo	T27-4	C	24	6,564		
1844	Bravo	T27-4	C	25	6,565		
1847	Bravo	T27-4	C	24	6,684		

TABLE A-2.2-14 (Cont)

SEQUENCE NO.	VENDOR	WEAPON NO.	MAGAZINE NO.	MAGAZINE ROUND	SUBTEST ROUND	MALFUCTION TYPE/DESCRIPTION	FD/SC SCORE/ CORRECTIVE ACTION
M27							
1842	Bravo	T27-4	C	22	6,562	FFD. The bolt lacked energy. The round was stubbed on the feed ramp at the intersection of the upper receiver and barrel extension. This weapon experienced excessive wear on the feed ramp intersection between the upper receiver and barrel extension. The excessive wear was caused by the M855A1 penetrator contacting the aluminum upper receiver feed ramp. The reason the penetrator was allowed to feed this low was because of the magazine feeding geometry. Wear on the feed ramp intersection area in this weapon was the primary cause of FFD stoppages changed from weapon to ammunition related. The steel M855A1 penetrator has removed material and damaged the feed path in the weapon itself to contribute to being the primary cause of FFD stoppages.	Class I/EFF. The stoppage was cleared, the round was replaced and fired successfully (Charged to system).
1920	Juliet	T27-10	C	23	6,563	FTC. The bolt lacked energy. The round was stubbed on the ramp and damaged the cartridge case. .	Class I/EFF. The stoppage was cleared, the round was replaced and fired successfully (Charged to system).
1848	Bravo	T27-4	D	26	6,716	FF2. The double feed occurred on rounds 26 and 27 due to the bolt over the base of round 27. Round 26 was mostly in the chamber and round 27 was drug up by the bolt lugs on the bottom of the bolt.	Class I/EFF. The bolt was pulled to the rear and the stoppage was cleared (Charged to magazine).
1851 1854	Bravo Bravo	T27-4 T27-4	C C	25 26	6,925 7,166	FFD. The bolt overrode the base of the cartridge and damaged the side of the cartridge case due to being pinched between the lugs of the bolt and the lugs of the barrel extension. The round was stubbed on the rear of the barrel. Weapon T27-4 has experienced excessive wear on the feed ramp intersection between the upper receiver and barrel extension. The excessive wear was caused by the M855A1 penetrator contacting the aluminum upper receiver feed ramp. The reason the penetrator was allowed to feed this low was because of the magazine feeding geometry. Wear on the feed ramp intersection area in this weapon was the primary cause of FFD stoppages changed from weapon to ammunition related. The steel M855A1 penetrator has removed material and damaged the feed path in the weapon itself to contribute to being the primary cause of FFD stoppages.	Class I/EFF. The stoppage was cleared, the round was replaced and fired successfully (Charged to system).
2143	Bravo	T27-4	C	21	7,521	FFD. The tip of the round became hung up on the seam between the upper receiver and the barrel extension. Although the bolt was behind the round, the bolt lacked sufficient energy to push the round into the chamber. The original round was stubbed.	Class I/EFF. A new round was inserted into the magazine (Charged to weapon).

TABLE A-2.2-14 (Cont)

SEQUENCE NO.	VENDOR	WEAPON NO.	MAGAZINE NO.	MAGAZINE ROUND	SUBTEST ROUND	MALFUCTION TYPE/DESCRIPTION	FD/SC SCORE/ CORRECTIVE ACTION
M27							
2134	Alpha	T27-3	A	16	7,936	FRA. Lug(s) was observed broken off of the left side of the extractor.	Class III/EFF. The bolt assembly was replaced (Charged to weapon).
2526	Charlie	T27-7	C-1	16	9,316		
2469	Foxtrot	T27-11	C	6	8,706		
2133	Alpha	T27-3	A	16	7,936	FTC. One of the bolt lugs was broke off of the bolt. The broken bolt lug was stuck between the bolt carrier and the ejection port of the upper receiver.	Dependent malfunction. Linked to sequence number 2469, 2526 and 2134 (Charged to magazine).
2525	Charlie	T27-7	C-1	16	9,316		
2468	Foxtrot	T27-11	C	6	8,706		
2460	Juliet	T27-10	B	2	8,552	FSR. The magazine did not present the round high enough.	Class I/EFF. The magazine was reinserted (Charged to magazine).
2415	Alpha	T27-3	B	22	8,932	FFD. The bolt overrode the base of the cartridge and damaged the side of the cartridge case due to being pinched between the lugs of the bolt and the lugs of the barrel extension. The round was stubbed on the rear of the barrel.	Class I/EFF. The round was replaced and fired successfully (Charged to magazine).
2141	Bravo	T27-4	A	25	7,345		
2144	Bravo	T27-4	C	25	7,525		
2145	Bravo	T27-4	D	23	7,553		
2146	Bravo	T27-4	D	25	7,555		
2148	Bravo	T27-4	B-1	25	7,615		
2150	Bravo	T27-4	D	25	7,675		
2152	Bravo	T27-4	D	17	7,787		
2418	Bravo	T27-4	C-1	25	8,485		
2420	Bravo	T27-4	A	27	8,547		
2422	Bravo	T27-4	A	27	8,667		
2423	Bravo	T27-4	C-1	29	8,729		
2424	Bravo	T27-4	D	23	8,753		
2426	Bravo	T27-4	D	19	8,869		
2427	Bravo	T27-4	D	27	8,877		
2429	Bravo	T27-4	A	23	8,903		
2430	Bravo	T27-4	D	23	8,993		
2492	Bravo	T27-4	A	25	9,025		
2493	Bravo	T27-4	A	29	9,029		
2494	Bravo	T27-4	C-1	29	9,089		
2495	Bravo	T27-4	D	25	9,115		
2496	Bravo	T27-4	D	27	9,117		
2498	Bravo	T27-4	D	25	9,235		
2501	Bravo	T27-4	C-1	25	9,445		
2503	Bravo	T27-4	A	26	9,506		
2504	Bravo	T27-4	C-1	22	9,562		
1881	Charlie	T27-7	B	3	6,033		
1883	Charlie	T27-7	C-1	5	6,185		
1885	Charlie	T27-7	A	23	6,263		
1886	Charlie	T27-7	C-1	13	6,313		
1887	Charlie	T27-7	C-1	15	6,315		
1895	Charlie	T27-7	D	13	7,063		
2193	Charlie	T27-7	A	4	7,804		
2445	Charlie	T27-7	B	2	8,432		
2447	Charlie	T27-7	C-1	2	8,582		
2520	Charlie	T27-7	A	4	9,004		

TABLE A-2.2-14 (Cont)

SEQUENCE NO.	VENDOR	WEAPON NO.	MAGAZINE NO.	MAGAZINE ROUND	SUBTEST ROUND	MALFUCTION TYPE/DESCRIPTION	FD/SC SCORE/ CORRECTIVE ACTION
						M27	
2519	Charlie	T27-7	A	4	9,004	FFD. The bolt overrode the base of the cartridge and damaged the side of the cartridge case due to being pinched between the lugs of the bolt and the lugs of the barrel extension. The round was stubbed on the rear of the barrel.	Class I/EFF. The round was replaced and fired successfully (Charged to magazine).
2521	Charlie	T27-7	B	3	9,033		
2522	Charlie	T27-7	D	9	9,099		
2212	Juliet	T27-10	B	8	7,238		
2214	Juliet	T27-10	A	4	7,324		
2540	Juliet	T27-10	D	28	9,478		
2403	Lima	T27-2	A	20	8,420		
2407	Lima	T27-2	D-1	23	8,873		

TABLE A-2.2-15. CLASS I/EFF RELIABILITY CHARACTERISTICS FOR M4A1 WEAPONS

VENDOR	WEAPON NO.	MAGAZINE NO.	ROUNDS FIRED	MAGAZINE				SYSTEM			
				NO. OF EFFs	PE	80% LCL	90% LCL	NO. OF EFFs	PE	80% LCL	90% LCL
Alpha	C41-3	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
		All	9,600	-	NA[a]	5,965	4,169	1	3,206	3,206	2,468
Bravo	C41-4	A	2,400	-	NA	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	4	600	357	300	4	600	357	300
		C	2,400	2	1,200	561	451	2	1,200	561	451
		D	2,400	2	1,200	561	451	2	1,200	561	451
		All	9,600	8	1,200	844	739	8	1,200	844	739
Charlie	C41-7	A	2,400	4	600	357	300	4	600	357	300
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	1	2,400	802	617	4	600	357	300
		All	9,600	5[b]	1,920	1,214	1,035	8[b]	1200	844	739
Delta	C41-5	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	-	NA[a]	5,965	4,169	1	9,600	3,206	2,468
Echo	C41-8	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	-	NA[a]	5,965	4,169	-	NA[a]	5,965	4,169
Foxtrot	C41-9	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	-	NA[a]	5,965	4,169	-	NA[a]	5,965	4,169

See notes at end of table.

TABLE A-2.2-15 (Cont)

VENDOR	WEAPON NO.	MAGAZINE NO.	ROUNDS FIRED	MAGAZINE				SYSTEM			
				NO. OF EFFs	PE	80% LCL	90% LCL	NO. OF EFFs	PE	80% LCL	90% LCL
Golf	C41-10	A	2,400	1	2,400	802	617	1	2,400	802	617
		B	1,470	8	184	129	113	8	184	129	113
		B-1	930	-	NA[a]	578	404	-	NA[a]	578	404
		C	1,800	9	200	144	127	9	200	144	127
		C-1	600	-	NA[a]	373	261	1	600	200	154
		D	2,400	5	480	304	259	5	480	304	259
		All	9,600	23[b]	417	343	315	24[b]	400	330	304
Hotel	C41-6	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	1	2,400	802	617	1	2,400	802	617
		All	9,600	1	9,600	3,206	2,468	1	9,600	3,206	2,468
India	C41-11	A	2,400	-	NA[a]	1,491	1042	-	NA[a]	1,491	1,042
		B	2,400	1	2,400	802	617	1	2,400	802	617
		C	2,400	9	267	192	169	9	267	192	169
		D	2,400	6	400	264	228	6	400	264	228
		All	9,600	16[b]	600	472	428	16[b]	600	472	428
Juliet	C41-12	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	-	NA[a]	5,965	4,169	-	NA[a]	5,965	4,169
Kilo	C41-1	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	-	NA[a]	5,965	4,169	-	NA[a]	5,965	4,169

See notes at end of table.

TABLE A-2.2-15 (Cont)

VENDOR	WEAPON NO.	MAGAZINE NO.	ROUNDS FIRED	MAGAZINE				SYSTEM			
				NO. OF EFFs	PE	80% LCL	90% LCL	NO. OF EFFs	PE	80% LCL	90% LCL
Lima	C41-2	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	2	1,200	561	451
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
All			9,600	-	NA[a]	5,965	4,169	3	3,200	1,741	1,437

[a]The PE could not be calculated since no failures occurred; however, since 2,400 rounds were successfully fired without a failure, it is concluded that the PE is greater than 2,400 rounds.
[b]Test results indicated statistical differences between the individual magazines, combined results are provided for informational purposes only.

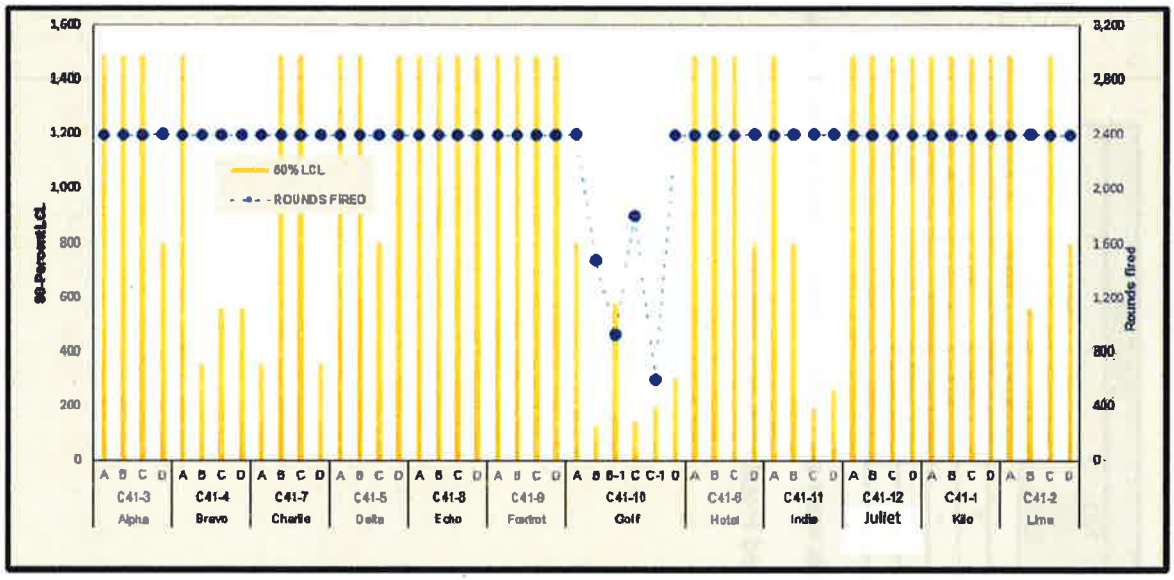


Figure A-2.2-6. M4A1 weapons actual reliability 80% LCL vs. rounds fired for class I/EFF stoppages.

TABLE A-2.2-16. CLASS III/EFF RELIABILITY CHARACTERISTICS FOR M4A1 WEAPONS

VENDOR	WEAPON NO.	MAGAZINE NO.	ROUNDS FIRED	MAGAZINE				SYSTEM			
				NO. OF EFFs	PE	80% LCL	90% LCL	NO. OF EFFs	PE	80% LCL	90% LCL
Alpha	C41-3	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	-	NA[a]	-	4,169	1	9,600	3,206	2,468
Bravo	C41-4	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
		All	9,600	-	NA[a]	5,965	4,169	1	9,600	3,206	2,468
Charlie	C41-7	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	-	NA[a]	5,965	4,169	1	9,600	3,206	2,468
Delta	C41-5	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	-	NA[a]	5,965	4,169	-	NA[a]	5,965	4,169
Echo	C41-8	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	-	NA[a]	5,965	4,169	1	9,600	3,206	2,468
Foxtrot	C41-9	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	1	2400	802	617
		All	9,600	-	NA[a]	5,965	4,169	1	9600	3,206	2,468

See notes at end of table.

TABLE A-2.2-16 (Cont)

VENDOR	WEAPON NO.	MAGAZINE NO.	ROUNDS FIRED	MAGAZINE				SYSTEM			
				NO. OF EFFs	PE	80% LCL	90% LCL	NO. OF EFFs	PE	80% LCL	90% LCL
Golf	C41-10	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	1,470	1	1,470	491	378	1	1,470	491	378
		B-1	930	-	NA[a]	578	404	-	NA[a]	578	404
		C	1,800	1	1,800	601	463	1	1,800	601	463
		C-1	600	-	NA[a]	373	261	-	NA[a]	373	261
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	2	4,800	2,244	1,804	2	4,800	2,244	1,804
Hotel	C41-6	A	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	-	NA[a]	5,965	4,169	1	9,600	3,206	2,468
India	C41-11	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
		D	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
		All	9,600	-	NA[a]	5,965	4,169	2	4,800	2,244	1,804
Juliet	C41-12	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
		All	9,600	-	NA[a]	5,965	4,169	1	9,600	3,206	2,468
Kilo	C41-1	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	-	NA[a]	5,965	4,169	1	9,600	3,206	2,468

TABLE A-2.2-16 (Cont)

VENDOR	WEAPON NO.	MAGAZINE NO.	ROUNDS FIRED	MAGAZINE				SYSTEM			
				NO. OF EFFs	PE	80% LCL	90% LCL	NO. OF EFFs	PE	80% LCL	90% LCL
Lima	C41-2	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
All			9,600	-	NA[a]	5,965	4,169	-	NA[a]	5,965	4,169

[a]The PE could not be calculated since no failures occurred; however, since 2,400 rounds were successfully fired without a failure, it is concluded that the PE is greater than 2,400 rounds.

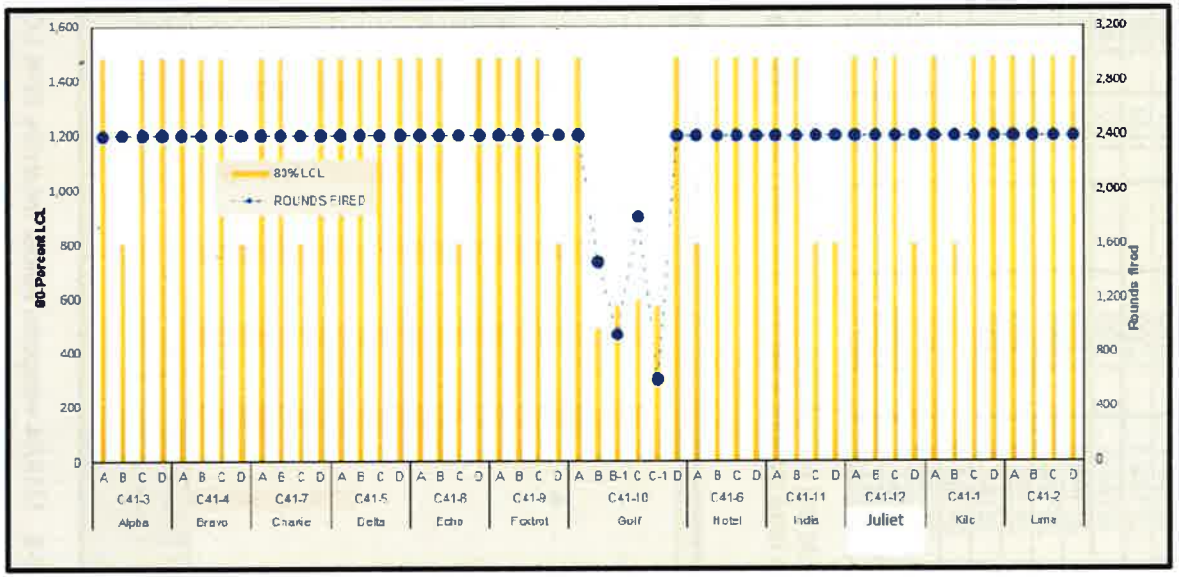


Figure A-2.2-7. M4A1 weapons actual reliability 80% LCL vs. rounds fired for class III/EFF failures.

TABLE A-2.2-17. CLASS I/EFF RELIABILITY CHARACTERISTICS FOR M16A4 WEAPONS

VENDOR	WEAPON NO.	ROUNDS FIRED	MAGAZINE				SYSTEM			
			NO. OF EFFs	PE	80% LCL	90% LCL	NO. OF EFFs	PE	80% LCL	90% LCL
Alpha	M164-3	1,200	-	NA[a]	746	521	-	NA[a]	746	521
Bravo	M164-4	1,200	-	NA[a]	746	521	2	600	280	225
Charlie	2T164-1	1,200	-	NA[a]	746	521	-	NA[a]	746	521
Delta	M164-5	1,200	-	NA[a]	746	521	-	NA[a]	746	521
Echo	2T164-2	1,200	-	NA[a]	746	521	-	NA[a]	746	521
Foxtrot	2T164-3	1,200	-	NA[a]	746	521	-	NA[a]	746	521
Golf	2T164-4	1,200	1	1,200	401	309	2	600	280	225
Hotel	M164-6	1,200	1	1,200	401	309	1	1,200	401	309
India	2T164-5	1,200	1	1,200	401	309	1	1,200	401	309
Juliet	2T164-6	1,200	-	NA[a]	746	521	-	NA[a]	746	521
Kilo	M164-1	1,200	-	NA[a]	746	521	-	NA[a]	746	521
Lima	M164-2	1,200	-	NA[a]	746	521	1	1,200	401	309

[a]The PE could not be calculated since no failures occurred; however, since 1,200 rounds were successfully fired without a failure, it is concluded that the PE is greater than 1,200 rounds.

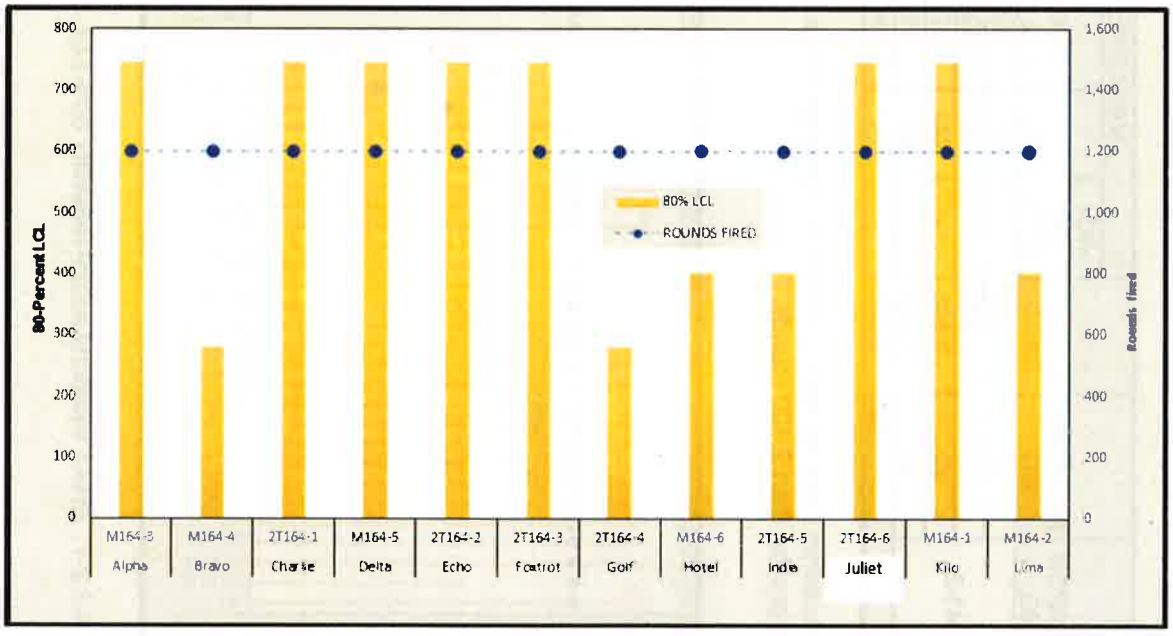


Figure A-2.2-8. M16A4 weapons actual reliability 80% LCL vs. rounds fired for class I/EFF stoppages.

TABLE A-2.2-18. CLASS III/EFF RELIABILITY CHARACTERISTICS FOR M16A4 WEAPONS

VENDOR	WEAPON NO.	ROUNDS FIRED	MAGAZINE				SYSTEM			
			NO. OF EFFs	PE	80% LCL	90% LCL	NO. OF EFFs	PE	80% LCL	90% LCL
Alpha	M164-3	1,200	-	NA[a]	746	521	-	NA[a]	746	521
Bravo	M164-4	1,200	-	NA[a]	746	521	-	NA[a]	746	521
Charlie	2T164-1	1,200	-	NA[a]	746	521	-	NA[a]	746	521
Delta	M164-5	1,200	-	NA[a]	746	521	-	NA[a]	746	521
Echo	2T164-2	1,200	-	NA[a]	746	521	-	NA[a]	746	521
Foxtrot	2T164-3	1,200	-	NA[a]	746	521	-	NA[a]	746	521
Golf	2T164-4	1,200	-	NA[a]	746	521	-	NA[a]	746	521
Hotel	M164-6	1,200	-	NA[a]	746	521	-	NA[a]	746	521
India	2T164-5	1,200	-	NA[a]	746	521	-	NA[a]	746	521
Juliet	2T164-6	1,200	-	NA[a]	746	521	-	NA[a]	746	521
Kilo	M164-1	1,200	-	NA[a]	746	521	-	NA[a]	746	521
Lima	M164-2	1,200	-	NA[a]	746	521	-	NA[a]	746	521

[a]The PE could not be calculated since no failures occurred; however, since 1,200 rounds were successfully fired without a failure, it is concluded that the PE is greater than 1,200 rounds.

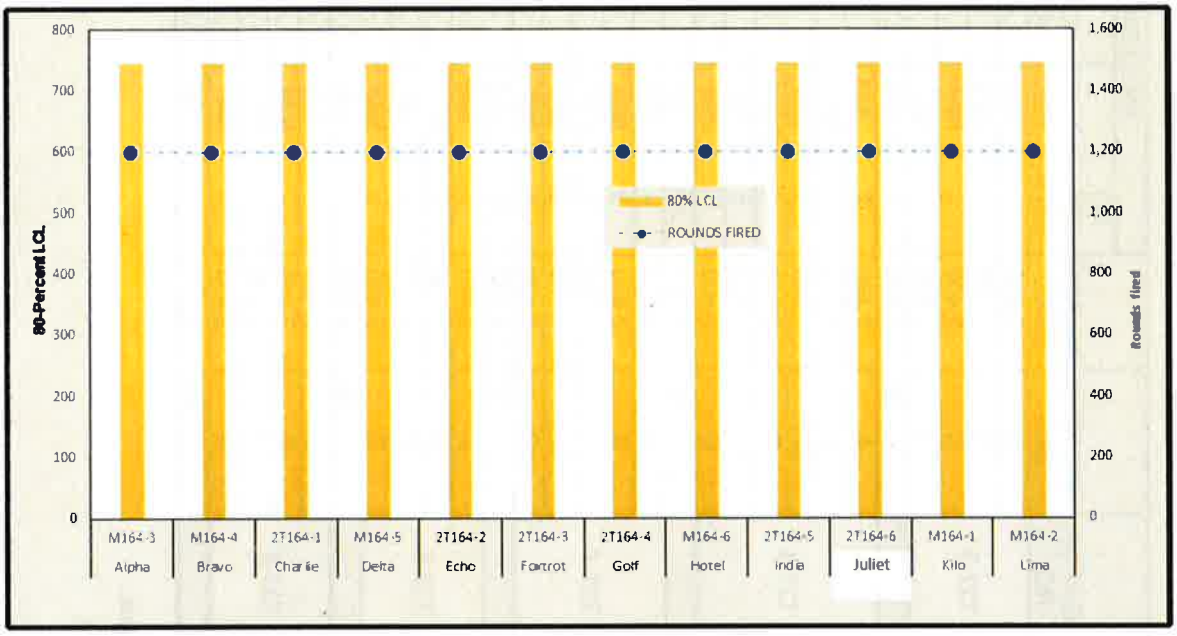


Figure A-2.2-9. M16A4 weapons actual reliability 80% LCL vs. rounds fired for class III/EFF stoppages.

TABLE A-2.2-19. CLASS I/EFF RELIABILITY CHARACTERISTICS FOR M27 WEAPONS

VENDOR	WEAPON NO.	MAGAZINE NO.	ROUNDS FIRED	MAGAZINE				SYSTEM			
				NO. OF EFFs	PE	80% LCL	90% LCL	NO. OF EFFs	PE	80% LCL	90% LCL
Alpha	T27-3	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	1	2,400	802	617	1	2,400	802	617
		C	2,400	-	NA[a]	1,491	1,042	2	1,200	561	451
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	1	9,600	3,206	2,468	3	3,200	1,741	1,437
Bravo	T27-4	A	2,400	7	343	235	204	13	185	141	127
		B	1,560	-	NA[a]	969	678	18	87	69	63
		B-1	840	1	840	281	216	2	420	196	158
		C	2,010	1	2,010	671	517	16	126	99	90
		C-1	390	5	78	49	42	5	78	49	42
		D	2,400	12	200	151	135	15	160	125	113
		All	9,600	26[b]	369	307	284	69	139	125	119
Charlie	T27-7	A	2,400	4	600	357	300	10	240	176	156
		B	2,400	3	800	435	359	10	240	176	156
		C	1,230	3	410	223	184	13	95	72	65
		C-1	1,170	4	293	174	146	5	234	148	126
		D	2,400	3	800	435	359	9	267	192	169
		All	9,600	17	565	448	407	47[b]	204	179	168
Delta	T27-5	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	-	NA[a]	5,965	4,169	1	9,600	3,206	2,468
Echo	T27-8	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
		All	9,600	-	NA[a]	5,965	4,169	1	9,600	3,206	2,468

See notes at end of table.

TABLE A-2.2-19 (Cont)

VENDOR	WEAPON NO.	MAGAZINE NO.	ROUNDS FIRED	MAGAZINE				SYSTEM			
				NO. OF EFFs	PE	80% LCL	90% LCL	NO. OF EFFs	PE	80% LCL	90% LCL
Foxtrot	T27-11	A	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
		B	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	-	NA[a]	5,965	4,169	2	4,800	2,244	1,804
Hotel	T27-6	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
		All	9,600	-	NA[a]	5,965	4,169	1	9,600	3,206	2,468
Juliet	T27-10	A	2,400	1	2,400	802	617	4	600	357	300
		B	2,400	2	1,200	561	451	4	600	357	300
		C	2,400	-	NA[a]	1,491	1,042	5	480	304	259
		D	2,400	1	2,400	802	617	2	1,200	561	451
		All	9,600	4	2,400	1,428	1,201	15	640	499	451
Kilo	T27-1	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	2	1,200	561	451
		C	2,400	-	NA[a]	1,491	1,042	2	1,200	561	451
		D	2,400	-	NA[a]	1,491	1,042	2	1,200	561	451
		All	9,600	-	NA[a]	5,965	4,169	6	1,600	1,058	912
Lima	T27-2	A	2,400	1	2,400	802	617	2	1,200	561	451
		B	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
		C	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
		D	1,530	2	765	358	287	7	219	150	130
		D-1	870	1	870	291	224	2	435	203	163
		All	9,600	4	2,400	1,428	1,201	13[b]	738	564	506

[a]The PE could not be calculated since no failures occurred; however, since 2,400 rounds were successfully fired without a failure, it is concluded that the PE is greater than 2,400 rounds.

[b]Test results indicated statistical differences between the individual magazines, combined results are provided for informational purposes only.

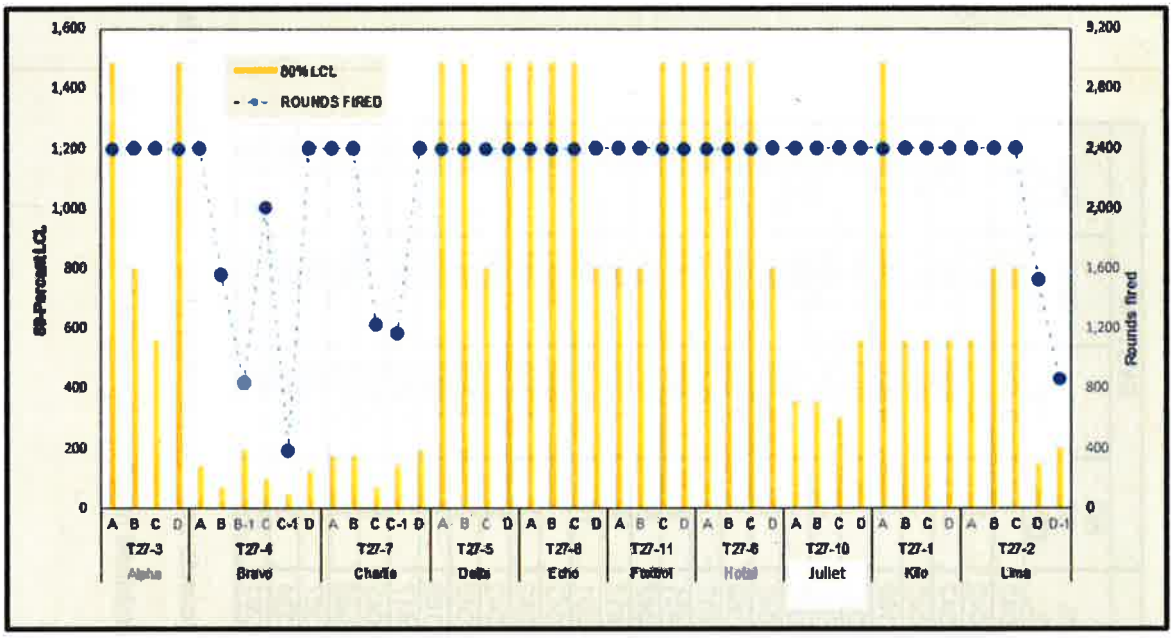


Figure A-2.2-10. M27 weapons actual reliability 80% LCL vs. rounds fired for class I/EFF stoppages.

TABLE A-2.2-20. CLASS III/EFF RELIABILITY CHARACTERISTICS FOR M27 WEAPONS

VENDOR	WEAPON NO.	MAGAZINE NO.	ROUNDS FIRED	MAGAZINE				SYSTEM			
				NO. OF EFFs	PE	80% LCL	90% LCL	NO. OF EFFs	PE	80% LCL	90% LCL
Alpha	T27-3	A	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	-	NA[a]	5,965	4,169	1	9,600	3,206	2,468
Bravo	T27-4	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	1,560	1	1,560	521	401	1	1,560	521	401
		B-1	840	-	NA[a]	522	365	-	NA[a]	522	365
		C	2,010	1	2,010	671	517	1	2,010	671	517
		C-1	390	-	NA[a]	242	169	-	NA[a]	242	169
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	2	4,800	2,244	1,804	2	4,800	2,244	1,804
Charlie	T27-7	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	1,230	1	1,230	411	316	1	1,230	411	316
		C-1	1,170	-	NA[a]	727	508	1	1,170	391	301
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	1	9,600	3,206	2,468	2	4,800	2,244	1,804
Delta	T27-5	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	-	NA[a]	5,965	4,169	-	NA[a]	5,965	4,169
Echo	T27-8	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	-	NA[a]	5,965	4,169	-	NA[a]	5,965	4,169

See notes at end of table.

TABLE A-2.2-20 (Cont)

VENDOR	WEAPON NO.	MAGAZINE NO.	ROUNDS FIRED	MAGAZINE				SYSTEM			
				NO. OF EFFs	PE	80% LCL	90% LCL	NO. OF EFFs	PE	80% LCL	90% LCL
Foxtrot	T27-11	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	1	2,400	802	617
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	-	NA[a]	5,965	4,169	1	9,600	3,206	2,468
Hotel	T27-6	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	-	NA[a]	5,965	4,169	-	NA[a]	5,965	4,169
Juliet	T27-10	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	-	NA[a]	5,965	4,169	-	NA[a]	5,965	4,169
Kilo	T27-1	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		All	9,600	-	NA[a]	5,965	4,169	-	NA[a]	5,965	4,169
Lima	T27-2	A	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		B	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		C	2,400	-	NA[a]	1,491	1,042	-	NA[a]	1,491	1,042
		D	1,530	1	1,530	511	393	1	1,530	511	393
		D-1	870	-	NA[a]	541	378	-	NA[a]	541	378
		All	9,600	1	9,600	3,206	2,468	1	9,600	3,206	2,468

[a]The PE could not be calculated since no failures occurred; however, since 2,400 rounds were successfully fired without a failure, it is concluded that the PE is greater than 2,400 rounds.

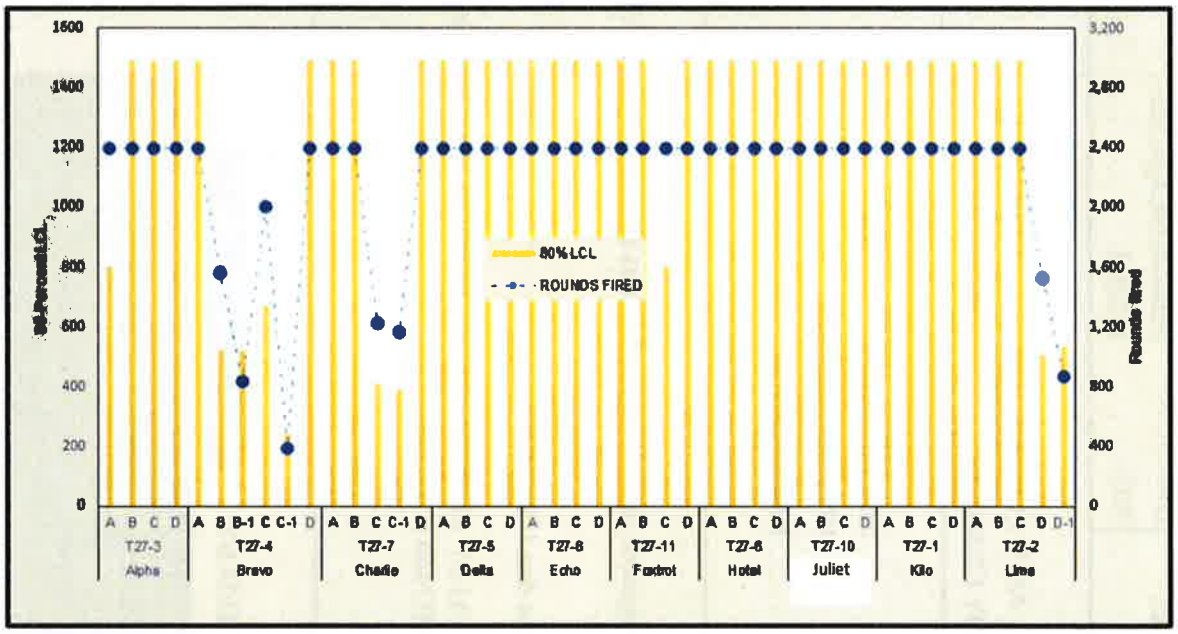


Figure A-2.2-11. M27 weapons actual reliability 80% LCL vs. rounds fired for class III/EFF failures.

USAATC Memo 750-1

DATE: 8/18/14 NONDESTRUCTIVE TEST INSPECTION

ITEM:	SN:	MODEL:	INSPECTION STATUS: AFAPG	ENGINEER: (b) (6)
Carbine	See Below	M4A1, 5.56mm	Rounds: EFC TOTAL: 9600	BRANCH: Small Arms Test BR
			OTHER: Magazine Test	WO: 18536.1

METHOD OF INSPECTION

MAGNETIC PARTICLE: WET XX DRY BLACKLIGHT BORESCOPE AMP: CONDUCTOR CONTACT COIL XX

MAGNETIC RECORDING BORESCOPE: ULTRASONICS: EDDY CURRENT: PENETRANT:

OTHER COMPONENTS INSPECTED	
1. Barrel	SERVICEABLE XX
2. Bolt	UNSERVICEABLE
3. Bolt Carrier	HAZARDOUS
4. Cam Pin	

REMARKS

1. Four components for each weapon were received for magnetic particle inspection. The magnetic particle inspection was conducted in accordance with ATC-NDT-1062.

2.Inspection was conducted using magnetic particle inspection station SN: 89624. Calibration due 1/30/2015.

3. The weapon serial/ATC numbers are 10588388 (C41-1), 10588390 (C41-2), 10588393 (C41-3), 10588659 (C41-4), 10588660 (C41-5), 10588861 (C41-6), 10592419 (C41-7), W281627 (C41-8), W282385 (C41-9), W499994 (C41-11), W937460 (C41-12).

4. No discontinuities indicative of a crack pattern or other defects were noted.

STEAP-MT Form 302, 1 Mar 76

APPROVED BY: (b) (6)

(b) (6)

INSPECTED BY: (b) (6)

(b) (6)

USAATC Memo 750-1

DATE: 8/18/14 NONDESTRUCTIVE TEST INSPECTION

ITEM:	SN:	MODEL:	INSPECTION STATUS: AFAPG	ENGINEER: (b) (6)
Carbine	W499818	M4A1, 5.56mm	Rounds: EFC TOTAL: 9600	BRANCH: Small Arms Test BR
			OTHER: Magazine Test	WO: 18536.1

METHOD OF INSPECTION

MAGNETIC PARTICLE: WET XX DRY BLACKLIGHT BORESCOPE AMP: CONDUCTOR CONTACT COIL XX

MAGNETIC RECORDING BORESCOPE: ULTRASONICS: EDDY CURRENT: PENETRANT:

OTHER COMPONENTS INSPECTED	
1. Barrel	SERVICEABLE
2. Bolt	UNSERVICEABLE XX
3. Bolt Carrier	HAZARDOUS
4. Cam Pin	

REMARKS

1. Four components for each weapon were received for magnetic particle inspection. The magnetic particle inspection was conducted in accordance with ATC-NDT-1062.

2.Inspection was conducted using magnetic particle inspection station SN: 89624. Calibration due 1/30/2015.

3. a 5mm and 3mm indication indicative of a crack pattern was noted on the lugs (see figures 1 and 2).

4. No other discontinuities indicative of a crack pattern or other defects were noted.

STEAP-MT Form 302, 1 Mar 76

APPROVED BY: (b) (6)

Digitally signed by

(b) (6)

INSPECTED BY: (b) (6)

(b) (6)

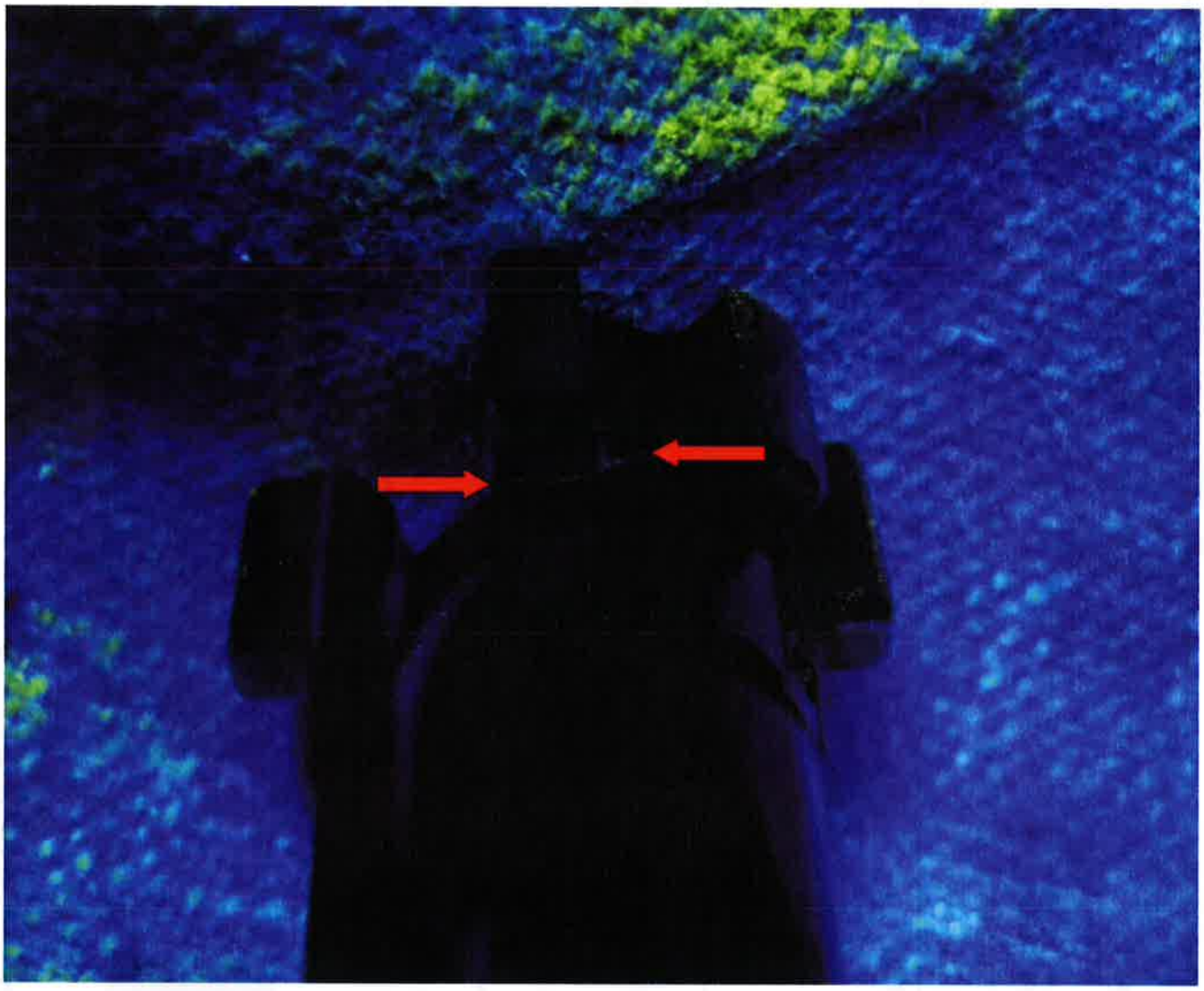


Figure 1. M4A1, 5.56mm, SN. W499818. The arrows show a 5mm indication indicative of a crack pattern forming on a bolt lug.

APPENDIX

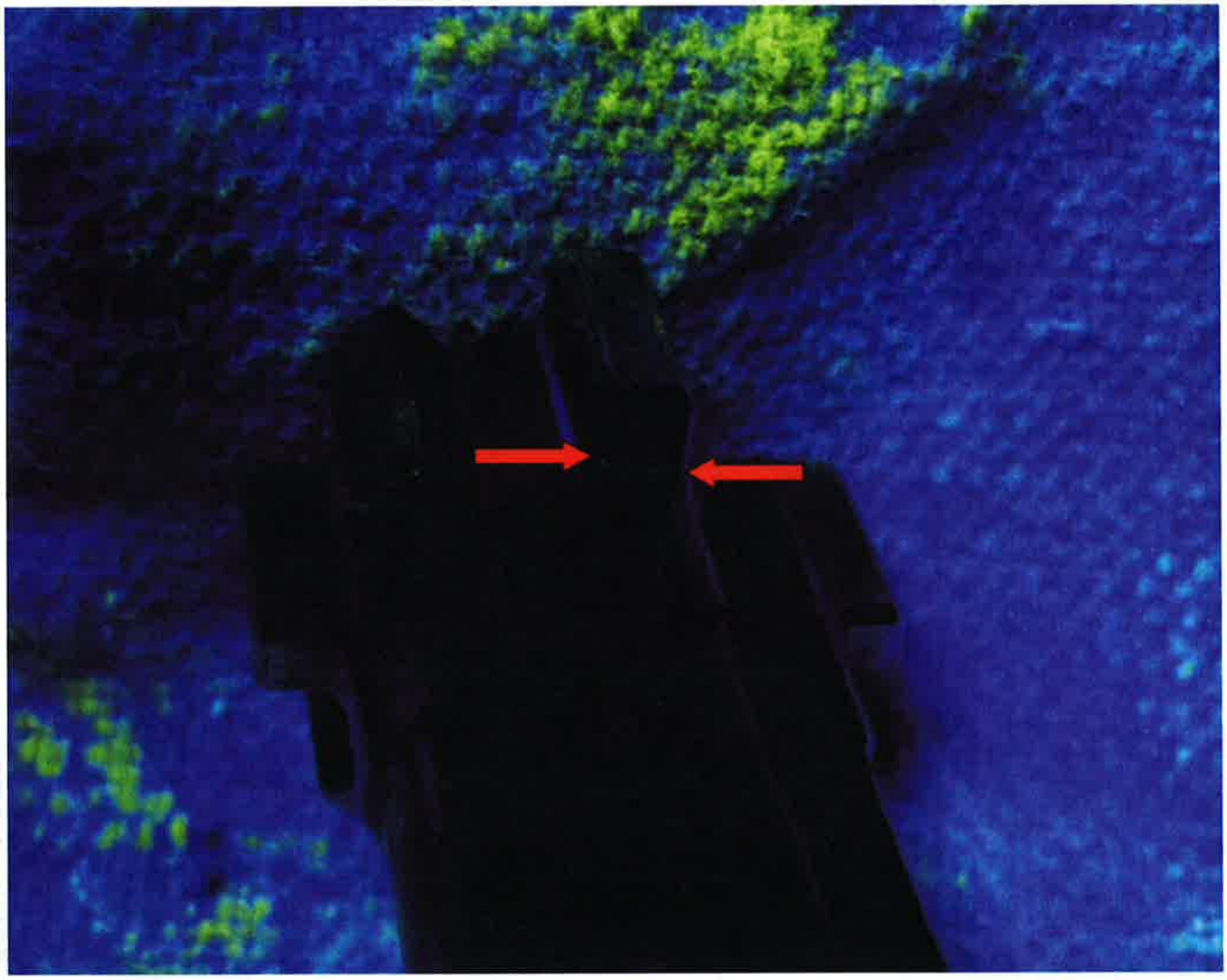


Figure 2. M4A1, 5.56mm, SN. W499818. The arrows show a 3mm indication indicative of a crack pattern forming on a bolt lug.

APPENDIX

USAATC Memo 750-1

DATE: 8/21/14 NONDESTRUCTIVE TEST INSPECTION

ITEM:	SN:	MODEL:	INSPECTION STATUS: BFAPG	ENGINEER: (b) (6)
Rifle (T164-(1-6))	See Below	M16A4, 5.56mm	Rounds: EFC TOTAL: 1200	BRANCH: Small Arms Test BR
			OTHER: Int Magazine Test	WO: 18536.1

METHOD OF INSPECTION

MAGNETIC PARTICLE: WET XX DRY BLACKLIGHT BORESCOPE AMP: CONDUCTOR CONTACT COIL XX

MAGNETIC RECORDING BORESCOPE: ULTRASONICS: EDDY CURRENT: PENETRANT:

OTHER COMPONENTS INSPECTED	
1. Barrel	SERVICEABLE XXX
2. Bolt	UNSERVICEABLE
3. Bolt Carrier	HAZARDOUS
4. Cam Pin	

REMARKS

1. Four components for each weapon were received for magnetic particle inspection. Inspections were conducted using magnetic particle horizontal machine SN 89624, Calibration due 1/30/2015.

2. Magnetic particle inspection was conducted in accordance with written procedure ATC-NDT- 1062.

3. The following weapon serial/ATC numbers were inspected; 10514979 (T164-1), 10515097 (T164-2), 10515188 (T164-3), 10515213 (T164-4), 10515266 (T164-5), 10515284 (T164-6).

4. No discontinuities indicative of a crack pattern or other defects were noted.

STEAP-MT Form 302, 1 Mar 76

APPROVED BY: (b) (6)

(b) (6)

INSPECTED BY: (b) (6)

(b) (6)

USAATC Memo 750-1

DATE: 8/19/14 NONDESTRUCTIVE TEST INSPECTION

ITEM:	SN:	MODEL:	INSPECTION STATUS: AFAPG	ENGINEER: (b) (6)
IAR	See Below	M27, 5.56mm	Rounds: EFC TOTAL: 9600	BRANCH: Small Arms Test BR
			OTHER: Magazine Test	WO: 18536.1

METHOD OF INSPECTION

MAGNETIC PARTICLE: WET XX DRY BLACKLIGHT BORESCOPE AMP: CONDUCTOR CONTACT COIL XX

MAGNETIC RECORDING BORESCOPE: ULTRASONICS: EDDY CURRENT: PENETRANT:

OTHER COMPONENTS INSPECTED	
1. Barrel	SERVICEABLE XXX
2. Bolt	UNSERVICEABLE
3. Bolt Carrier	HAZARDOUS
4. Cam Pin	

REMARKS

1. Four components for each weapon were received for magnetic particle inspection. Inspections were conducted using magnetic particle horizontal machine SN 89624, Calibration due 1/30/2015

2. Magnetic particle inspection was conducted in accordance with written procedure ATC-NDT- 1062.

3. The following weapon serial/ATC numbers were inspected; 172-006441 (T27-3), 172-006598 (T27-7), 172-006599 (T27-8), 172-006603 (T27-10), 172-006605 (T27-11).

4. No discontinuities indicative of a crack pattern or other defects were noted.

STEAP-MT Form 302, 1 Mar 76

APPROVED BY: (b) (6)

INSPECTED BY: (b) (6)

(b) (6)

USAATC Memo 750-1

DATE: 8/19/14 NONDESTRUCTIVE TEST INSPECTION

ITEM:	SN:	MODEL:	INSPECTION STATUS: AFAPG	ENGINEER: (b) (6)
IAR (T27-1)	172-0037 50	M27, 5.56mm	Rounds: EFC TOTAL: 9600	BRANCH: Small Arms Test BR
			OTHER: Magazine Test	WO: 18536.1

METHOD OF INSPECTION

MAGNETIC PARTICLE: WET XX DRY BLACKLIGHT BORESCOPE AMP: CONDUCTOR CONTACT COIL XX

MAGNETIC RECORDING BORESCOPE: ULTRASONICS: EDDY CURRENT: PENETRANT:

OTHER COMPONENTS INSPECTED	
1. Barrel	SERVICEABLE
2. Bolt	UNSERVICEABLE XX
3. Bolt Carrier	HAZARDOUS
4. Cam Pin	

REMARKS

1. Four components for each weapon were received for magnetic particle inspection. Inspections were conducted using magnetic particle horizontal machine SN 89624, Calibration due 1/30/2015

2. Magnetic particle inspection was conducted in accordance with written procedure ATC-NDT- 1062.

3. A 3mm and 4mm indication indicative of a crack pattern was noted on the bolt lugs (see figures 1 and 2).

4. No other discontinuities indicative of a crack pattern or other defects were noted.

STEAP-MT Form 302, 1 Mar 76

APPROVED BY: (b) (6) Digitally signed by (b) (6)

INSPECTED BY: (b) (6) (b) (6)

Figure 1. M27, 5.56mm, SN. 172-003750. The arrows show a 3mm indication indicative of a crack pattern forming on a bolt lug.

APPENDIX

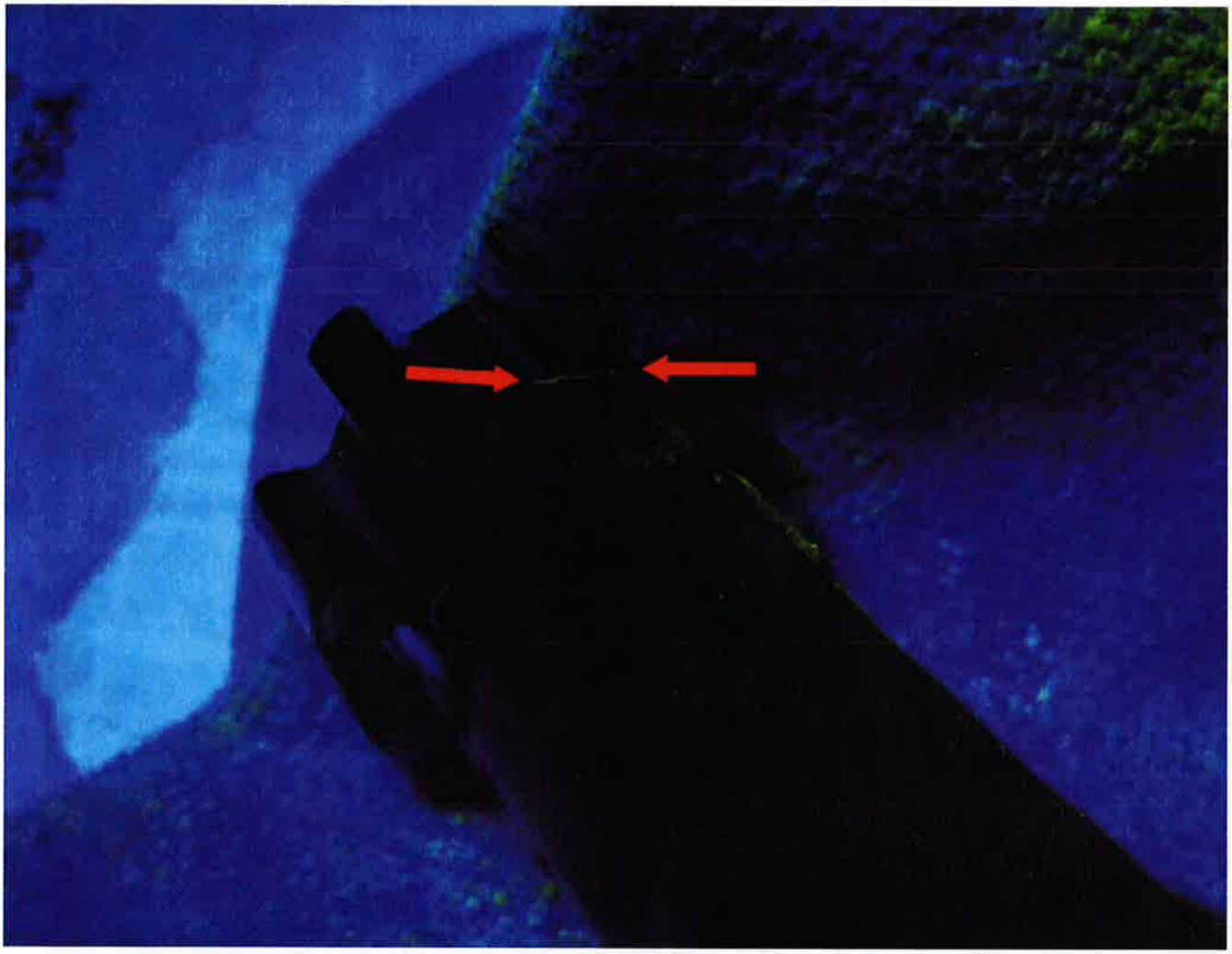


Figure 2. M27, 5.56mm, SN. 172-003750. The arrows show a 4mm indication indicative of a crack pattern forming on a bolt lug.

APPENDIX

USAATC Memo 750-1

DATE: 8/19/14 NONDESTRUCTIVE TEST INSPECTION

ITEM:	SN:	MODEL:	INSPECTION STATUS: AFAPG	ENGINEER: (b) (6)
IAR (T27-2)	172-0037 77	M27, 5.56mm	Rounds: EFC TOTAL: 9600	BRANCH: Small Arms Test BR
			OTHER: Magazine Test	WO: 18536.1

METHOD OF INSPECTION

MAGNETIC PARTICLE: WET XX DRY BLACKLIGHT BORESCOPE AMP: CONDUCTOR CONTACT COIL XX

MAGNETIC RECORDING BORESCOPE: ULTRASONICS: EDDY CURRENT: PENETRANT:

OTHER COMPONENTS INSPECTED	
1. Barrel	SERVICEABLE
2. Bolt	UNSERVICEABLE XX
3. Bolt Carrier	HAZARDOUS
4. Cam Pin	

REMARKS

1. Four components for each weapon were received for magnetic particle inspection. Inspections were conducted using magnetic particle horizontal machine SN 89624, Calibration due 1/30/2015

2. Magnetic particle inspection was conducted in accordance with written procedure ATC-NDT- 1062.

3. A 3mm and 3.5m indication indicative of a crack pattern was noted on the bolt lugs (see figures 1 and 2).

4. No other discontinuities indicative of a crack pattern or other defects were noted.

STEAP-MT Form 302, 1 Mar 76

APPROVED BY: (b) (6)

Digitally signed by (b) (6)

INSPECTED BY: (b) (6)

(b) (6)

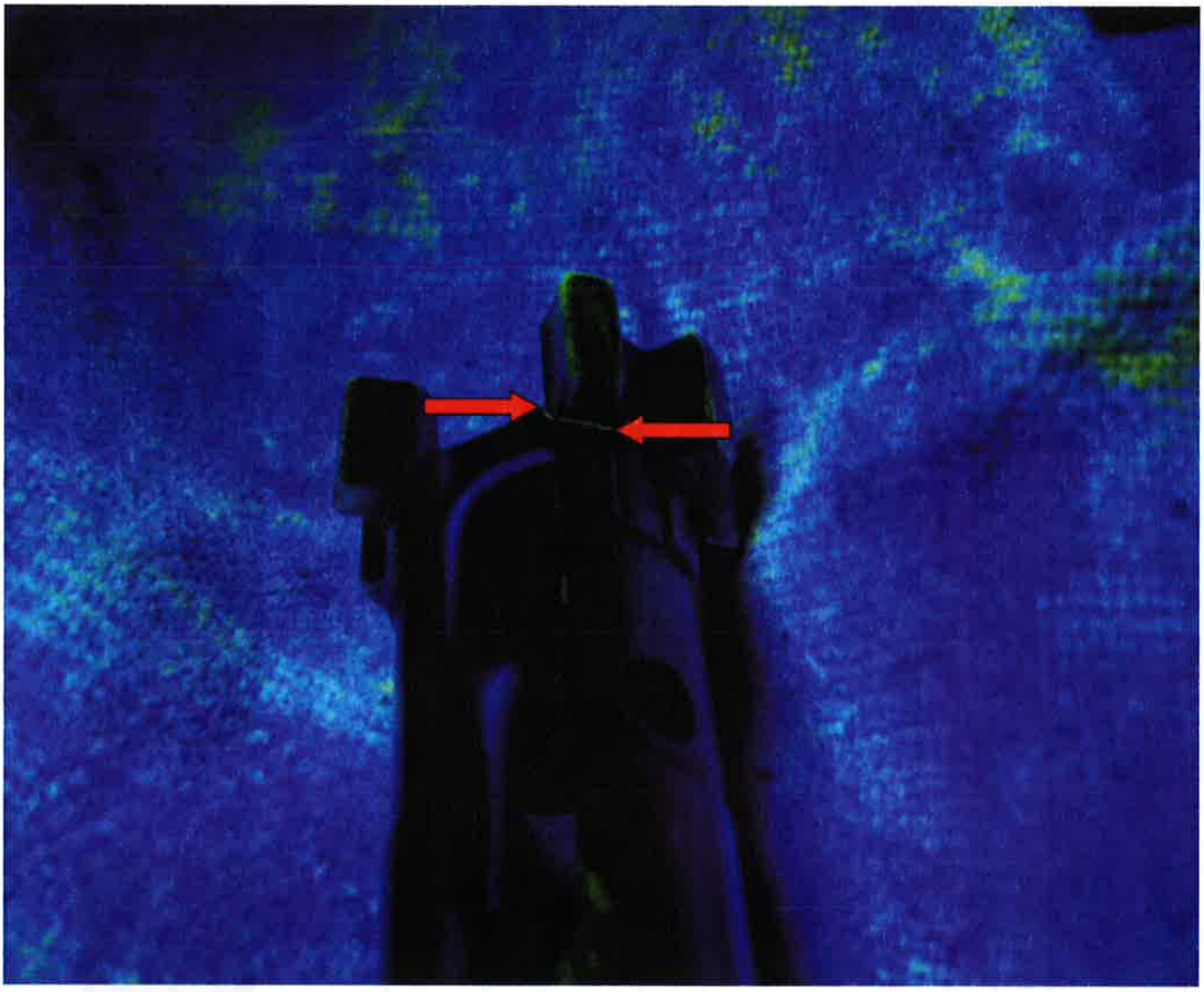


Figure 1. M27, 5.56mm, SN. 172-003777. The arrows show a 3.5mm indication indicative of a crack pattern forming on a bolt lug.

APPENDIX

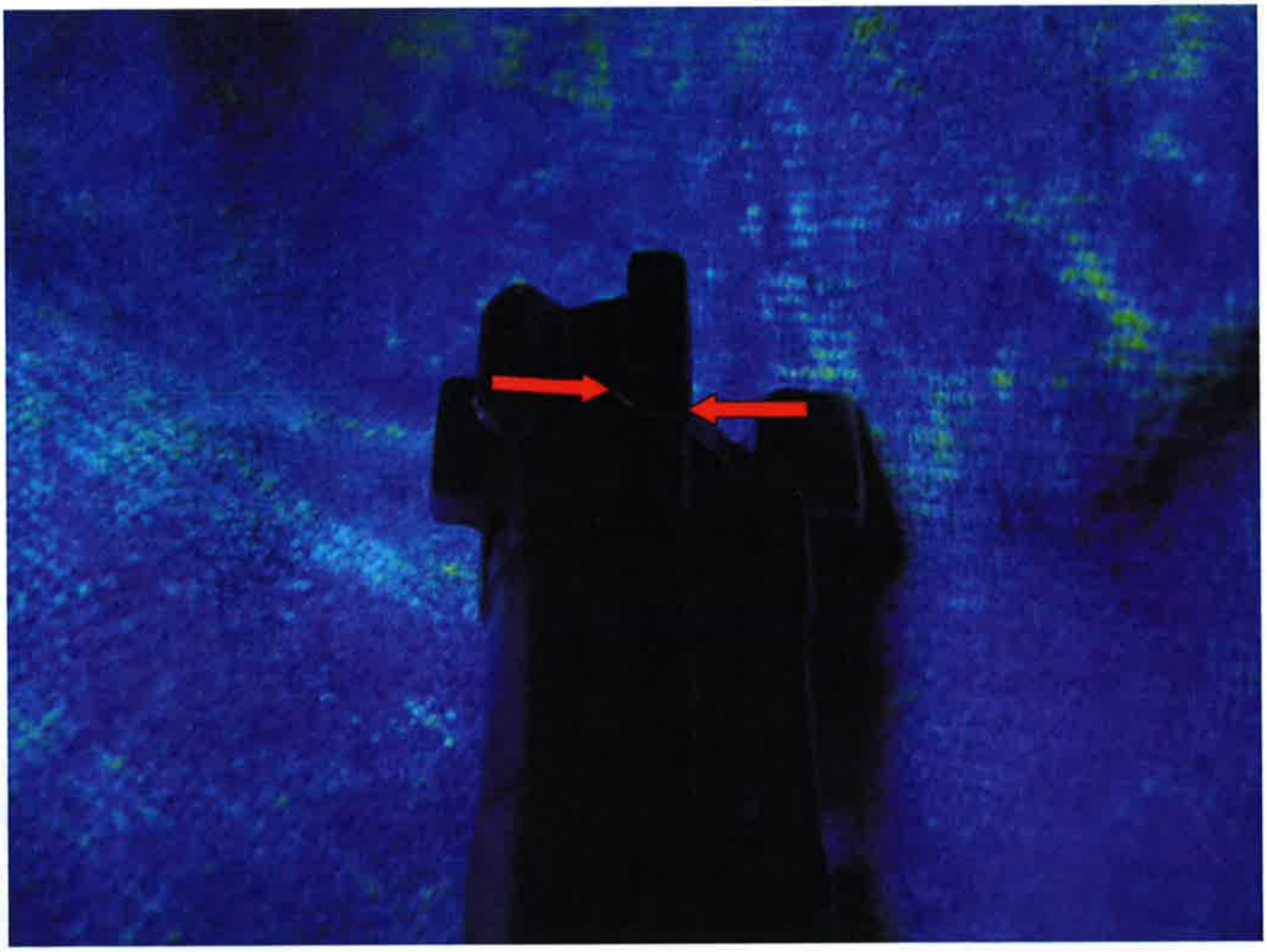


Figure 2. M27, 5.56mm, SN. 172-003777. The arrows show a 3mm indication indicative of a crack pattern forming on a bolt lug.

APPENDIX

USAATC Memo 750-1

DATE: 8/19/14 NONDESTRUCTIVE TEST INSPECTION

ITEM:	SN:	MODEL:	INSPECTION STATUS: AFAPG	ENGINEER: (b) (6)
IAR (T27-4)	172-00642	M27, 5.56mm	Rounds: EFC TOTAL: 9600	BRANCH: Small Arms Test BR
			OTHER: Magazine Test	WO: 18536.1

METHOD OF INSPECTION

MAGNETIC PARTICLE: WET XX DRY BLACKLIGHT BORESCOPE AMP: CONDUCTOR CONTACT COIL XX

MAGNETIC RECORDING BORESCOPE: ULTRASONICS: EDDY CURRENT: PENETRANT:

OTHER COMPONENTS INSPECTED	
1. Barrel	SERVICEABLE
2. Bolt	UNSERVICEABLE XX
3. Bolt Carrier	HAZARDOUS
4. Cam Pin	

REMARKS

1. Four components for each weapon were received for magnetic particle inspection. Inspections were conducted using magnetic particle horizontal machine SN 89624, Calibration due 1/30/2015

2. Magnetic particle inspection was conducted in accordance with written procedure ATC-NDT- 1062.

3. A 4mm indication indicative of a crack pattern was noted on the bolt lugs (see figure 1).

4. No other discontinuities indicative of a crack pattern or other defects were noted.

STEAP-MT Form 302, 1 Mar 76

APPROVED BY: (b) (6)

(b) (6)

INSPECTED BY: (b) (6)

(b) (6)

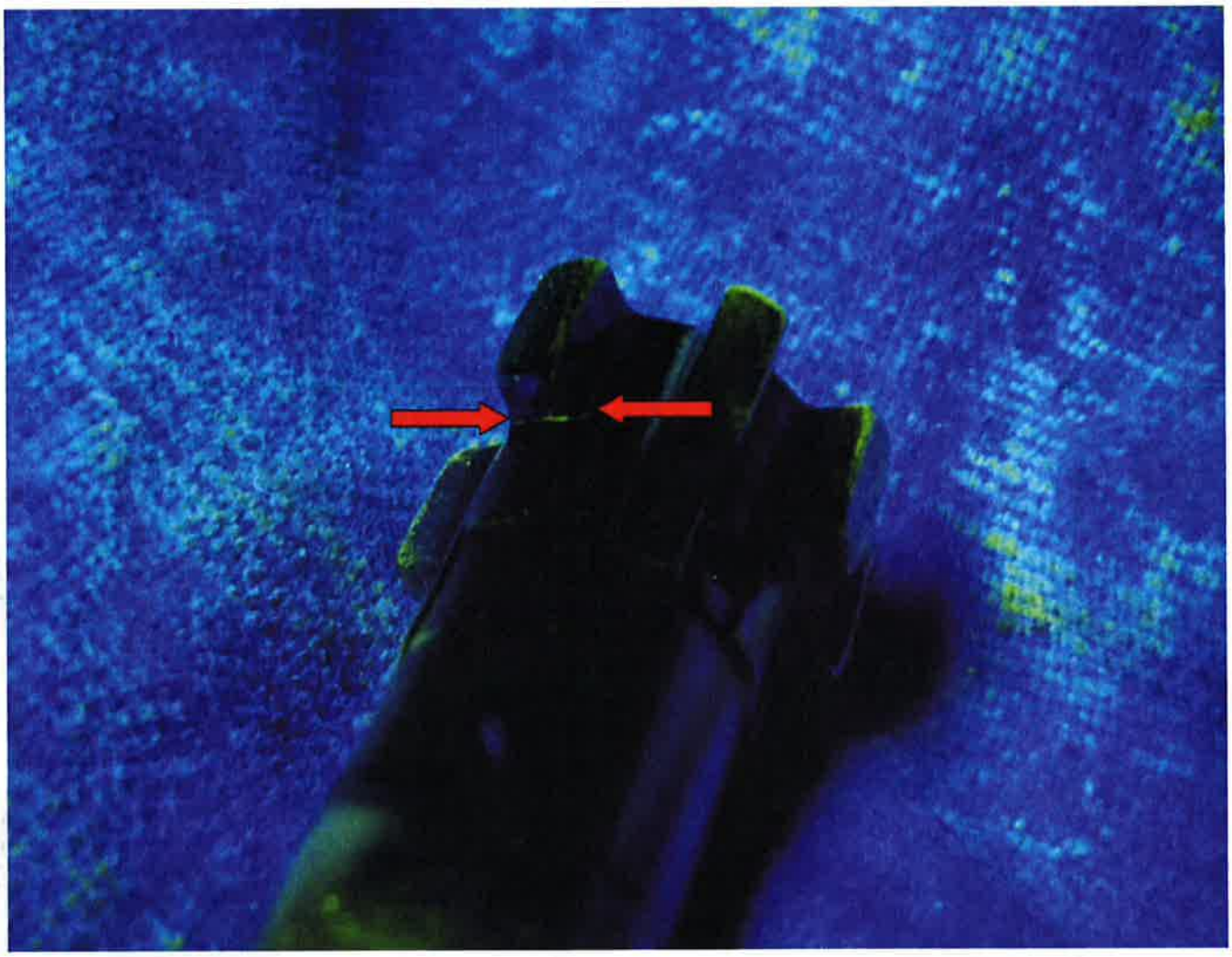


Figure 1. M27, 5.56mm, SN. 172-006442. The arrows show a 4mm indication indicative of a crack pattern forming on a bolt lug.

APPENDIX

USAATC Memo 750-1

DATE: 8/19/14 NONDESTRUCTIVE TEST INSPECTION

ITEM:	SN:	MODEL:	INSPECTION STATUS: AFAPG	ENGINEER: (b) (6)
IAR (T27-5)	172-00659 6	M27, 5.56mm	Rounds: EFC TOTAL: 9600	BRANCH: Small Arms Test BR
			OTHER: Magazine Test	WO: 18536.1

METHOD OF INSPECTION

MAGNETIC PARTICLE: WET XX DRY BLACKLIGHT BORESCOPE AMP: CONDUCTOR CONTACT COIL XX

MAGNETIC RECORDING BORESCOPE: ULTRASONICS: EDDY CURRENT: PENETRANT:

OTHER COMPONENTS INSPECTED	
1. Barrel	SERVICEABLE
2. Bolt	UNSERVICEABLE XX
3. Bolt Carrier	HAZARDOUS
4. Cam Pin	

REMARKS

1. Four components for each weapon were received for magnetic particle inspection. Inspections were conducted using magnetic particle horizontal machine SN 89624, Calibration due 1/30/2015

2. Magnetic particle inspection was conducted in accordance with written procedure ATC-NDT- 1062.

3. A 4mm and 4.5m indication indicative of a crack pattern was noted on the bolt lugs (see figures 1 and 2).

4. No other discontinuities indicative of a crack pattern or other defects were noted.

STEAP-MT Form 302, 1 Mar 76

APPROVED BY: (b) (6)

(b) (6)

INSPECTED BY: (b) (6)

Digitally signed by (b) (6)

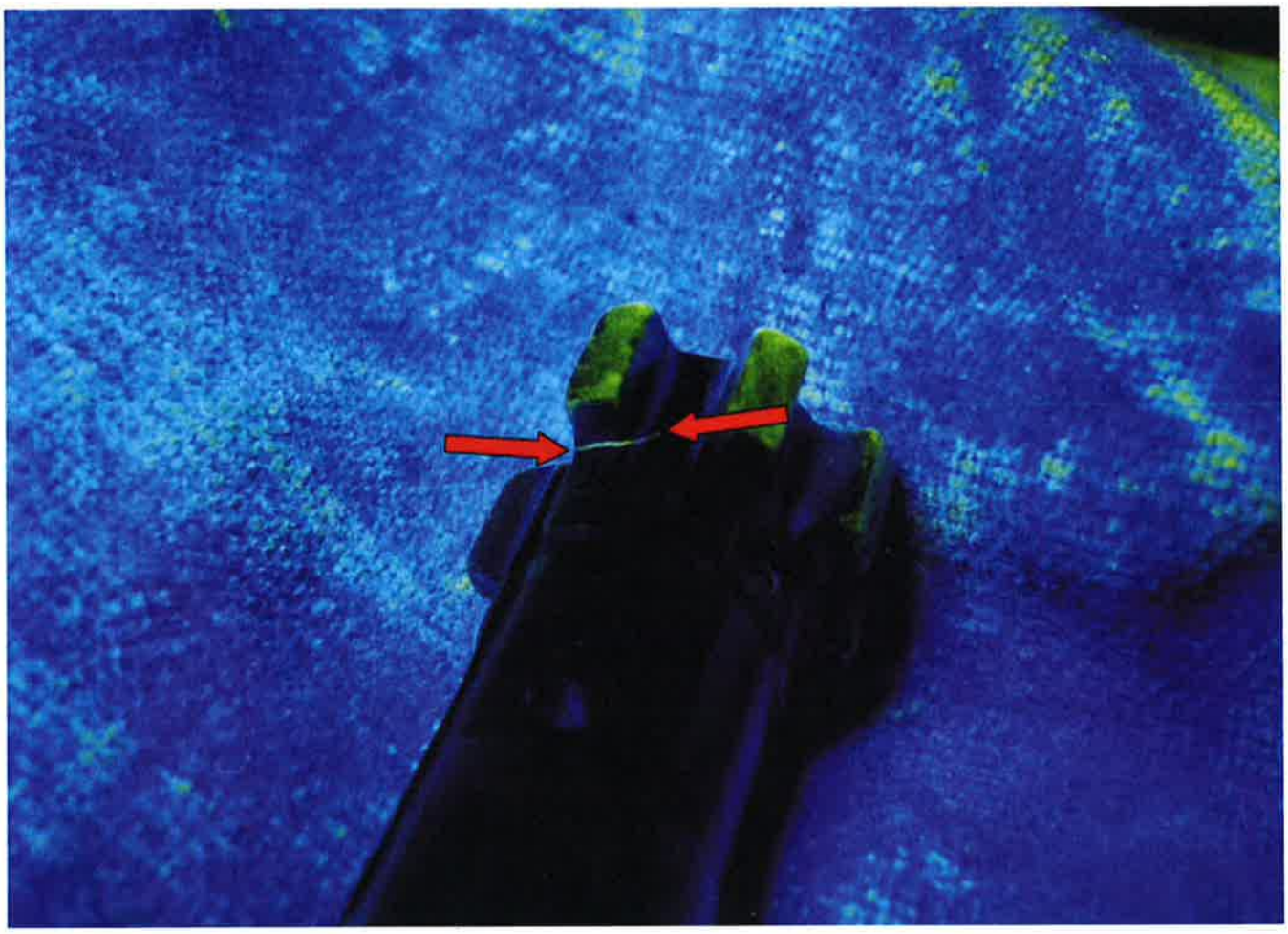


Figure 1. M27, 5.56mm, SN. 172-006596. The arrows show a 4.5mm indication indicative of a crack pattern forming on a bolt lug.

APPENDIX

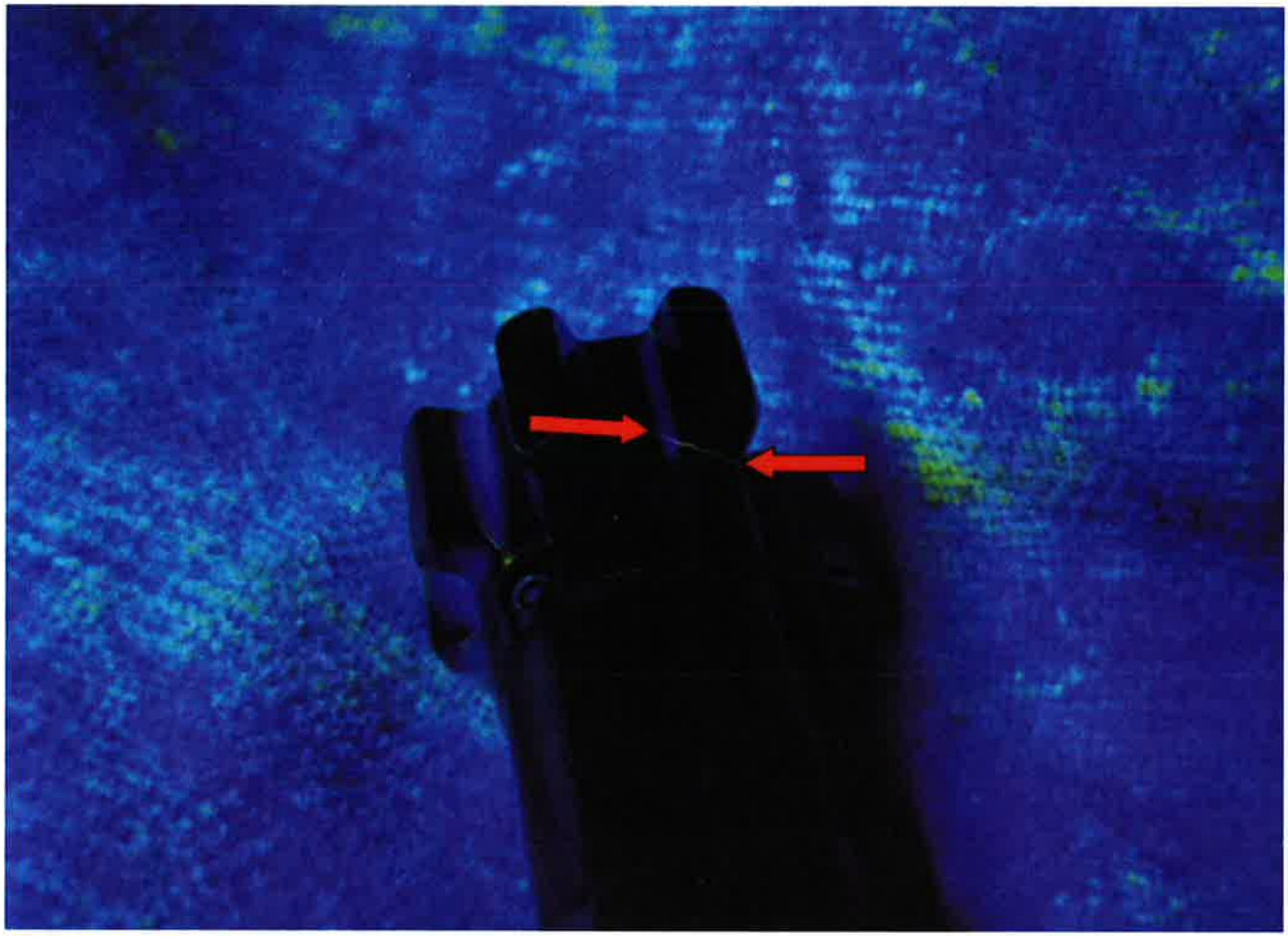


Figure 2. M27, 5.56mm, SN. 172-006596. The arrows show a 4mm indication indicative of a crack pattern forming on a bolt lug.

APPENDIX

USAATC Memo 750-1

DATE: 8/19/14 NONDESTRUCTIVE TEST INSPECTION

ITEM:	SN:	MODEL:	INSPECTION STATUS: AFAPG	ENGINEER: (b) (6)
IAR (T27-6)	172-0065 97	M27, 5.56mm	Rounds: EFC TOTAL: 9600	BRANCH: Small Arms Test BR
			OTHER: Magazine Test	WO: 18536.1

METHOD OF INSPECTION

MAGNETIC PARTICLE: WET XX DRY BLACKLIGHT BORESCOPE AMP: CONDUCTOR CONTACT COIL XX

MAGNETIC RECORDING BORESCOPE: ULTRASONICS: EDDY CURRENT: PENETRANT:

OTHER COMPONENTS INSPECTED

1. Barrel
2. Bolt
3. Bolt Carrier
4. Cam Pin

SERVICEABLE
UNSERVICEABLE XX
HAZARDOUS

REMARKS

1. Four components for each weapon were received for magnetic particle inspection. Inspections were conducted using magnetic particle horizontal machine SN 89624, Calibration due 1/30/2015

2. Magnetic particle inspection was conducted in accordance with written procedure ATC-NDT- 1062.

3. A 3mm and 4mm indication indicative of a crack pattern was noted on the bolt lugs (see figures 1 and 2).

4. No other discontinuities indicative of a crack pattern or other defects were noted.

STEAP-MT Form 302, 1 Mar 76

APPROVED BY: (b) (6)

Digitally signed by

(b) (6)

INSPECTED BY: (b) (6)

(b) (6)

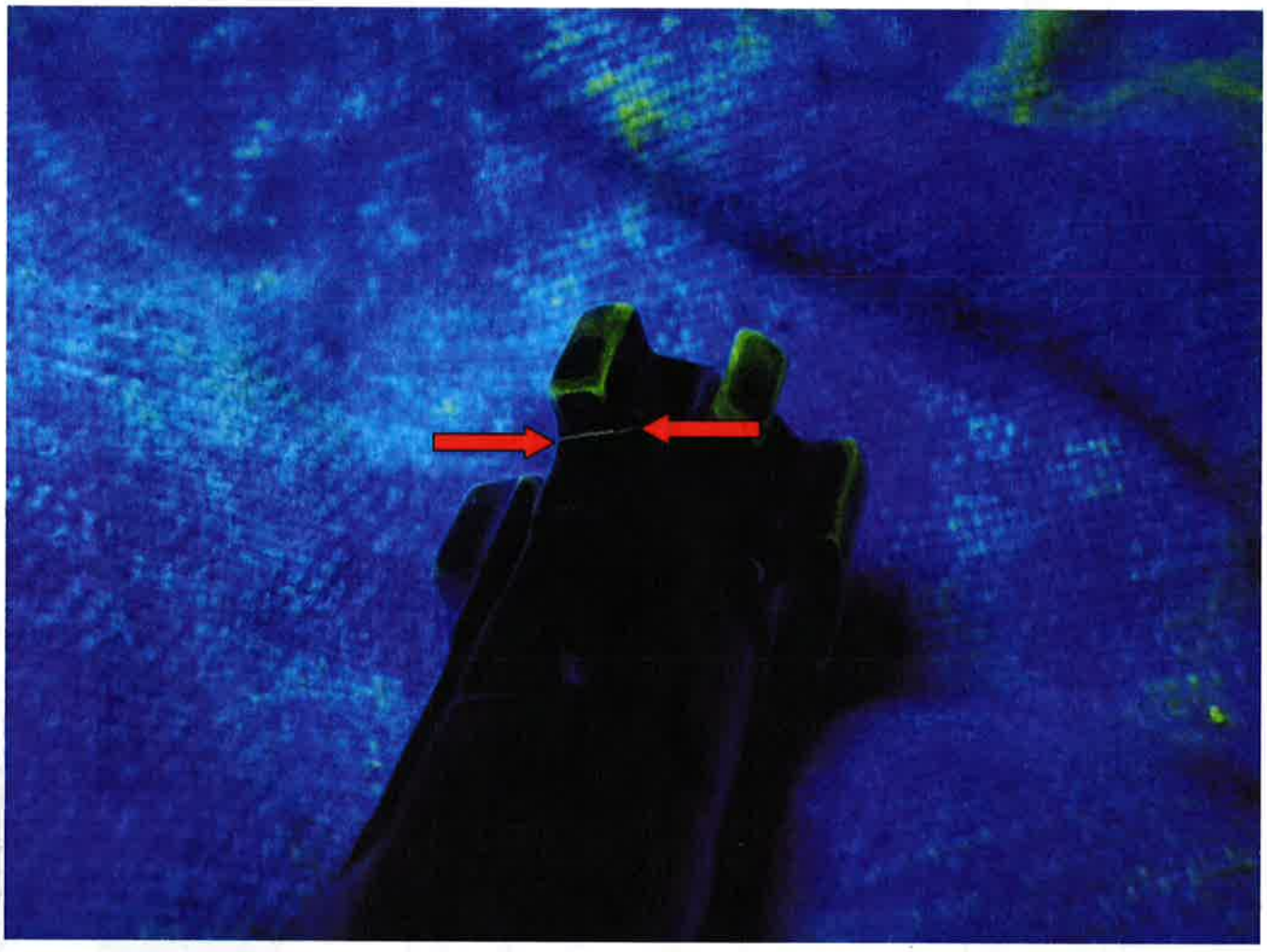


Figure 1. M27, 5.56mm, SN. 172-006597. The arrows show a 4mm indication indicative of a crack pattern forming on a bolt lug.

APPENDIX

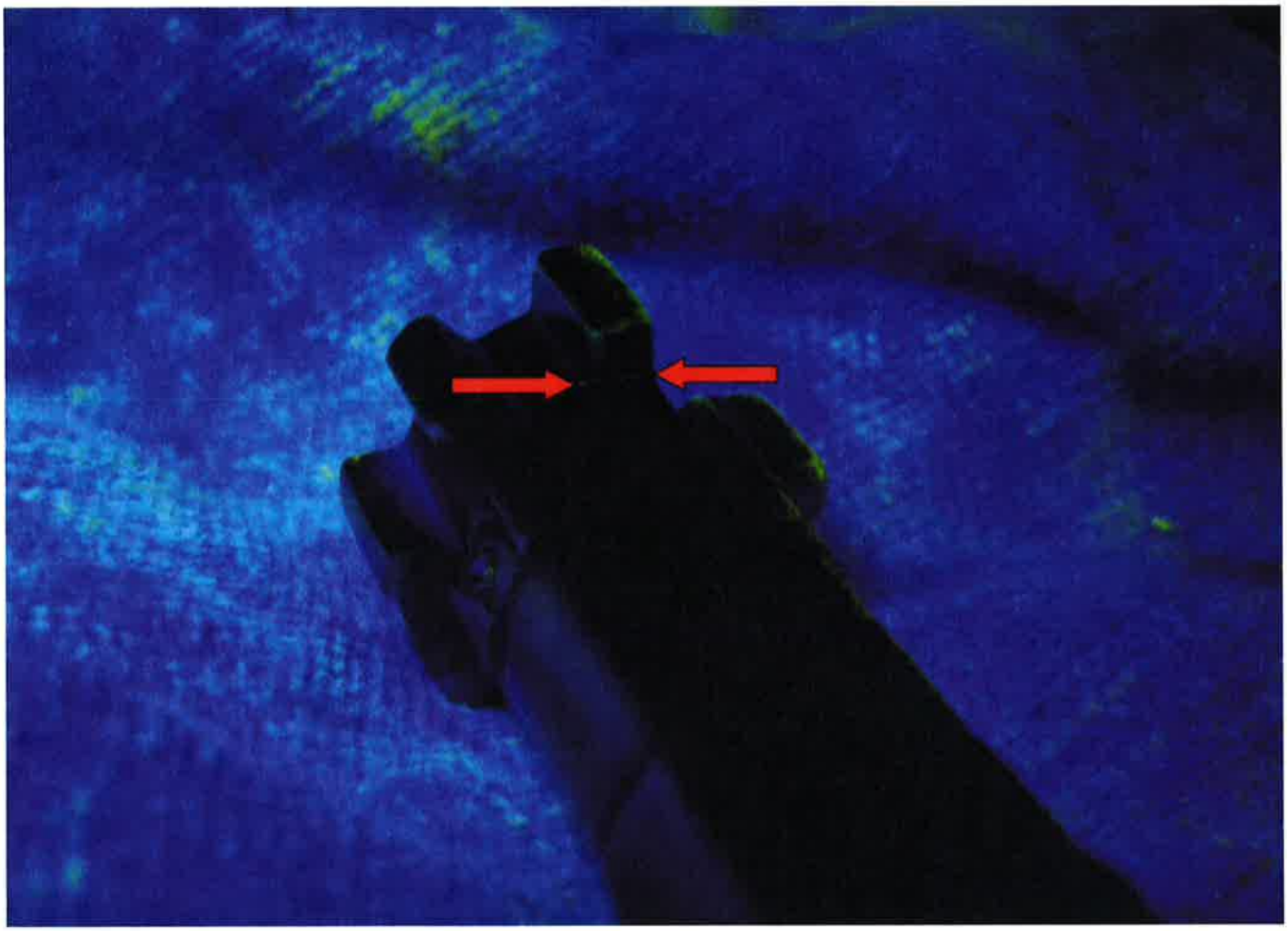


Figure 2. M27, 5.56mm, SN. 172-006597. The arrows show a 3mm indication indicative of a crack pattern forming on a bolt lug.

APPENDIX

APPENDIX B. TEST INCIDENT REPORT (TIR) INDEX

Uploaded to VDLS.

APPENDIX C. INSTRON FORCE GAUGE RESULTS

Uploaded to external hard drive and provided to customer.

APPENDIX D. COMPUTED TOMOGRAPHY (CT) X-RAY MAGAZINE RESULTS

Uploaded to external hard drive and provided to customer.

APPENDIX E. COMPUTED TOMOGRAPHY (CT) X-RAY ROUND POSITION RESULTS

The remaining data was uploaded to external hard drive and provided to customer.

Images show dimensional references which would reveal unclassified critical technical data.

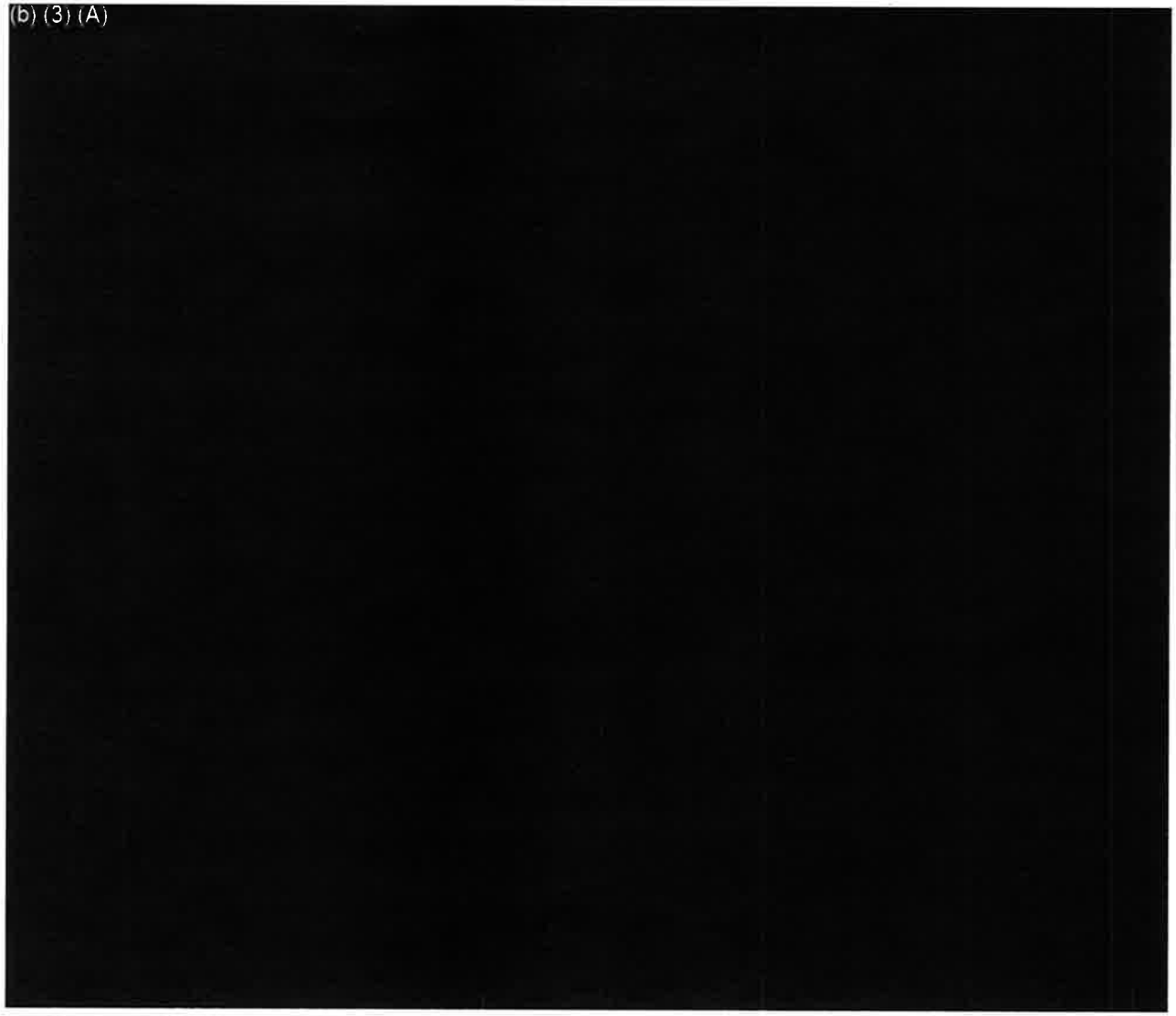


Figure E-1. CT X-ray, internal feeding geometry, graph 1.

Figure E-2. CT X-ray, internal feeding geometry, graph 2.

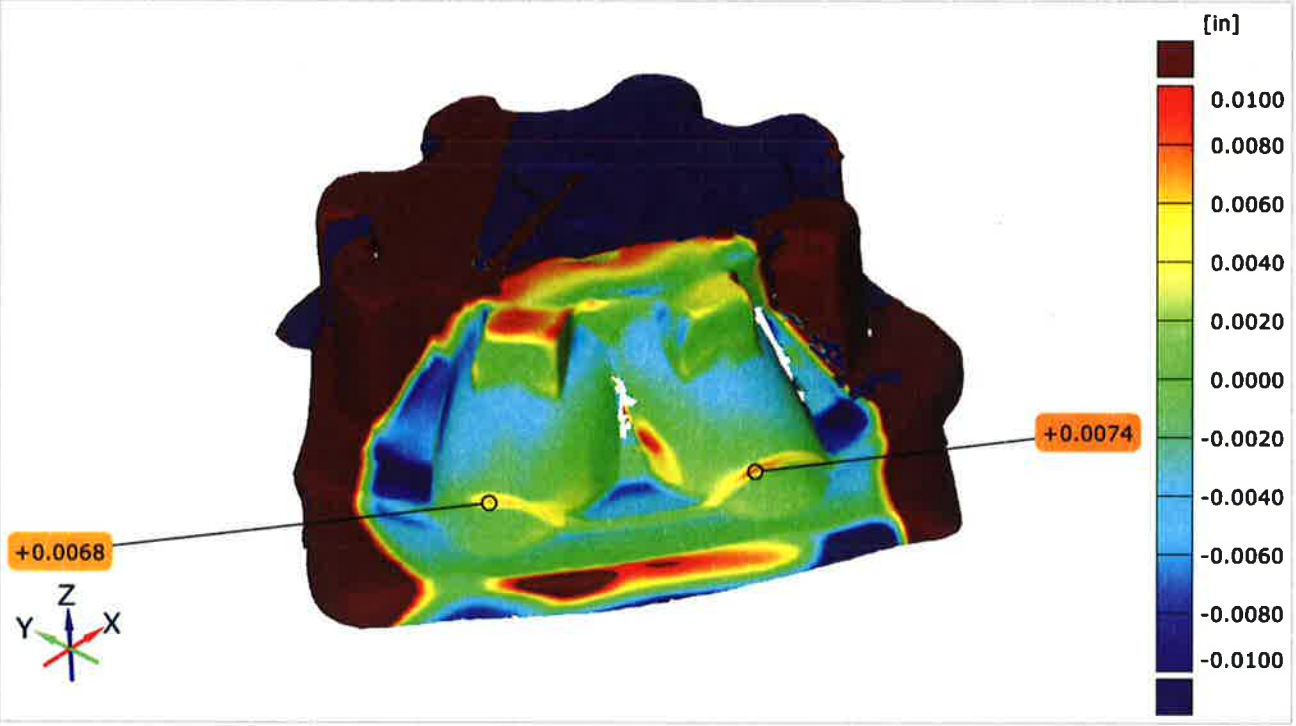
Figure E-3. CT X-ray, internal feeding geometry, graph 3.

Figure E-4. CT X-ray, internal feeding geometry, graph 4.

Figure E-5. CT X-ray, internal feeding geometry, graph 5.

APPENDIX F. LASER SCAN FEED RAMP DATA

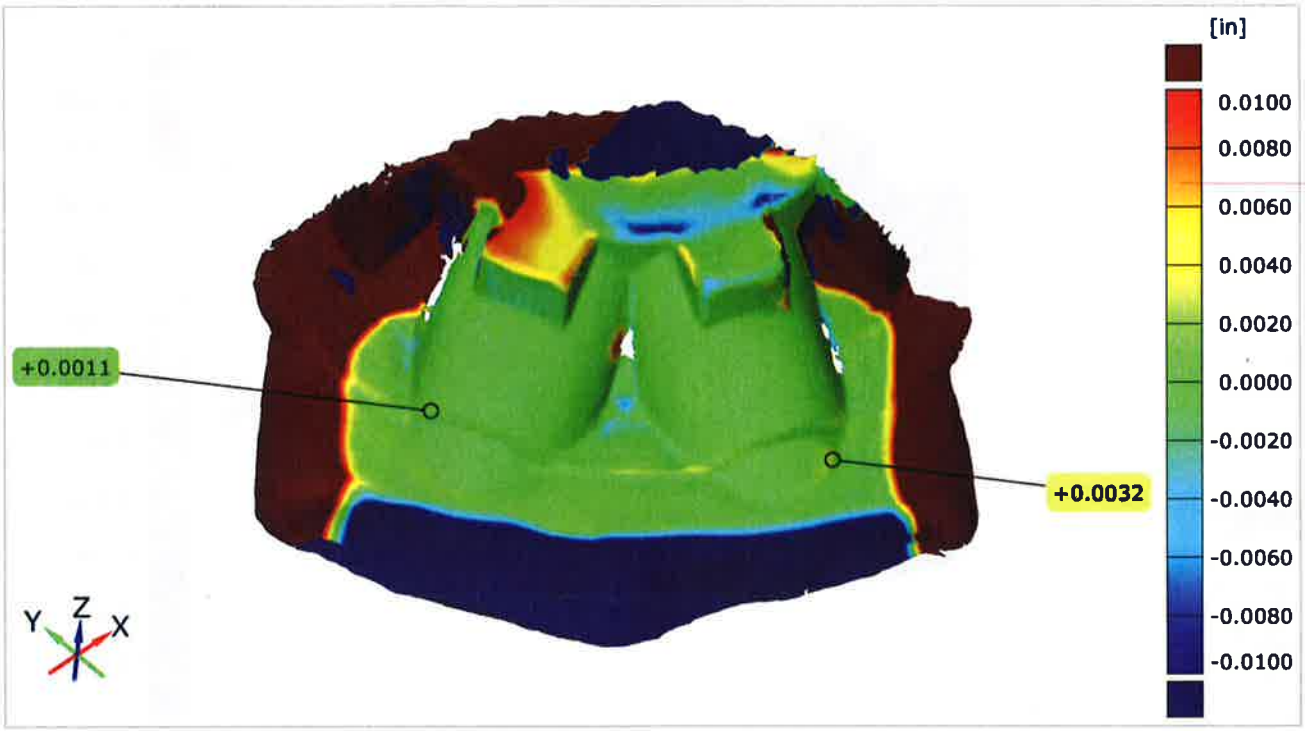
C41-1



E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0074
Right	dXYZ			+0.0068

Prea gnment 1 Length un t: n

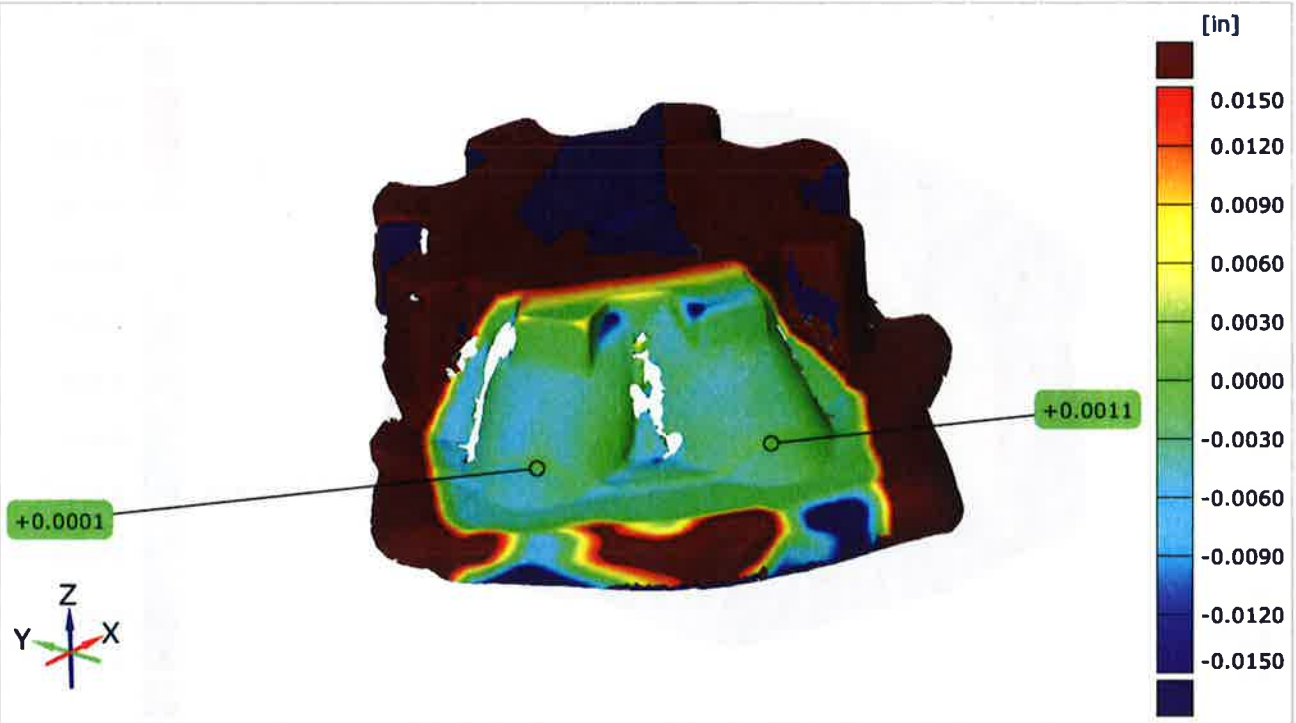
C41-2



E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0032
Right	dXYZ			+0.0011

Loca best-ft 1 Length un t: n

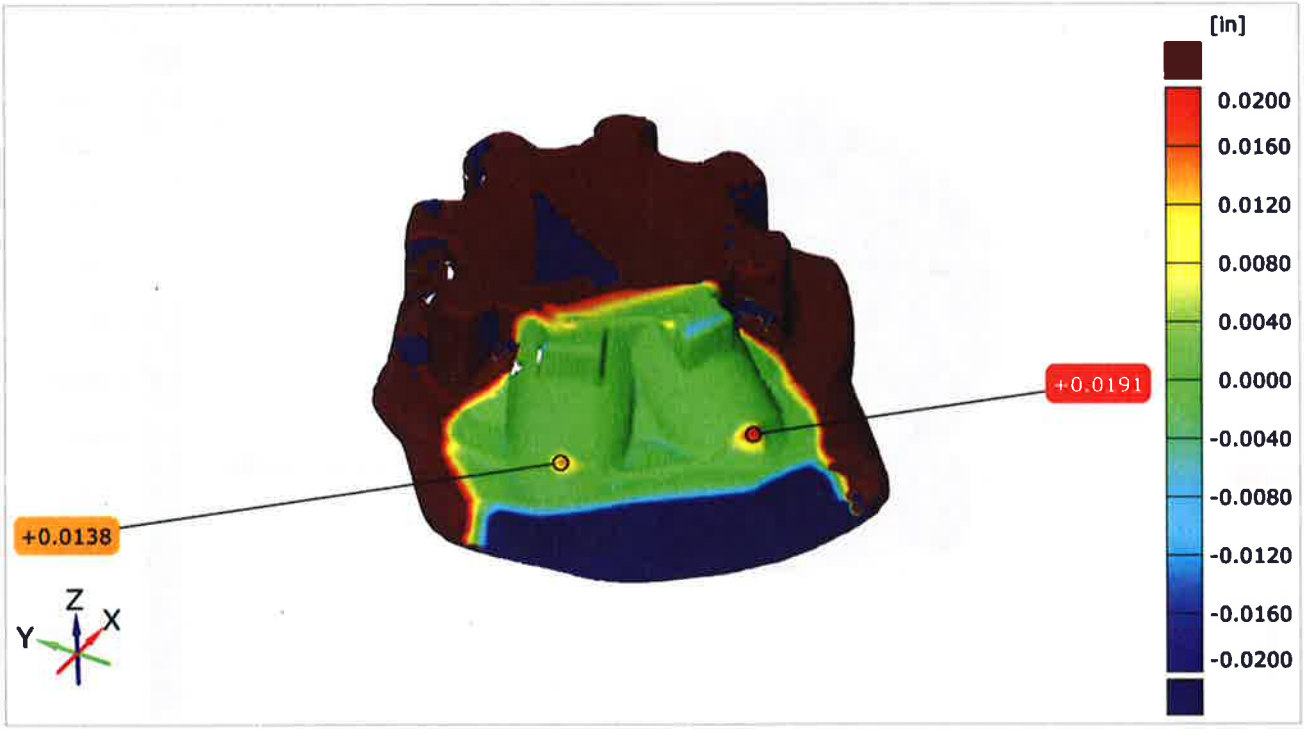
C41-3



Element	Property	To -	To +	Dev
Left	dXYZ			+0.0011
Right	dXYZ			+0.0001

Prealignment 1 — Length unit: mm

C41-4



Element	Property	To -	To +	Dev
Left	dXYZ			+0.0191
Right	dXYZ			+0.0138

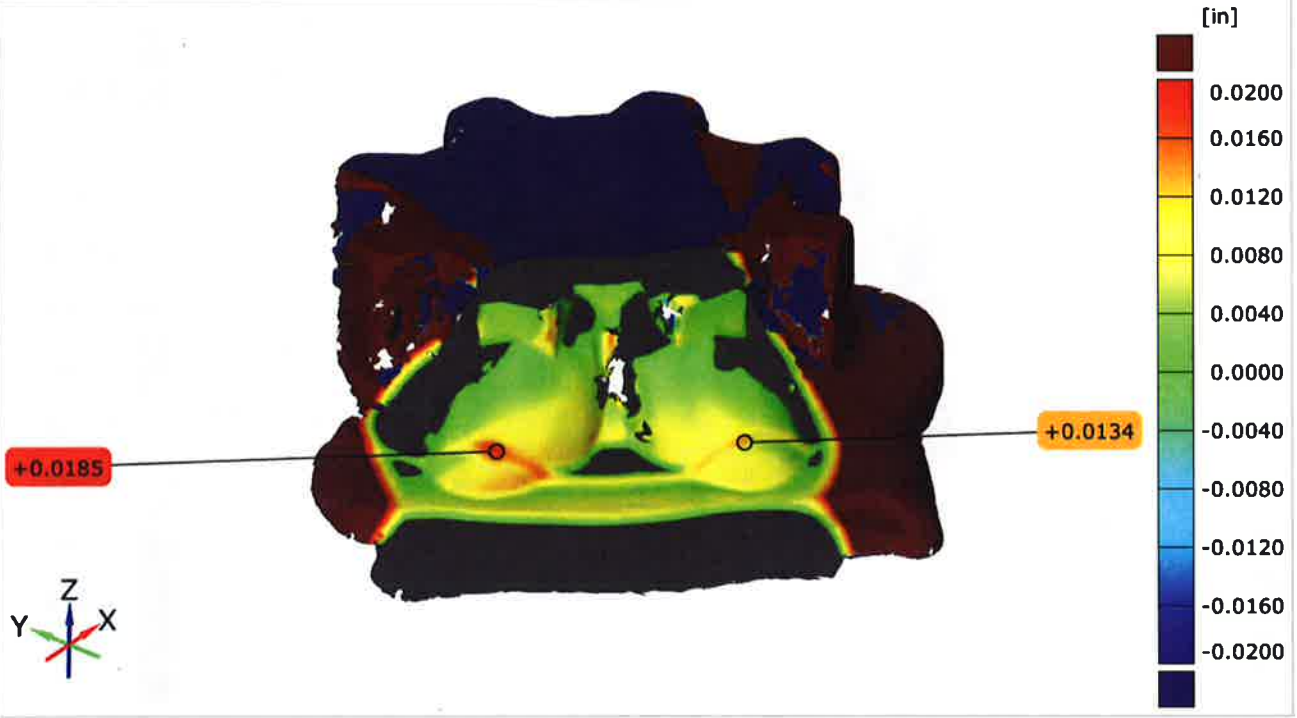
Local best-fit 1 — Length unit: mm

C41-5

E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0062
Right	dXYZ			+0.0074

Prea gnment 1 Length un t: n

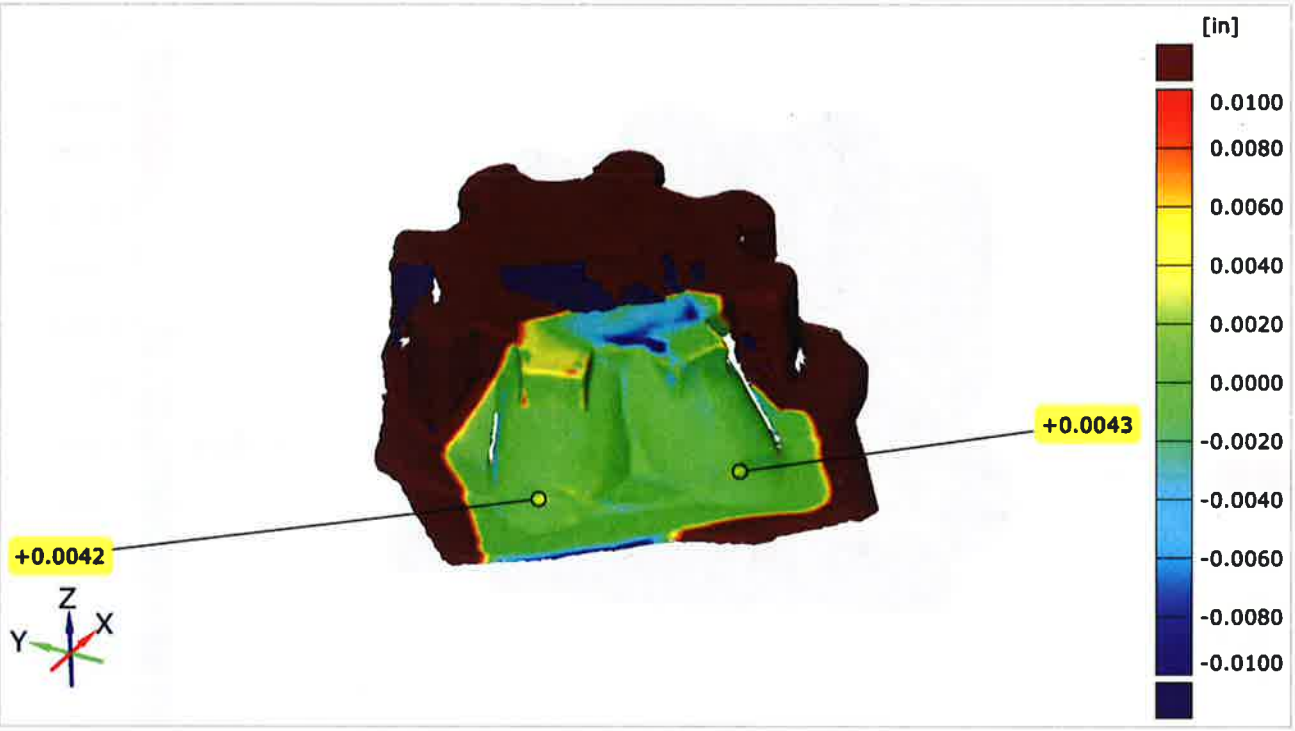
C41-6



E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0134
Right	dXYZ			+0.0185

Prea gnment 1 Length un t: n

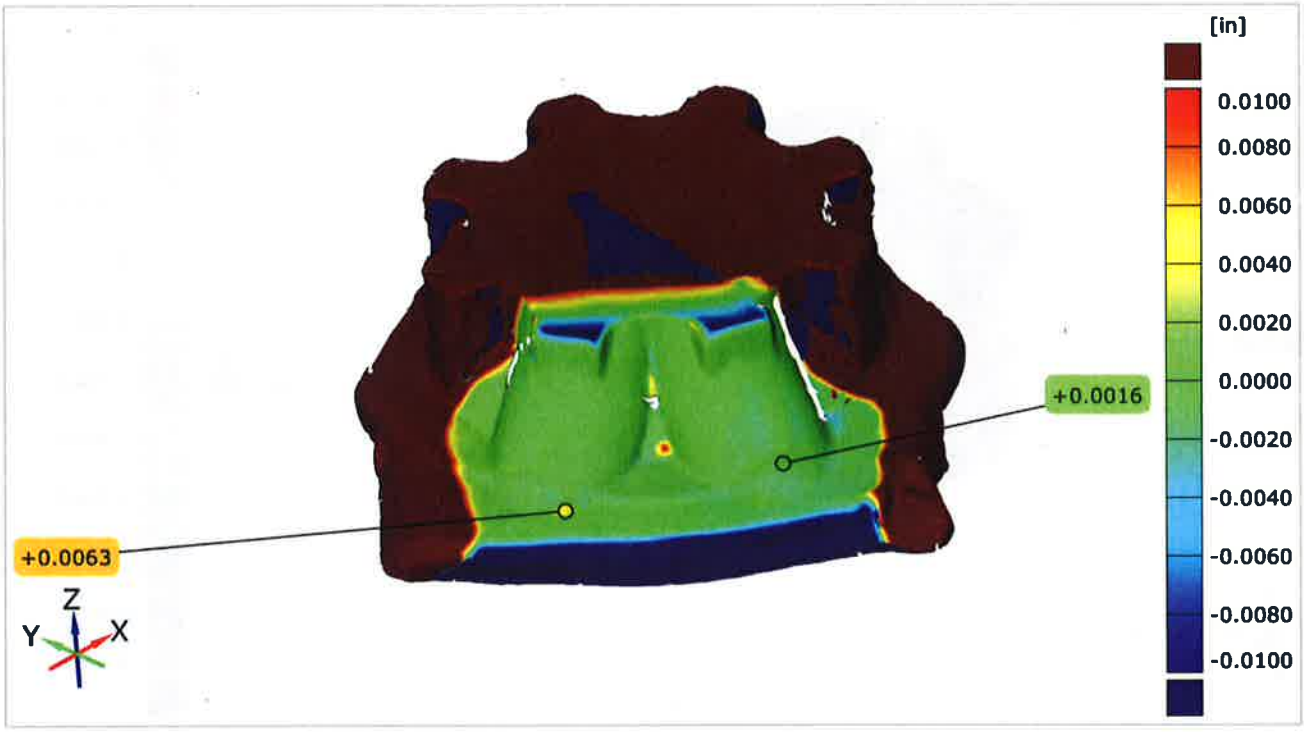
C41-7



E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0043
Right	dXYZ			+0.0042

Prea gnment 1 Length un t: n

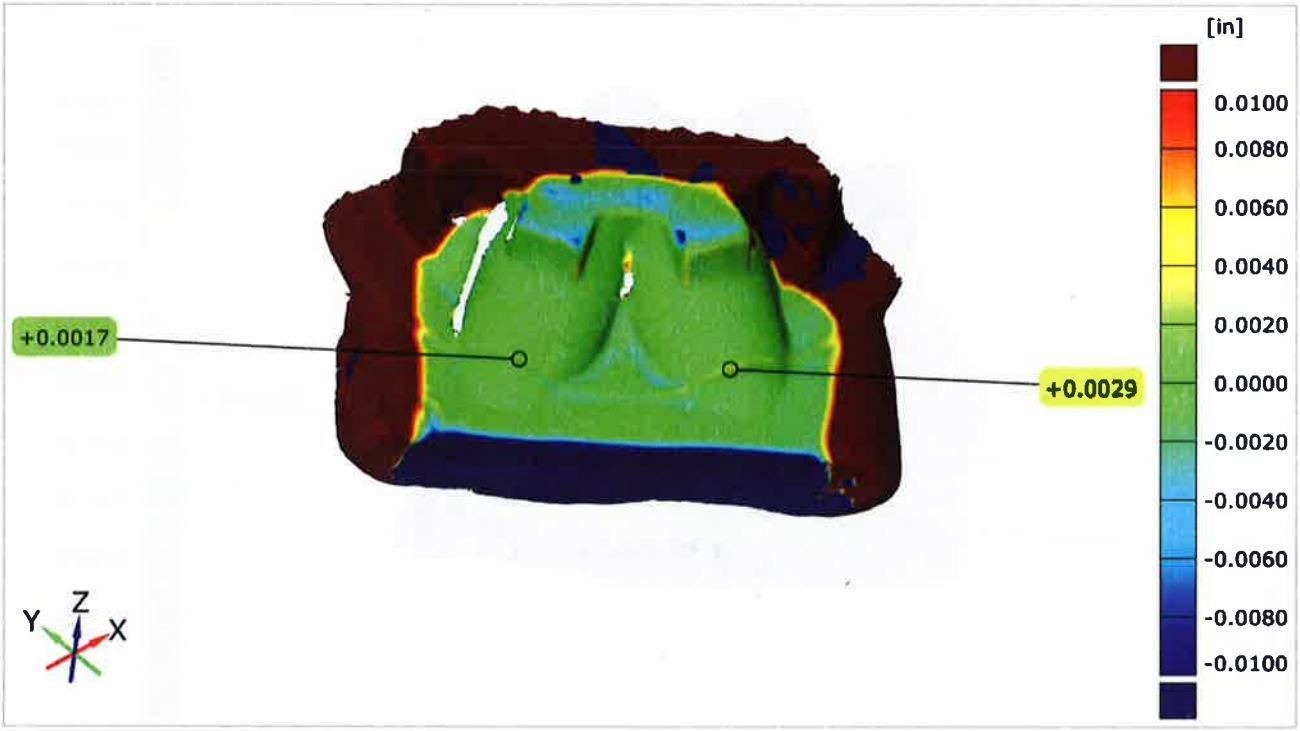
C41-8



E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0016
Right	dXYZ			+0.0063

Loca best-f t 1 Length un t: n

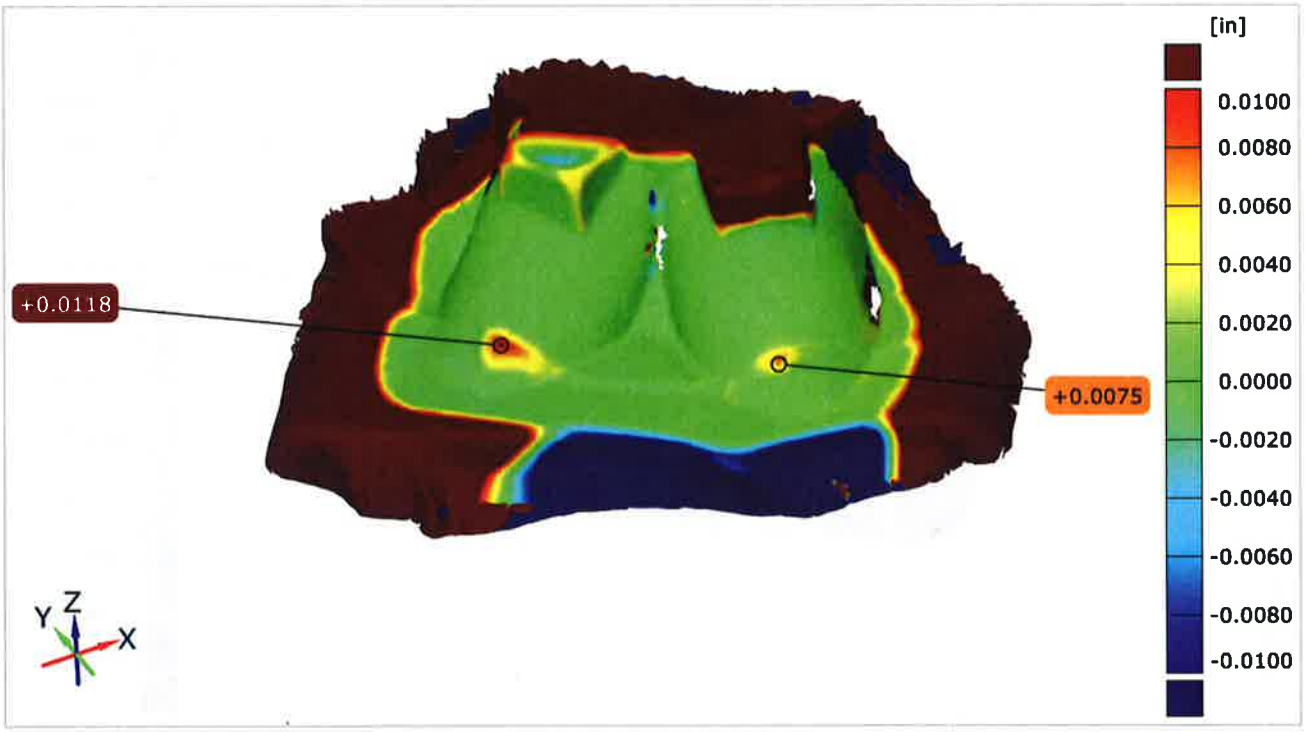
C41-9



E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0029
Right	dXYZ			+0.0017

Loca best-f t 1 Length un t: n

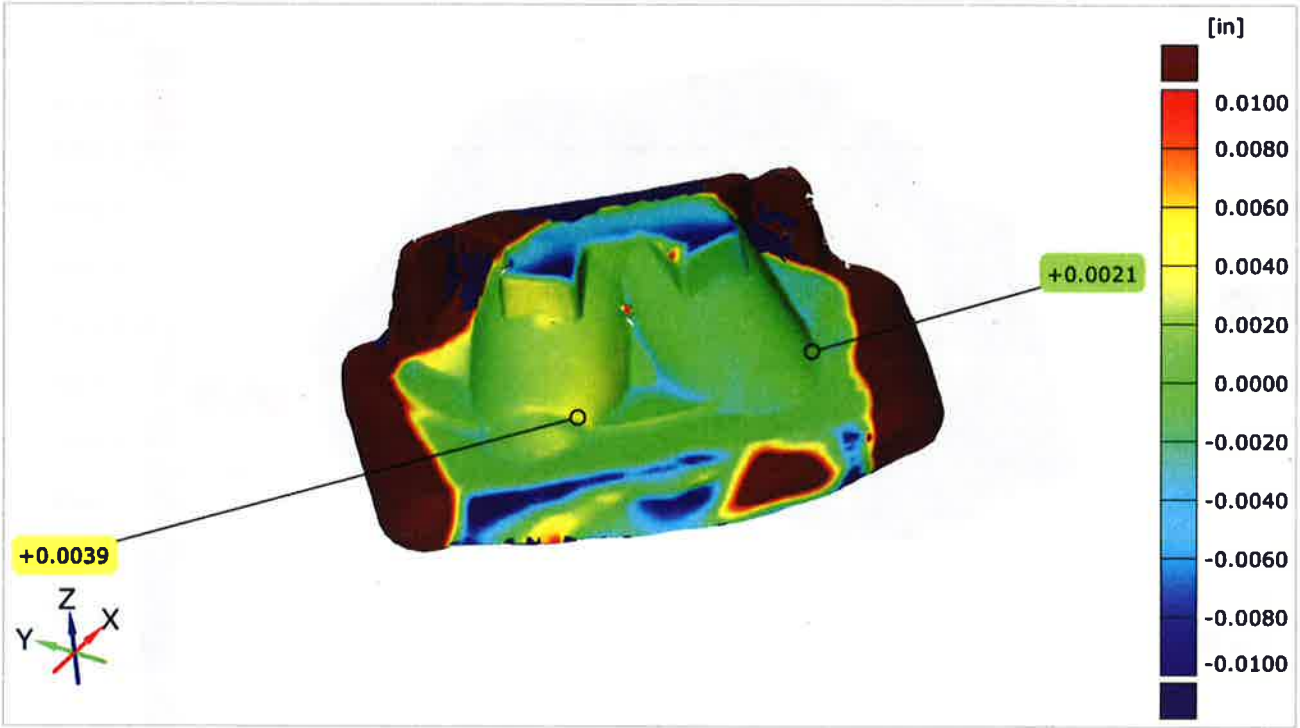
C41-10



E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0075
Right	dXYZ			+0.0118

Loca best-f t 1 — Length un t: n

C41-11

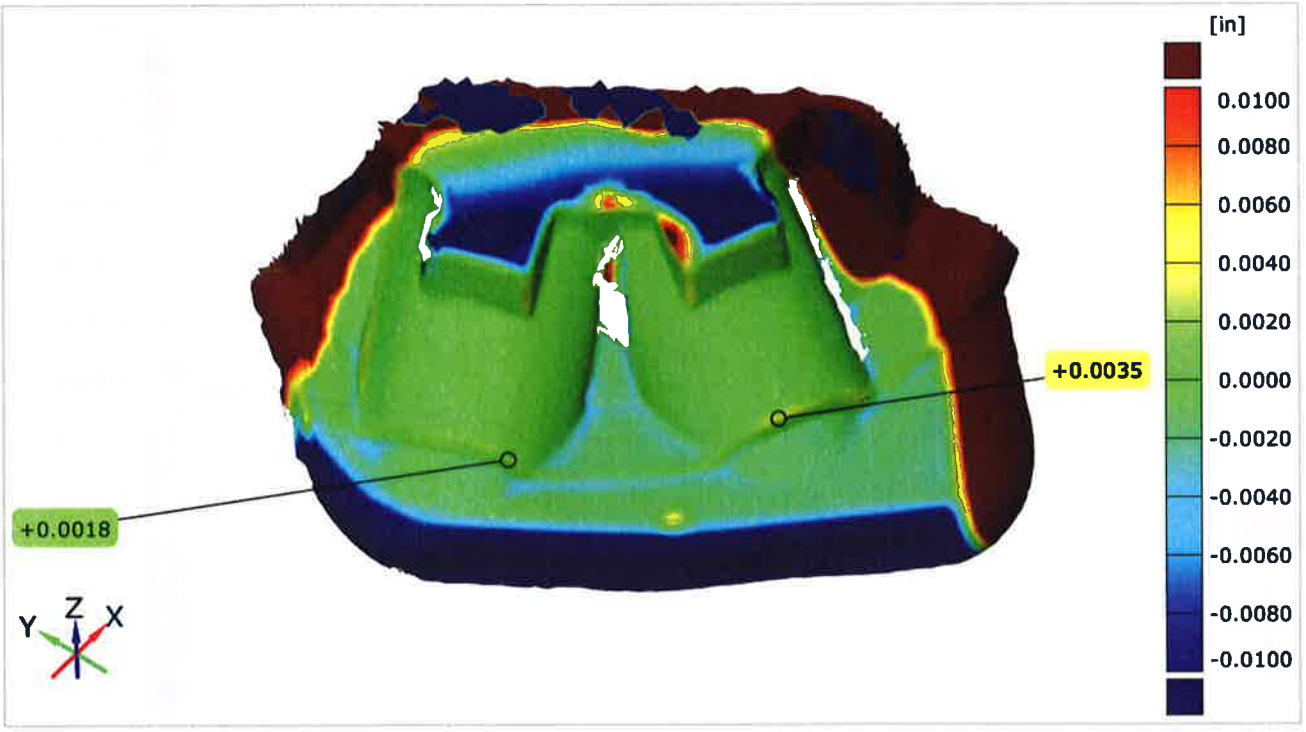


E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0021
Right	dXYZ			+0.0039

Prea gnment 2

Length un t: n

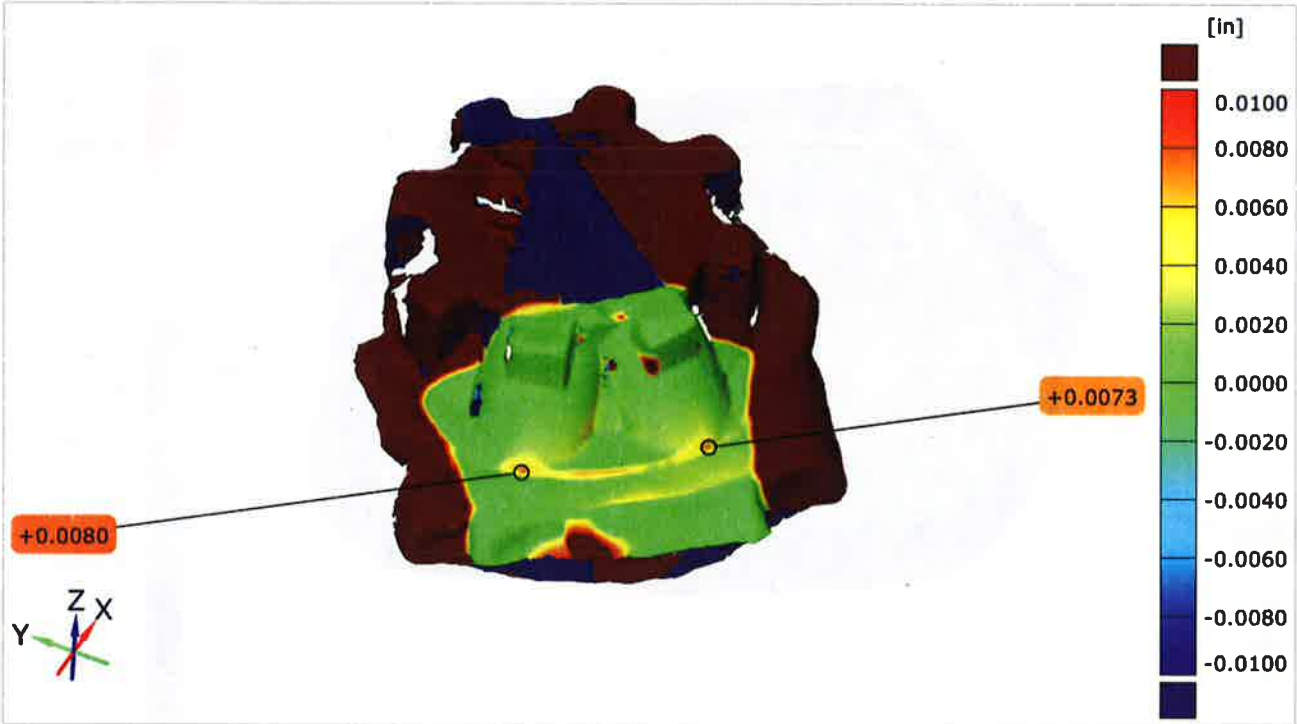
C41-12



E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0035
Right	dXYZ			+0.0018

Loca best-ft 1 Length un t: n

T164-1

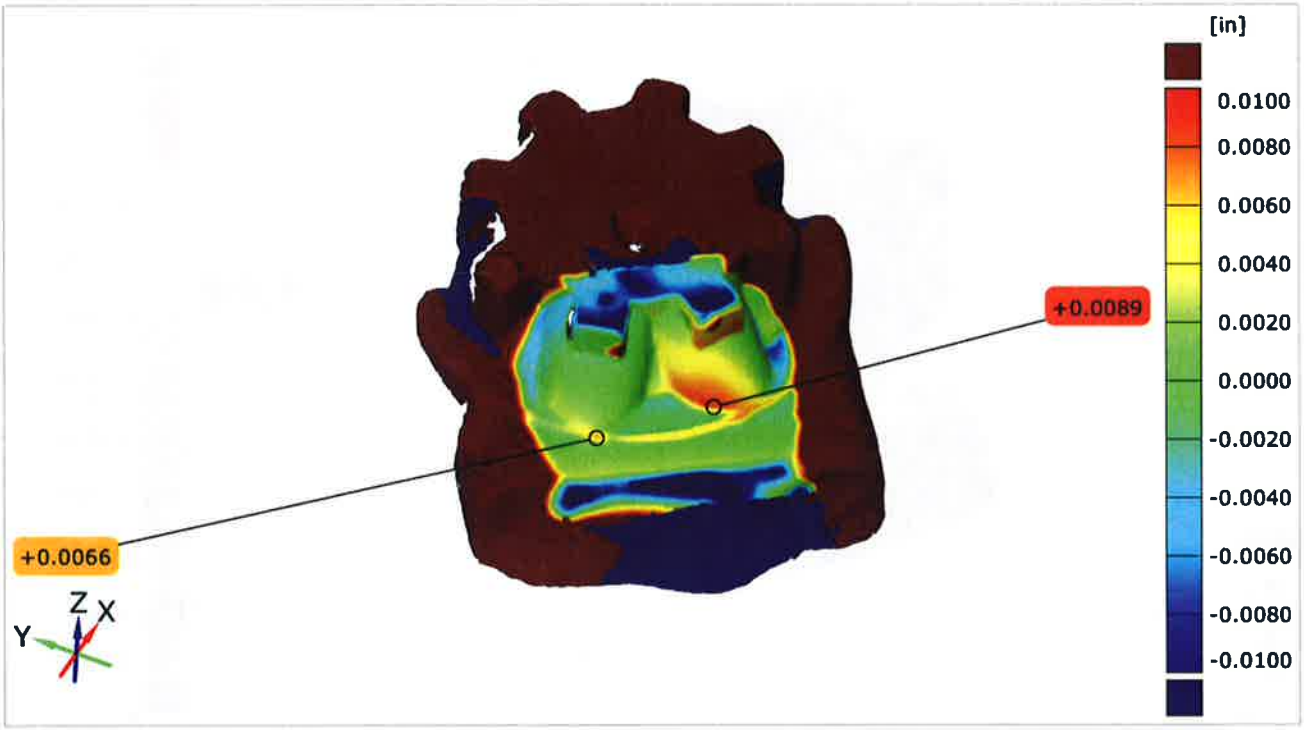


E ement	Property	To -	To +	Dev
Left	dXYZ	-0.0039	+0.0039	+0.0073
Right	dXYZ	-0.0039	+0.0039	+0.0080

Prea gnment 1

Length un t: n

T164-2



Element	Property	To -	To +	Dev
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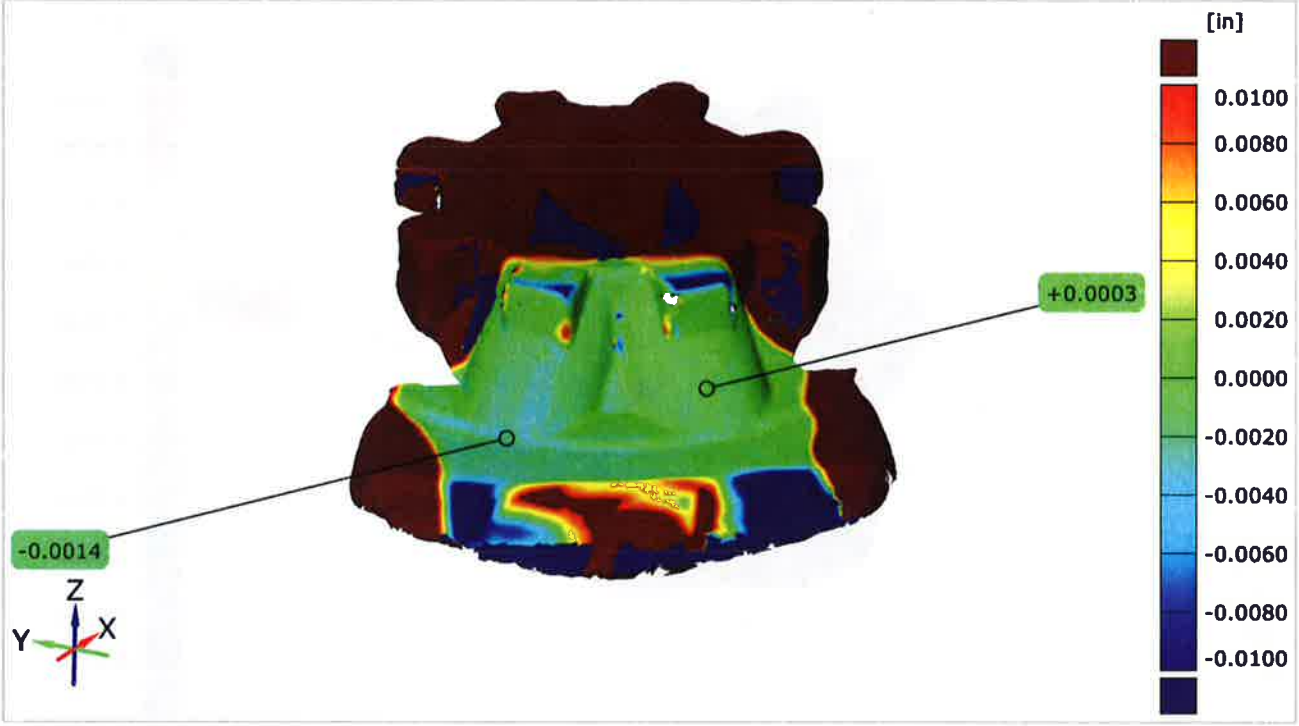
Right	dXYZ			+0.0066

Prealignment 1 — Length unit: mm

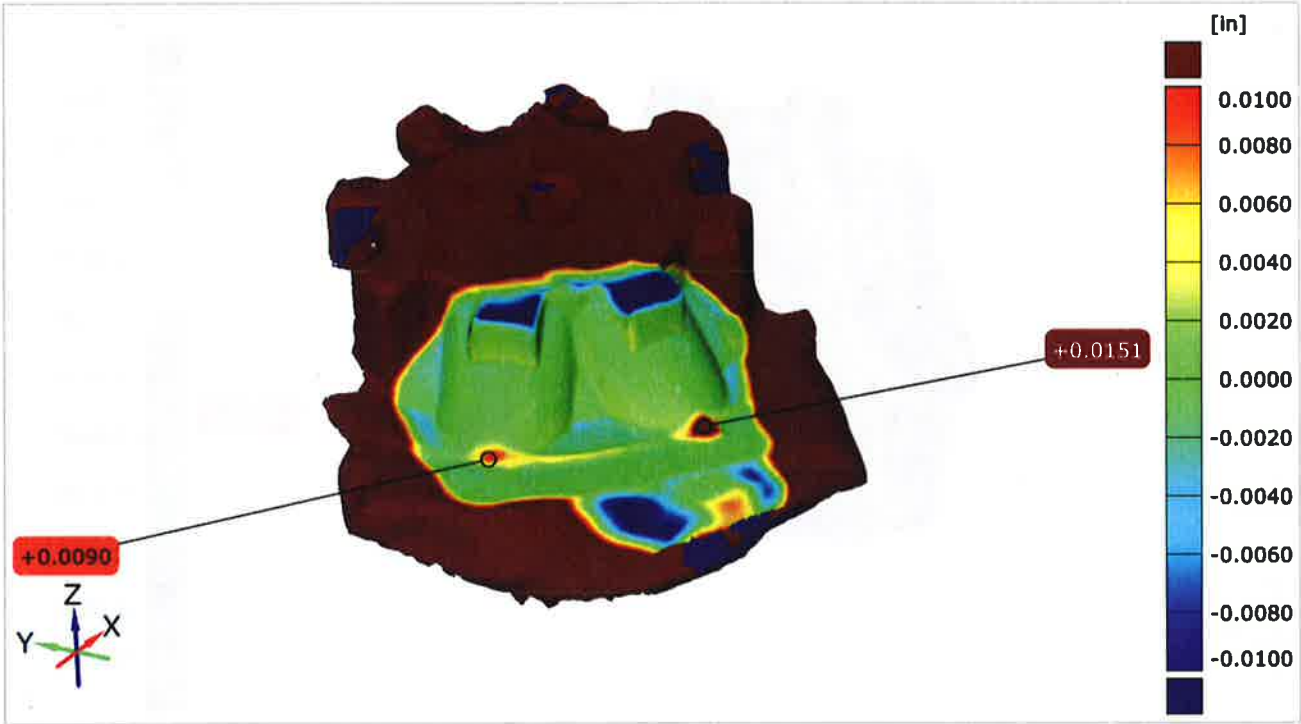
T164-3



E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0003
Right	dXYZ			-0.0014

Prea gnment 1 Length un t: n

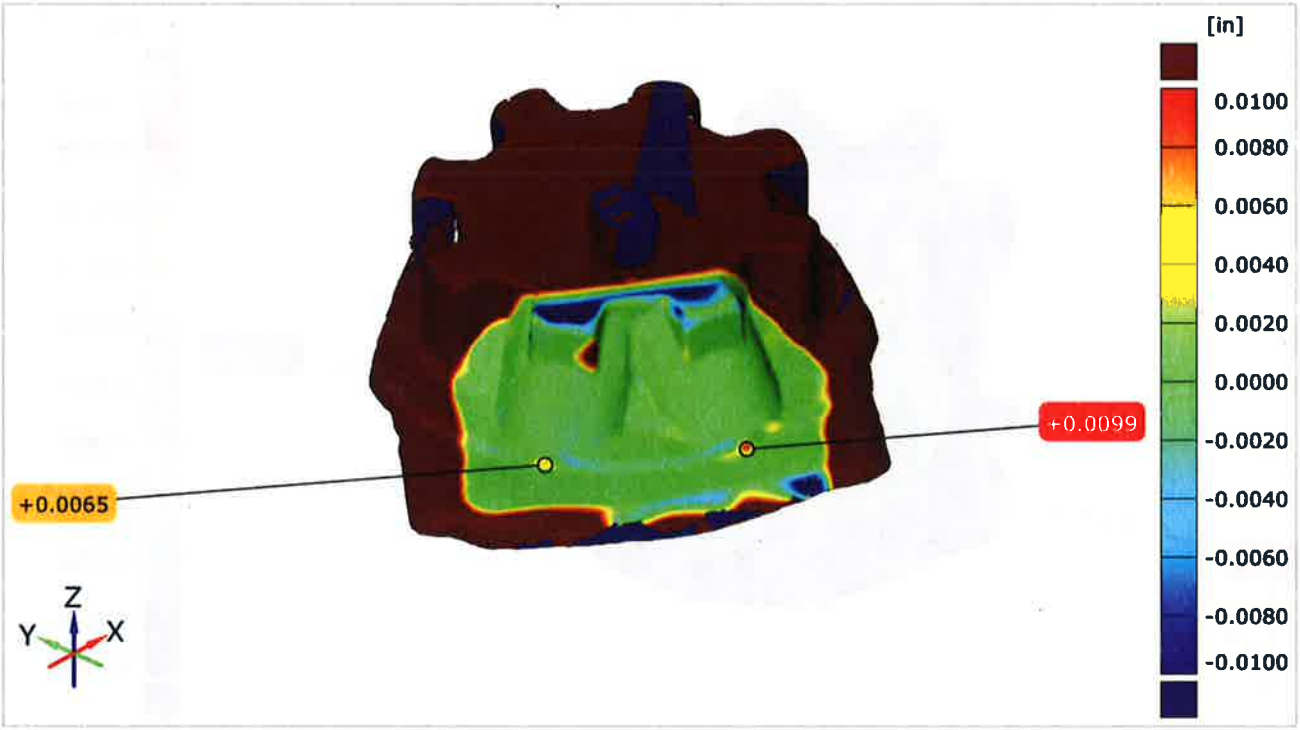
T164-4



E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0151
RIght	dXYZ			+0.0090

Prea gnment 1 Length un t: n

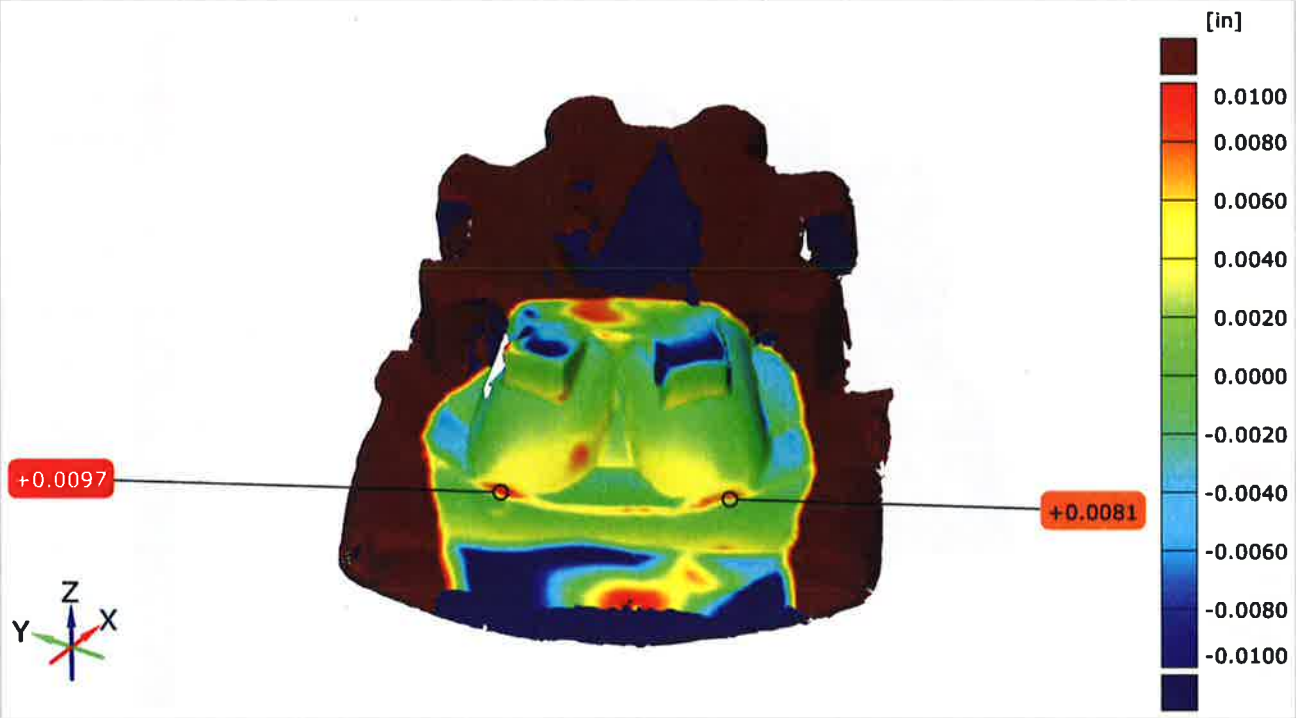
T164-5



E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0099
Right	dXYZ			+0.0065

Prea gnment 1 Length un t: n

T164-6



E ement	Property	To -	To +	Dev
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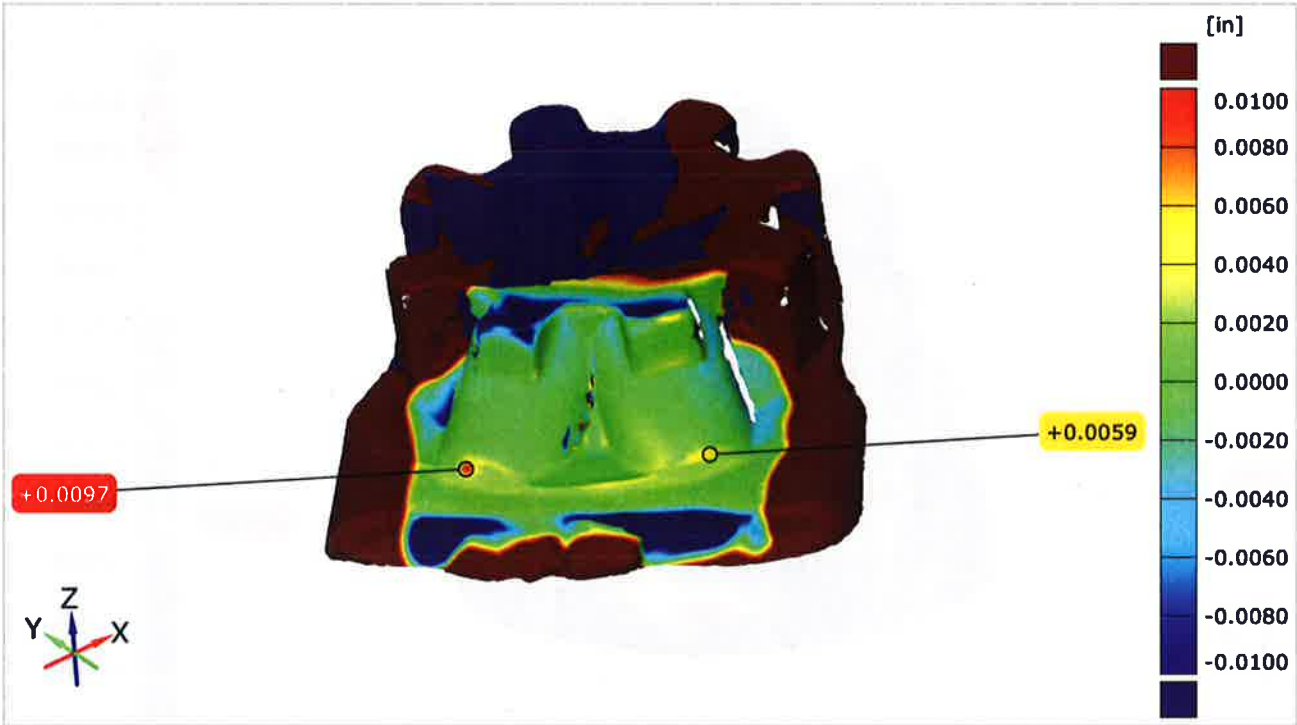
Right	dXYZ			+0.0097

Prea gnment 1 Length un t: n

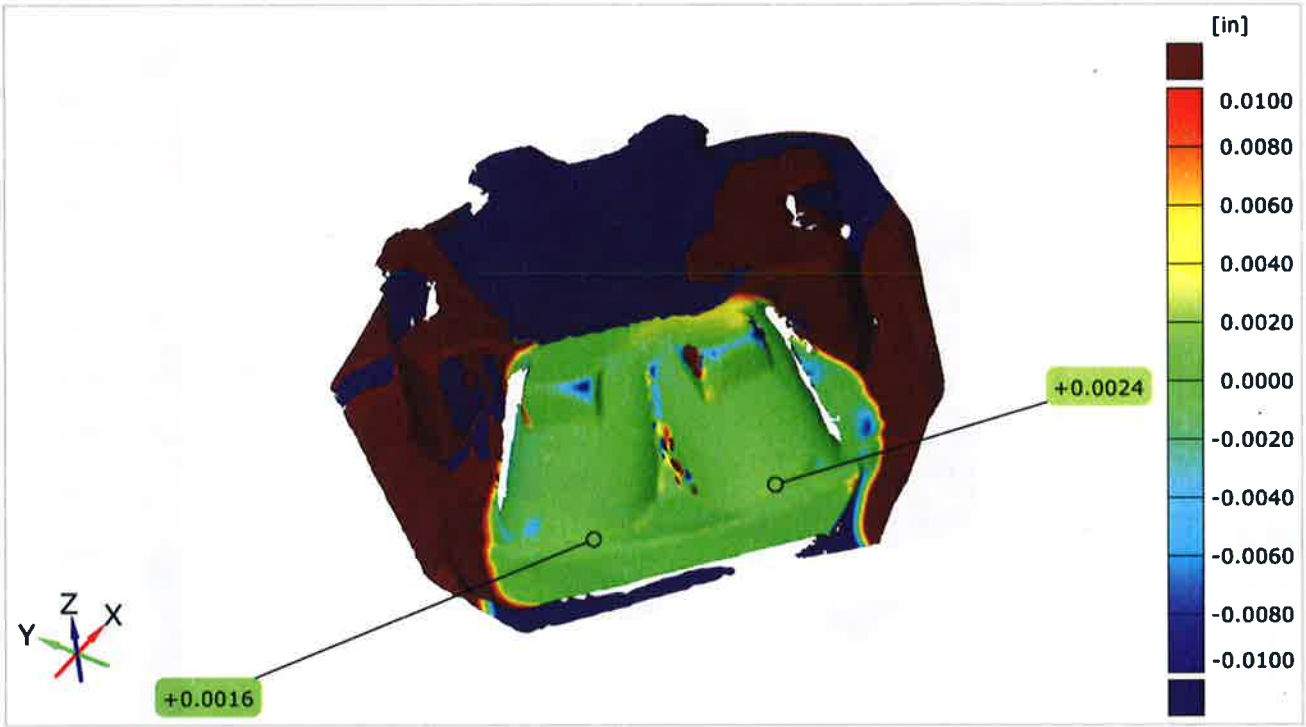
T27-1



E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0059
Right	dXYZ			+0.0097

Prea gnment 1 Length un t: n

T27-2



E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0024
Right	dXYZ			+0.0016

Prea gnment 2 Length un t: n

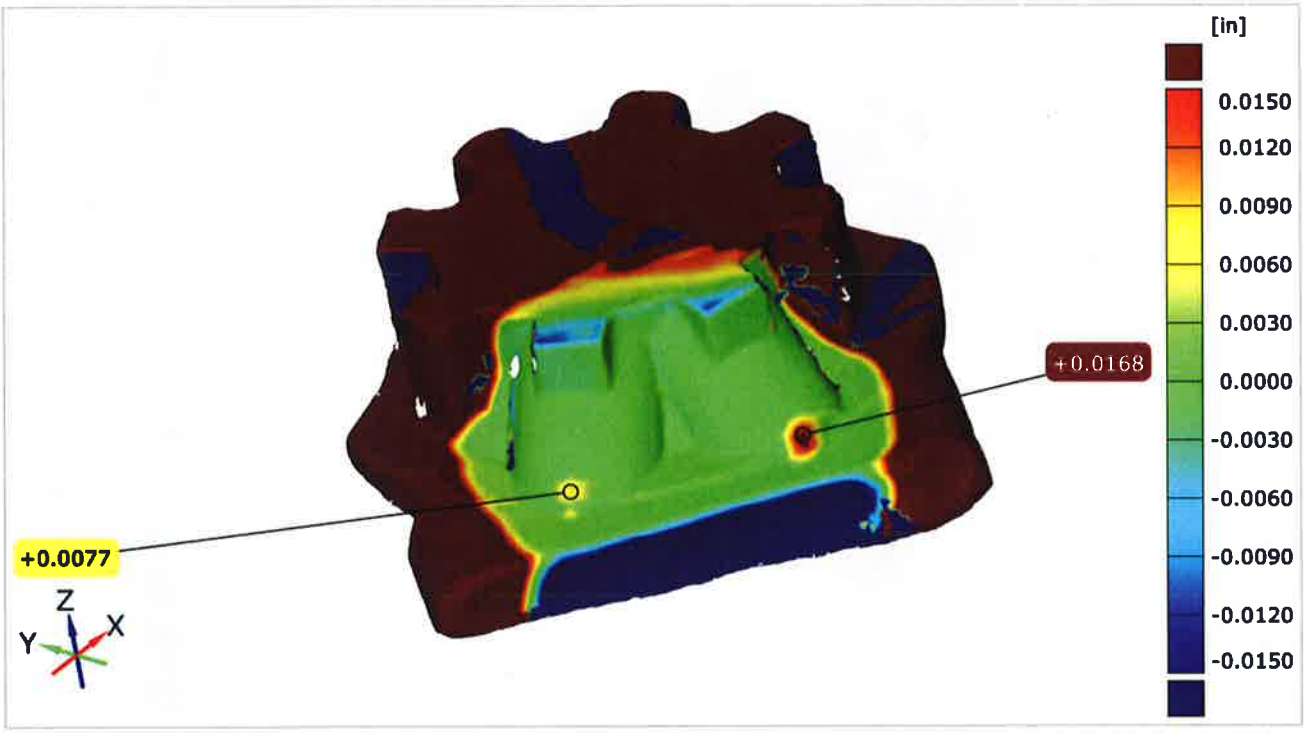
T27-3

E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0063
Right	dXYZ			+0.0008

Loca best-f t 1

Length un t: n

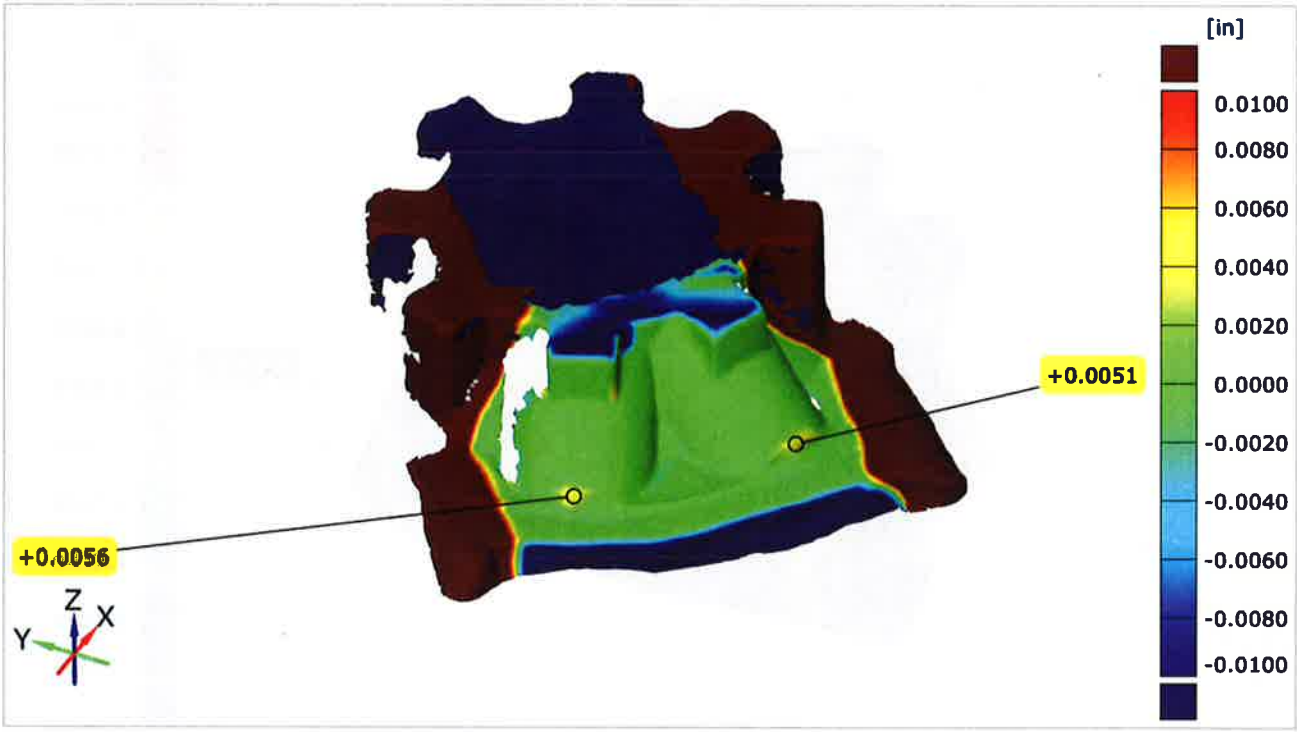
T27-4



E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0168
Right	dXYZ			+0.0077

Loca best-f t 1 Length un t: n

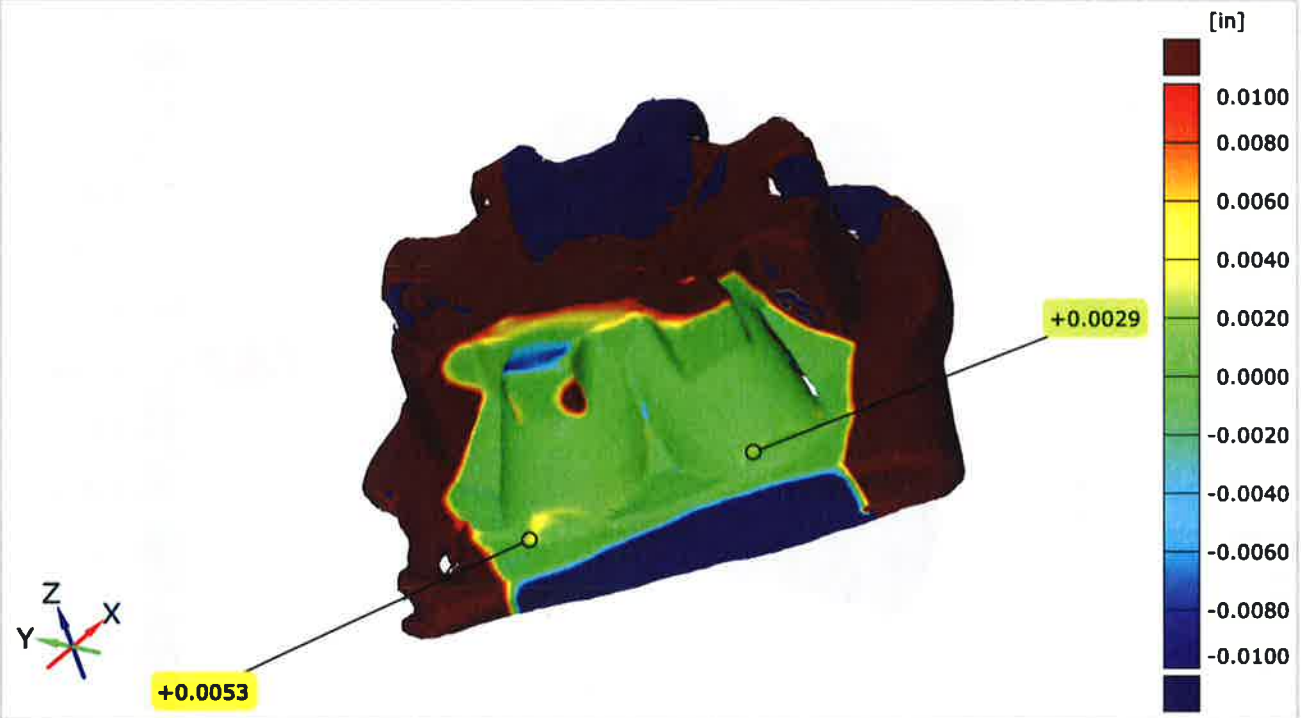
T27-5



E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0051
Right	dXYZ			+0.0056

Loca best-f t 2 | Length un t: n

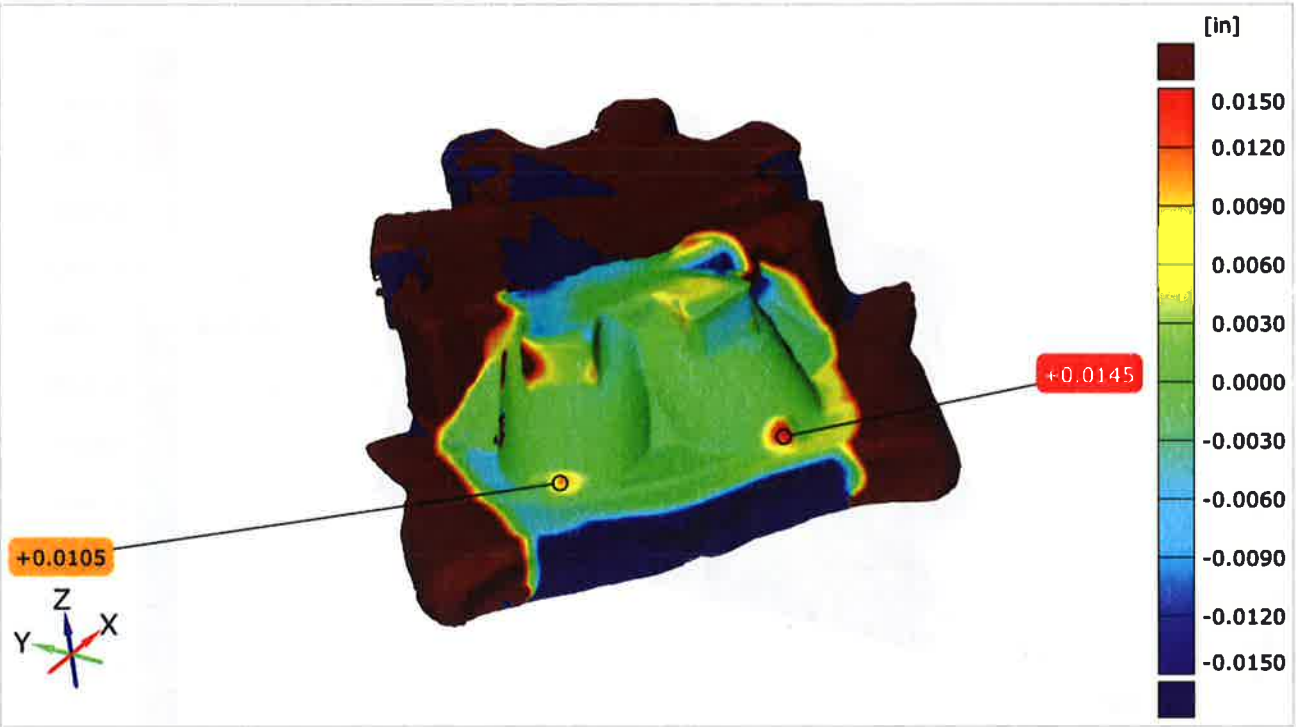
T27-6



E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0029
Right	dXYZ			+0.0053

Loca best-f t 1 Length un t: n

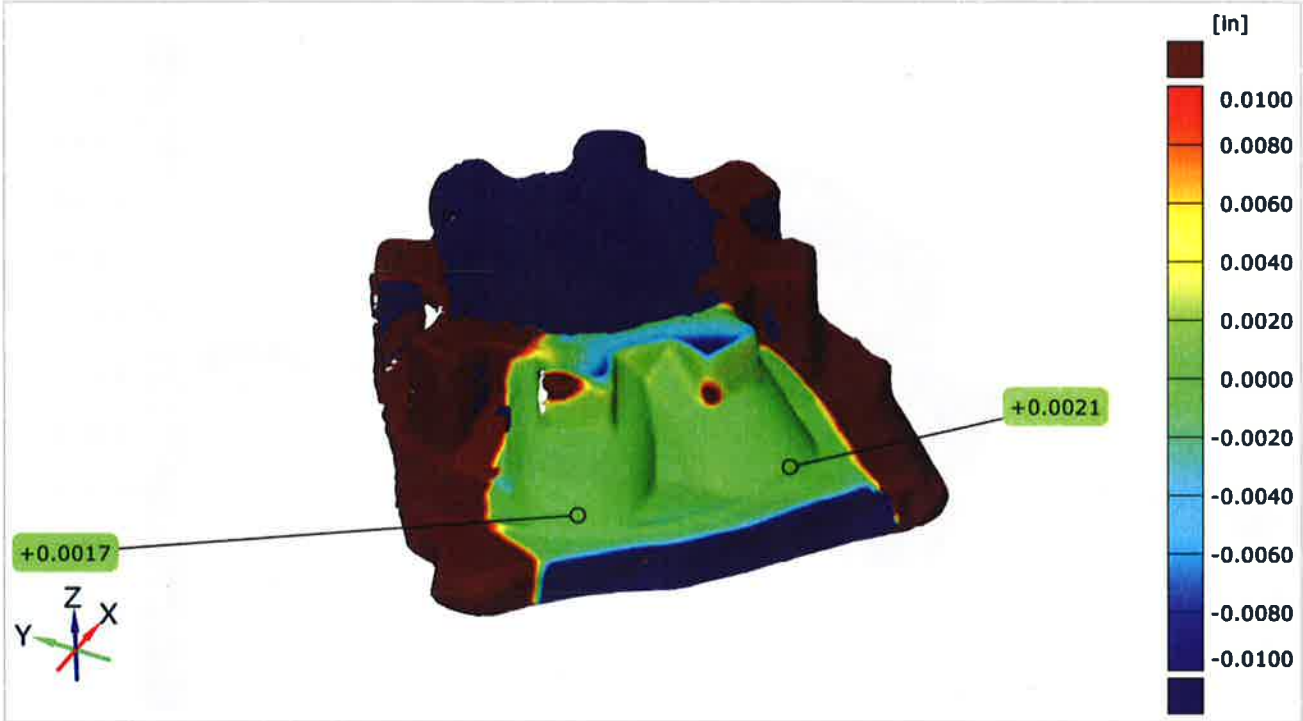
T27-7



Element	Property	To -	To +	Dev
Left	dXYZ			+0.0145
Right	dXYZ			+0.0105

Local best-fit 1 — Length unit: mm

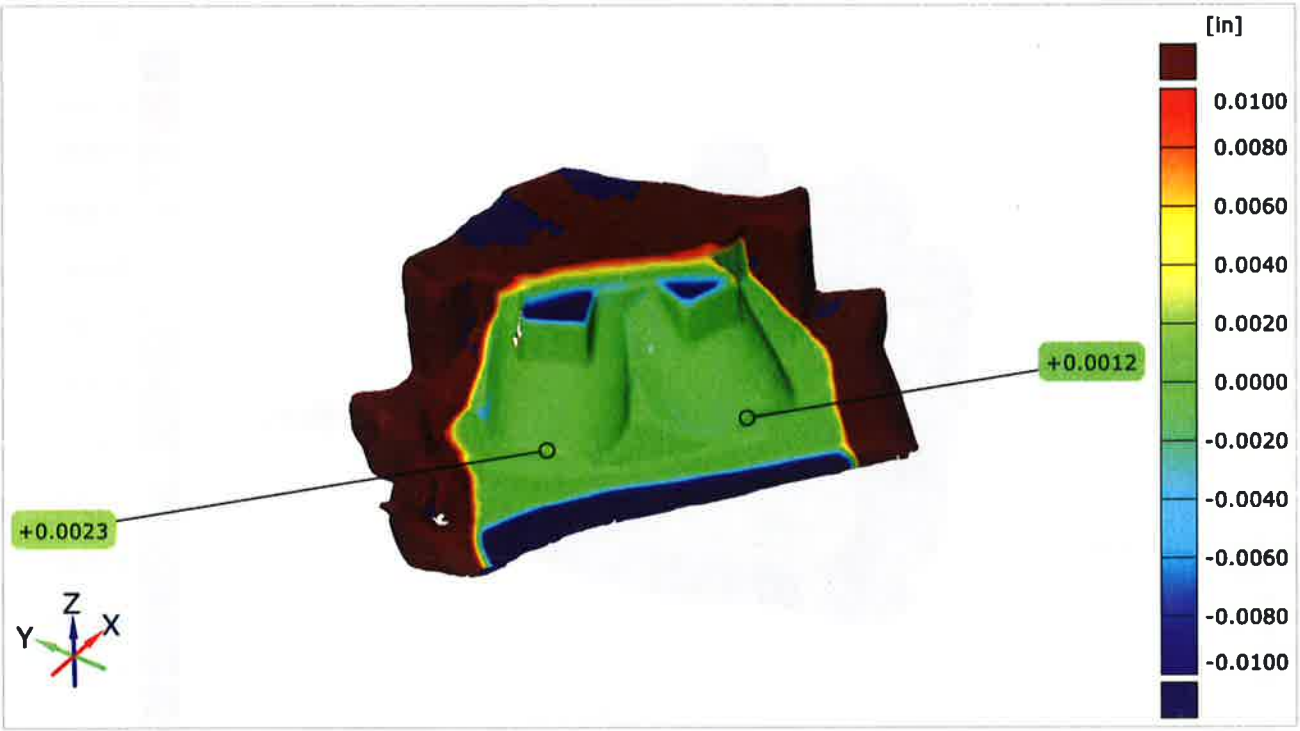
T27-8



E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0021
Right	dXYZ			+0.0017

Loca best-f t 1 Length un t: n

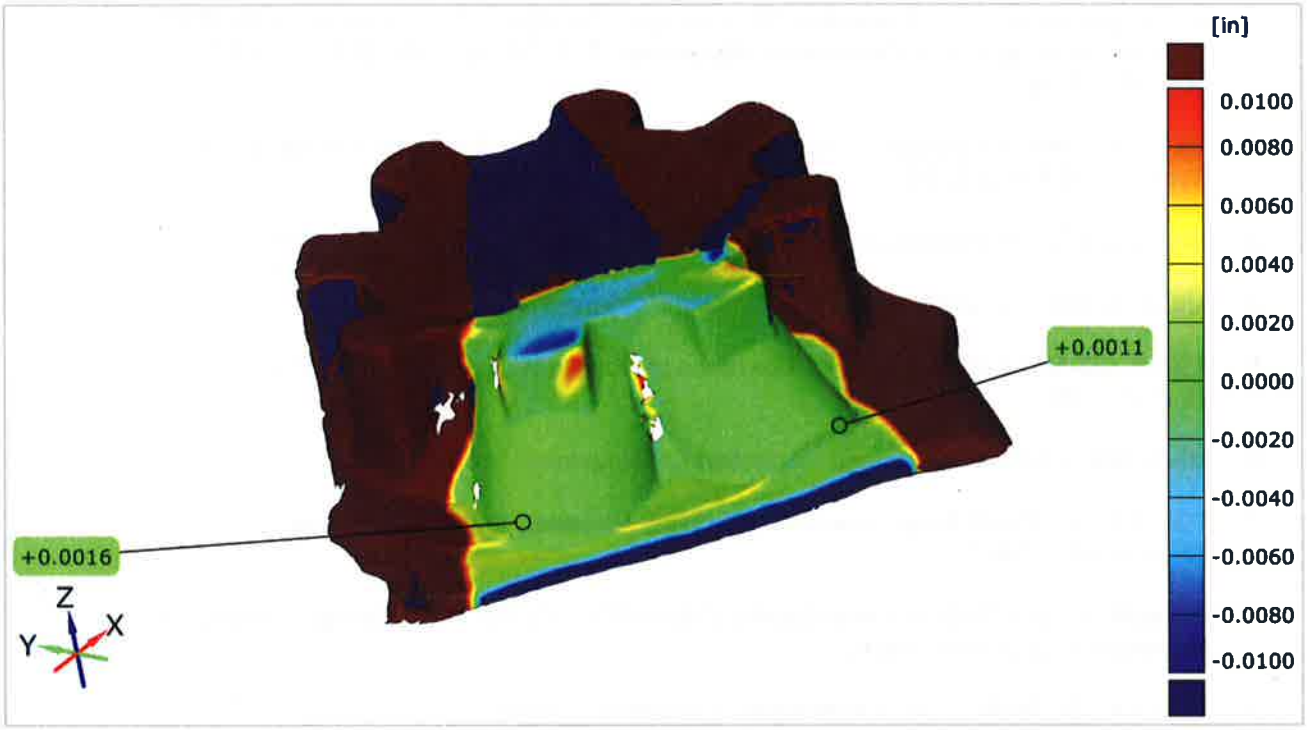
T27-10



E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0012
Right	dXYZ			+0.0023

Loca best-f t 1 — Length un t: n

T27-11



E ement	Property	To -	To +	Dev
Left	dXYZ			+0.0011
Right	dXYZ			+0.0016

Prea gnment 1 Length un t: n

APPENDIX G. REFERENCES

1. Memorandum, AEC, 16 December 2013, subject: Test Execution Directive for M855A1 Conformance Testing on Commercial Magazines, ATEC Project No. 2014-DT-ATC-M4CAR-F9278.
2. MIL-PRF-63460E, Lubricant, Cleaner, and Preservative for Weapons and Weapons Systems, 15 March 2006.
3. MIL-STD-271F, Nondestructive Testing Requirements for Metal, 27 June 1986.
4. MIL-STD-1949, Magnetic Particle Inspection Process, 1 August 1985.
5. AMCP-702-10, Quality Assurance Guidance to Nondestructive Test Techniques, 29 April 1970.
6. MIL-I-6866B, Penetrant Method Inspection, 29 November 1985.
7. TOP 3-2-045, Small Arms - Hand and Shoulder Weapons and Machineguns, 17 September 2007.
8. Reliability Failure Definition and Scoring Criteria (FD/SC) For The Individual Carbine (IC), Increment I, 18 October 2010.
9. TOP 1-1-030, RAM-D and ILS Analysis, 8 September 2008.
10. Final Report for the Confirmatory Test of the M4A1 Carbine M855A1 Modified Magazine, August 2014, Report No. ATC-11503, ATEC Project No. 2013-DT-ATC-M4CAR-F7255.

APPENDIX H. ABBREVIATIONS

AEC	=	U.S. Army Evaluation Center
AMCP	=	U.S. Army Materiel Command Pamphlet
APG	=	Aberdeen Proving Ground
ATC	=	U.S. Army Aberdeen Test Center
ATEC	=	U.S. Army Test and Evaluation Command
BOB	=	bolt over base
CIL	=	cleaned, inspected, and lubricated
CLP	=	cleaner, lubricant, and preservative
COTS	=	commercial off the shelf
CT	=	Computed Tomography
DC	=	direct current
DF	=	Dependent Failure
EFF	=	Essential Function Failure
FBR	=	failure of the bolt to lock to the rear
FD/SC	=	failure definition/scoring criteria
FEJ	=	failure-to-eject
FFD	=	failure-to-feed
GFE	=	government furnished equipment
LCL	=	lower confidence limit
MCSC	=	Marine Corps Systems Command
MRBS	=	mean rounds between stoppage
NATO	=	North Atlantic Treaty Organization
NDT	=	nondestructive test
NEFF	=	Nonessential Function Failure
PE	=	point estimate
PM	=	Product Manager
ROF	=	rate-of-fire
TIR	=	Test Incident Report
TOP	=	Test Operations Procedure
USMC	=	United States Marine Corps
VDLS	=	VISION Digital Library System
VISION	=	Versatile Information Systems Integrated Online

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