MAJ YJ Yi
Operations Officer
Land Test and Evaluation Agency
Army Headquarters

THE ENGINEERING EVALUATION
ON
THE INDIVIDUAL WEAPONS
FOR
THE SMALL ARMS REPLACEMENT PROJECT - ASR 48.8
DEFENCE TRIAL DIRECTIVE 8/513
VOLUME THREE
PART FOUR - ADVERSE CONDITIONS TESTS
PART FIVE - MISCELLANEOUS TESTS AND INFORMATION

EDE PUB 17/85
(VOLUME 3 OF 3)

ENGINEERING DEVELOPMENT ESTABLISHMENT

THE ENGINEERING EVALUATION

ON

THE INDIVIDUAL WEAPONS

FOR

THE SMALL ARMS REPLACEMENT PROJECT - ASR 48.8

DEFENCE TRIAL DIRECTIVE 8/513

VOLUME THREE

PART FOUR

ADVERSE CONDITIONS TESTS

Part 4 contains the aims, methodology, results and conclusions of various Adverse Conditions tests.

These tests are presented as:

ANNEX A	-	Toxicity Test
ANNEX B	-	Obstruction in the Barrel
ANNEX C	-	Cook Off and Barrel Heating Test
ANNEX D	-	Static and Dynamic (Sand and Dust) Tests
ANNEX E	-	Mud Test
ANNEX F	-	Accelerated Water Spray Test
ANNEX G	-	Salt Water Immersion Test
ANNEX H	-	Sand Drag Test
ANNEX I	-	Low Temperature Test
ANNEX J	-	High Temperature (HOT) Test

PART FOUR

ADVERSE CONDITIONS TESTING OF

SARP INDIVIDUAL WEAPONS

INTRODUCTION

1. Adverse Conditions testing of the Individual Weapon (IW) contenders in the Australian Army Small Arms Replacement Project (SARP) was carried out at Engineering Development Establishment (EDE) over the period 11 Oct 84 - 11 Jun 85.

2. Adverse conditions for the purpose of this report is a generic term describing those tests laid down in Reference C as adverse, climatic and potentially hazardous.

WEAPONS USED

3. The weapons used during the testing are shown below:

Weapon Type	Identifier	Remarks
STEYR AUG	S5	
STEYR AUG	S6	Replaced S5 for completion of Barrel Obstruction Test.
STEYR AUG VARIANT	SV2	Used on ballistic pendulum only.
COLT M16A2	C4	
COLT M16A2	C5	Replaced C4 for completion of Barrel Obstruction Test.
COLT VARIANT	CV2	Used on ballistic pendulum only.
RIFLE 7.62 mm L1A1	AD 71000719	Control weapon.

AMMUNITION USED

4. The ammunition used throughout the testing was FN SS109 LOT 13 FNB 83.

TESTS CONDUCTED

5. The following tests (together with their EDE Report Annex) were conducted.

Test	D/14 Para No	Annex
Toxicity	2.13.2	A
Cold	2.14.1	I
Hot	2.14.2	J
Salt Water Immersion	2.18.3	G
Accelerated Water Spray	2.18.2	F
Mud	2.18.6	E
Static and Dynamic Sand	2.18.4	D
Sand Drag	2.18.5	H
Cook Off and Barrel Heating	2.19.1	C
Obstruction in Barrel	2.15.3	B

TESTS NOT CONDUCTED

6. The following tests were not carried out by EDE. The reason/s for non-completion are noted.

Test	D/14 Para No	Notes
Position Disclosing Effects	2.12	Conducted by User.
Hazardous Effects - Noise	2.13.1	Conducted by User.
Temperature & Humidity	2.14.3	Not conducted due to its similarity to the salt water immersion humidity cycle. Both tests require a humidity cycle extending over 10 days during which regular firings are carried out with no cleaning or lubrication. The salt water test is considered to be more severe than the humidity test. Additional weapons were not readily available.
Icing	2.14.4	Not conducted due to lack of secure facilities and similarity to cold and water spray tests.
Ancillary items - high and low angle firing	2.17.2c	Not conducted due to equipment not being available (dismantled at 3AQAU). EDE recommends that this test be done at first available opportunity perhaps by P&EE Group.
Unlubricated	2.18.1	Reportedly done by User.

GENERAL OBSERVATIONS

Salt Water Immersion

7. This test appears to be too severe in its current format. It is the opinion of the test team that a minimum lubrication criterion be applied, that is lubrication without disassembly. This would bring the test into line with the requirements for the Hot and Cold tests and provide a logical consistency between tests.

Hot Test

8. During this test, hard extractions were experienced with both contender weapons, predominantly with the COLT. This is attributed to minimum long cone taper and long overall length relative to the head diameter of the SS109 case. In most cases the hard extraction resulted in a portion of the rim being torn away. In addition to case design, limited primary extraction is also a contributor. Repeated operation of the bolt mechanism as an IA only aggravated the situation making extraction by the operation of the weapon mechanism alone, impossible.

9. Because the Hot Test is considered representative of the Australian environment it is recommended that standard drills for clearing hard extractions be developed and promulgated to the user. The following suggestions are made in this regard:

a. That the cleaning rod be carried by each soldier so that it can be assembled and used to clear this stoppage should it occur with the COLT M16A2. No other easier fix is considered possible or practicable.

b. That the screwdriver on the STEYR combination tool be modified for use in the cannelure of the case of a hard extraction; this is considered the best alternative for the STEYR due to the ease of removal of the affected barrel. (A clasp knife or edge of the bayonet would suffice in an emergency.)

Comparative Testing

10. Where possible tests on both weapons have been carried out under the same environmental conditions, ie, standard ammunition temperature and weather conditions. In some tests, in particular the Mud Test, this is considered to be a primary consideration. In the Mud Test, the mud at low temperatures appears to act as a lubricant, whilst at elevated temperatures it dries and acts as a binding medium.

Video Tape Recording

11. A video camera was used to record all tests. This was found to be an invaluable asset in that it minimised record keeping and enabled critical examination (repeatedly if required) of any facet of the tests being conducted. As an aside, it provided a useful information medium for demonstrations, etc.

Marking of STEYR Gas Regulator

12. Because the functions of preparing the weapons and firing them were segregated it was noticeable that some confusion was experienced in determining the gas setting. A better method of marking the gas regulator is required. Letter stamping or colour coding are considered viable alternatives.

Corrosion of Pins and Springs

13. The degradation of pins and springs was noticeable during most testing and in particular after the Salt Water Immersion and could be anticipated with the Humidity Test.

Failure Criteria

14. Although D/14 (Reference C) is explicit in much detail, some tests have not any definite failure criteria. To offset this limitation the following base was adopted (at times tempered by the need to remain objective and yet be comparative). EDE failure criteria were:

a. Three consecutive stoppages, or

b. three stoppages of the same type, or

c. a stoppage that could not be cleared by Immediate Action (IA) drills.

Deficiencies in Facilities

15. D/14 (Reference C) calls up the use of a Standard Test Chamber which can be maintained at a definite temperature and free from sudden changes due to wind (chill factor) and the incidence of the sun's rays. At times, marginal differences in performance may have been attributed to these two uncontrollable variables.

Packaging of Cleaner, Lubricant Preservative (CLP)

16. It was found that trials staff needed to be constantly reminded that for the optimal benefit to be gained from the use of this product that it had to be shaken well before use. It is believed that the major cause was the opaque packaging. This could be remedied by the use of clear packaging so that the teflon component is visible to the user.

Statistical Reliability

17. Due to the limited quantity of weapons available the same weapon had been used on previous adverse tests. Although the condition of the weapon was critically checked and components replaced where necessary there was a risk that the results could be affected by previous tests. However, the results still indicate a definite difference in performance of the two systems used.

PART FOUR

ANNEX A

TOXICITY TEST

This Annex contains information about the Toxicity Test carried out at EDE's 25 metre range. The following are included in this Annex.

TABLE 1	% PER VOLUME CO IN SAMPLES.
TABLE 2	TOTAL CO CONCENTRATION IN LITRES.
APPENDIX 1	TOXICITY VALUE (LITRES) CALCULATIONS.
FIG 1	DRAGER TEST PUMP.

ANNEX A TO
PART FOUR TO
EDE 17/85

TOXICITY TEST

REFERENCES: A. Evaluation Procedures For Future NATO Small Arms Weapon Systems D/14 para 2.13.2

B. EDE Firing Programme - Serial 10

INTRODUCTION

1. The Toxicity Test was carried out at EDE 25 metre range over the period 5-8 Feb 85.

AIM

2. The aim of the test was to provide a measurement of the carbon monoxide (CO) present in a known confined space for a known number of rounds.

3. Each weapon was subjected to a test firing of 40 ball rounds.

4. 'DRAGER' CO test tubes (Catalogue Number 6728751 with a range of 0.01-0.3%) were used to measure the % of CO in the test chamber. The 'DRAGER' test apparatus is shown in Figure 1.

METHOD

5. Each weapon was in turn placed in the blown sand test box which had been modified by blocking all exit holes, except for the handling gloves and the exit point through which the muzzle was placed up to just past the flash eliminator. The muzzle exit point was sealed using a 4 mm thick sheet of polyurethane elastomer.

6. The weapons were then loaded and 40 rounds were fired as quickly as possible (some difficulty was experienced with changing magazines, due to the physical constraints of the box).

7. At the end of the firing cycle the 'DRAGER' test tube was inserted, given one pump of the bellows pump and then the % of CO was read off the exposed dial.

8. The test as outlined above was carried out three times to produce the data shown in Table 1.

9. To ensure circulation of the gases within the chamber a MAKITA Model PB-20 Centrifugal Blower was fitted and operated during the firing stages and whilst measurements were being taken.

RESULTS

10. The results obtained are shown in Table 1.

TABLE 1 - % CONCENTRATION CO IN SAMPLES

		Readings				
Weapon	Ammo Used	1st	2nd	3rd	Average	Remarks
STEYR AUG	SS109	0.010	0.015	0.011	0.012	Ammunition Lot No 13FNB 83
COLT M16A2	SS109	0.075	0.055	0.055	0.061	Ammunition Lot No 13FNB 83
RIFLE 7.62 mm L1A1	F4	0.152	0.143	0.156	0.150	Control Weapon

11. It should be noted that the Threshold Limit Value-Ceiling (TLV-C), 1981, is 30 ppm (30mg/m^3). This is equivalent to 0.003%.

12. The total volume of CO in litres was calculated to give the results shown in Table 2 (Calculations are shown in Appendix 1).

TABLE 2 - TOTAL CO VOLUME IN LITRES

Weapon	CO Concentration
STEYR AUG	0.226 L *
COLT M16A2	1.186 L *
RIFLE 7.62 mm L1A1	2.916 L *

* These TOTALS are for 40 Ball Rounds

13. The tests conducted are a simplification of Reference A of this Annex.

CONCLUSIONS

14. Due to the high concentration levels of CO, Commanders need to be aware that a hazard exists when firing either of these weapons from confined spaces such as pill boxes/bunkers, armoured vehicles and buildings.

15. Because CO is not detected by normal physical observation, the hazard may not be observed until those exposed lapse into a coma.

16. Other exhaust gases would make the confined areas untenantable.

APPENDIX 1

TOXICITY VALUE (LITRES) CALCULATIONS

The following figure is included in this Appendix.

FIG 1 - DRAGER TEST PUMP.

APPENDIX 1 TO
ANNEX A TO
PART FOUR TO
EDE 17/85

TOXICITY VALUE (LITRES) CALCULATIONS

Data

Volume of Test Facility	= 1944 L.
Average % Per Volume CO STEYR AUG	= 0.0116 %.
Average % Per Volume CO COLT M16A2	= 0.061 %.
Average % Per Volume CO RIFLE 7.62 mm L1A1 (Control Weapon)	= 0.150 %.

Calculations

(1) CO Concentration (Litres) STEYR AUG = 1944 x 0.0116/100
= 22.5504 /100
= 0.2255 L

(2) CO Concentration (Litres) COLT M16A2 = 1944 x 0.061/100
= 118.5840 /100
= 1.1858 L

(3) CO Concentration (Litres) RIFLE 7.62 mm L1A1 = 1944 x 0.150/100
= 291.60 /100
= 2.916 L

APPENDIX 1

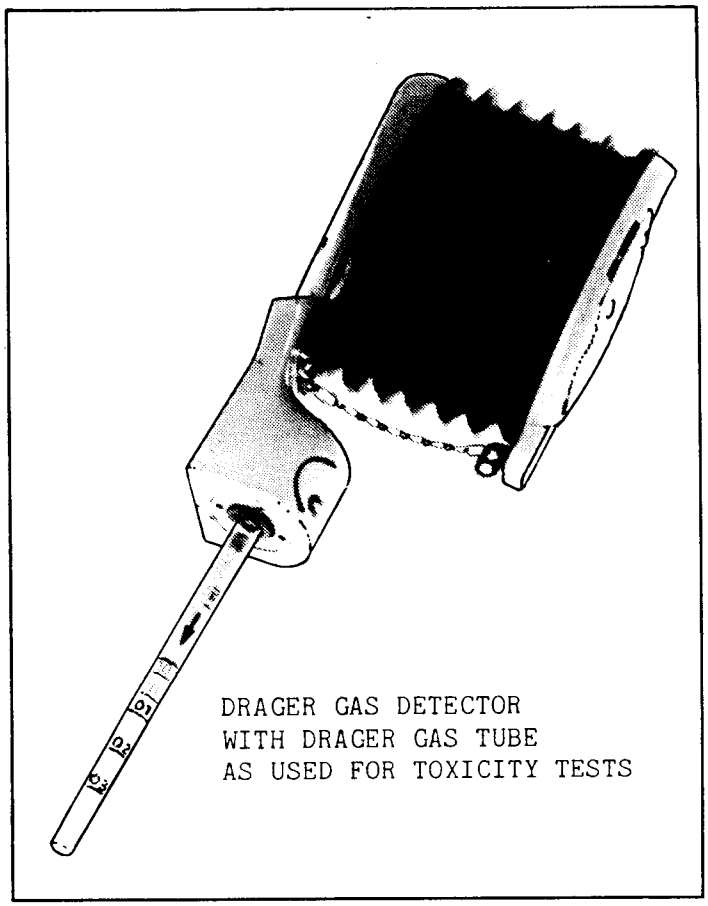


FIG 1 DRAGER TEST PUMP COMPLETE
WITH TEST TUBE (RANGE 0.01 - 0.3% CO)
CAT NUMBER 6718751

PART FOUR

ANNEX B

OBSTRUCTION IN THE BARREL

This Annex deals with the Obstruction in the Barrel Tests which were carried out at EDE's 25 m range. The following are included in this Annex.

FIG 1 LOCATION OF COLT M16A2 WEAPON PIECES (REFER TABLE 2)

FIG 2 LOCATION OF STEYR AUG WEAPON PIECES (REFER TABLE 2)

FIG 3 COLT M16A2 SHOWING DAMAGE TO UPPER RECEIVER (LEFT VIEW) WITH PROJECTILE LODGED AT LEAD

FIG 4 COLT M16A2 SHOWING DAMAGE TO UPPER RECEIVER (RIGHT VIEW) WITH PROJECTILE LODGED AT LEAD

FIG 5 COLT M16A2 (REAR VIEW) SHOWING DAMAGE FROM PROJECTILE LODGED IN LEAD

FIG 6 COLT M16A2 (BOTTOM VIEW) SHOWING DAMAGE TO BOLT CARRIER FROM PROJECTILE LODGED AT LEAD

FIG 7 COLT M16A2 (TOP VIEW)

FIG 8 COLT M16A2 (BOTTOM VIEW)

FIG 9 COLT M16A2 BOLT SHOWING DAMAGE TO EXTRACTOR AND EXTRACTOR SPRING AND PART OF CASE FROM PROJECTILE LODGED AT LEAD

FIG 10 COLT M16A2 SHOWING DAMAGE TO MAGAZINE FROM OBSTRUCTION WITH PROJECTILE LODGED AT LEAD

FIG 11 STEYR AUG SHOWING STRUCTURAL DAMAGE (SIDE VIEW) WITH PROJECTILE LODGED IN LEAD

FIG 12 STEYR AUG SHOWING STRUCTURAL DAMAGE (TOP VIEW) WITH PROJECTILE LODGED IN LEAD

FIG 13 STEYR AUG SHOWING DAMAGE TO RECEIVER (REAR VIEW) FROM PROJECTILE LODGED AT LEAD

ANNEX B TO
PART FOUR TO
EDE 17/85

OBSTRUCTION IN BARREL

REFERENCES: A. Evaluation Procedures For Future NATO Small Arms Weapon Systems D/14, para 2.15.3.

B. EDE Firing Programme - Serial 18

INTRODUCTION

1. The Obstruction in the Barrel Tests were carried out at EDE 25 metre range over the period 2 May - 18 June 1985.

AIM

2. The aim of this test was to ascertain the danger to personnel and the damage to the weapon resulting from overpressure, due to firing, when the barrel is obstructed.

METHOD

3. All ammunition including obstructions used in this test were of SS109 type.

4. The weapons were cleaned and lubricated before each of the tests with NSN 9150-01-053-6688, CLEANER, LUBRICANT, PRESERVATIVE (CLP).

5. Each weapon was in turn placed in the fixed mount to which had been connected a solenoid for remote firing. The solenoid was then connected to the remote firing device which was triggered by a high speed cine camera once it had obtained the required operating speed. The camera was positioned at right angles to the weapon which had been laid horizontal.

6. The test was divided into 3 distinct parts:

a. Obstruction by Water

In this test the horizontal weapon was injected with 10 cc of water, administered by a syringe just rearward of the gas port of each weapon. This water was injected after the round had been chambered. The weapon was then fired by the method described in para 5.

b. Obstruction by Projectile (At Gas Port)

With a projectile located with its rear face level with the forward edge of the gas port, the weapon was again fired as described above.

c. Obstruction by Projectile (At Lead)

With a projectile located with its rear face 0 mm from the tip of the detonating round after the latter had been chambered and locked. The weapon was then fired by the method described in para 5.

7. It should be noted that all firings were carried out under precautions. Screens were provided to protect the camera and the lighting equipment against possible damage should the weapon or part thereof disintegrate during detonation.

RESULTS

8. This is a destructive test. A summary of results is shown in Table 1 to 3.

TABLE 1 - RESULTS BARREL OBSTRUCTION BY WATER

Weapon	Weapon Number	Remarks
COLT M16A2	C4	Used barrel C4B. Resulted in no physical damage except bulging of barrel at 275 mm from muzzle. Depth = 0.14 mm (radial).
STEYR AUG	S6	Used barrel S6A. Resulted in no physical damage except bulging of barrel at 250 mm from muzzle. Depth = 0.06 mm (radial).

TABLE 2 - DAMAGE RESULTS BARREL OBSTRUCTION BY PROJECTILE AT LEAD

Weapon	Weapon Number	Remarks
COLT M16A2 (with Plastic Magazine)	C5	Weapon was substantially damaged. Weapon pieces were located at following distances from chamber: a. 2.35 m Magazine pieces b. 1.55 m Magazine pieces c. 1.55 m Magazine pieces d. 1.16 m Magazine pieces (4) plus magazine spring e. 3 magazine pieces on firing platform f. 1.76 m Magazine pieces g. 2.21 m Dust cover h. 6.60 m Magazine pieces i. 6.50 m Magazine pieces j. 1.40 m Magazine pieces k. 3.00 m Magazine pieces Structural damage as shown in Appendix 1 was revealed on post test examination
STEYR AUG	S4	Weapon was substantially damaged. Weapon pieces were located at following distances from chamber: a. 2.55 m Ejection port cover b. 5.10 m Piece of stock c. 0.88 m Metal plate from ejection cover Structural damage as shown in Appendix 2 was revealed on post test examination

NOTE: (See Appendixes 1 and 2)

9. Shown in figures 1 and 2 are the locations of components found for M16A2 and STEYR respectively. These locations are relative to the distances shown in Table 2.

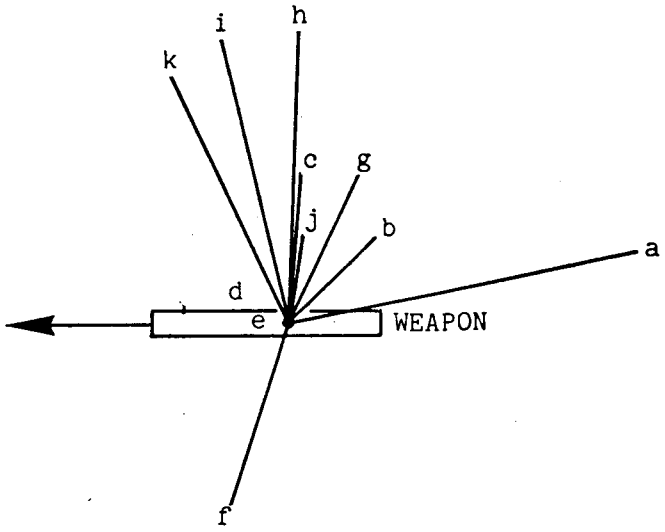


FIG 1
LOCATION OF COLT M16A2 WEAPON PIECES (REFER TABLE 2)

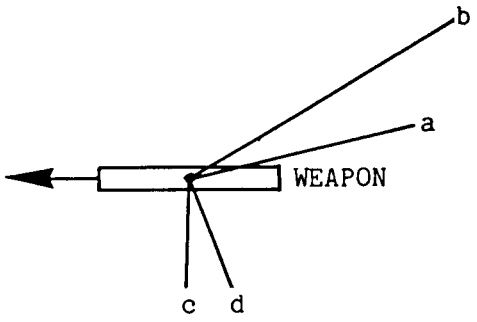


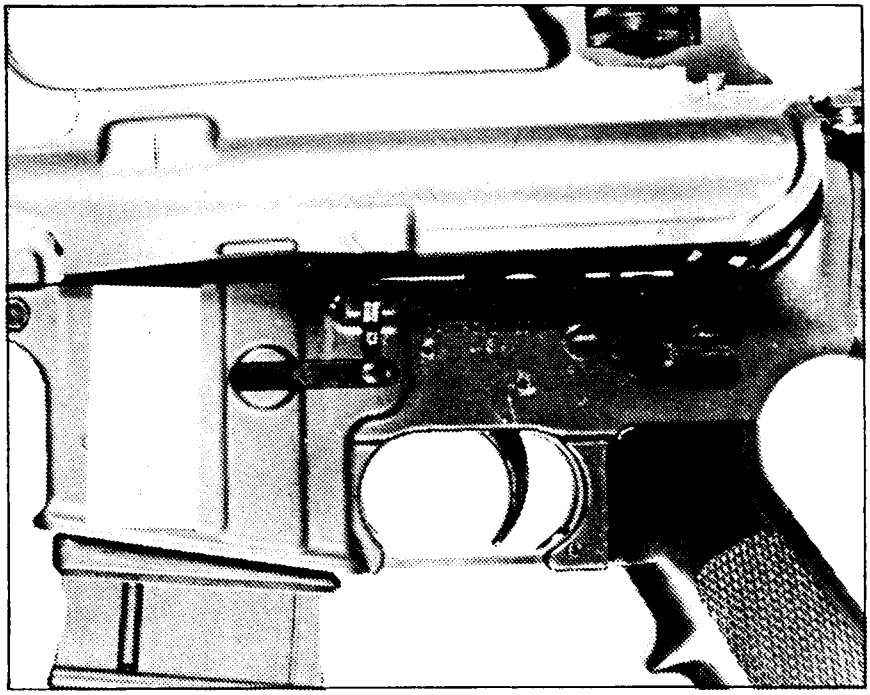
FIG 2
LOCATION OF STEYR AUG WEAPON PIECES (REFER TABLE 2)

TABLE 3 - RESULTS - BARREL OBSTRUCTION BY PROJECTILE FORWARD OF GAS PORT

Weapon	Weapon Number	Remarks
COLT M16A2	8000356	Weapon was ex user trial. Resulted in no physical damage except bulging forward of gas port (see fig 15).
STEYR AUG	AUG 006	Weapon was ex user trial. Resulted in no physical damage except bulging forward of gas port (see fig 16).

10. It was found that at speed of 9000 feet per sec initiating at 280 feet, using a HYCAM 2 HIGH SPEED 16 mm camera, produced satisfactory results.

11. Photographic records of this test are contained in figs 3 to 16.



8502AP

FIG 4
COLT M16A2 SHOWING DAMAGE TO UPPER RECEIVER
(RIGHT VIEW) WITH PROJECTILE LODGED AT LEAD

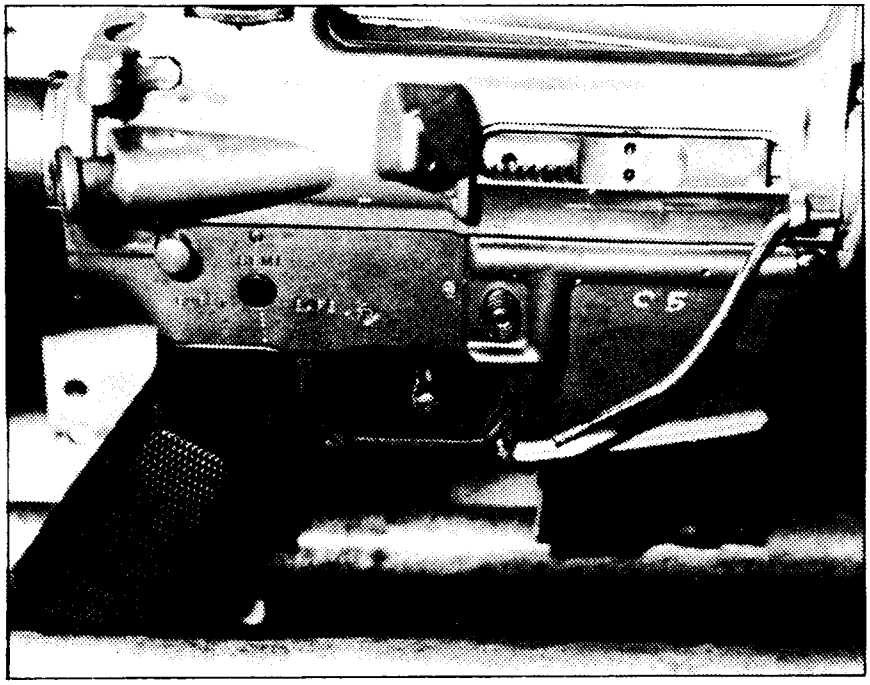


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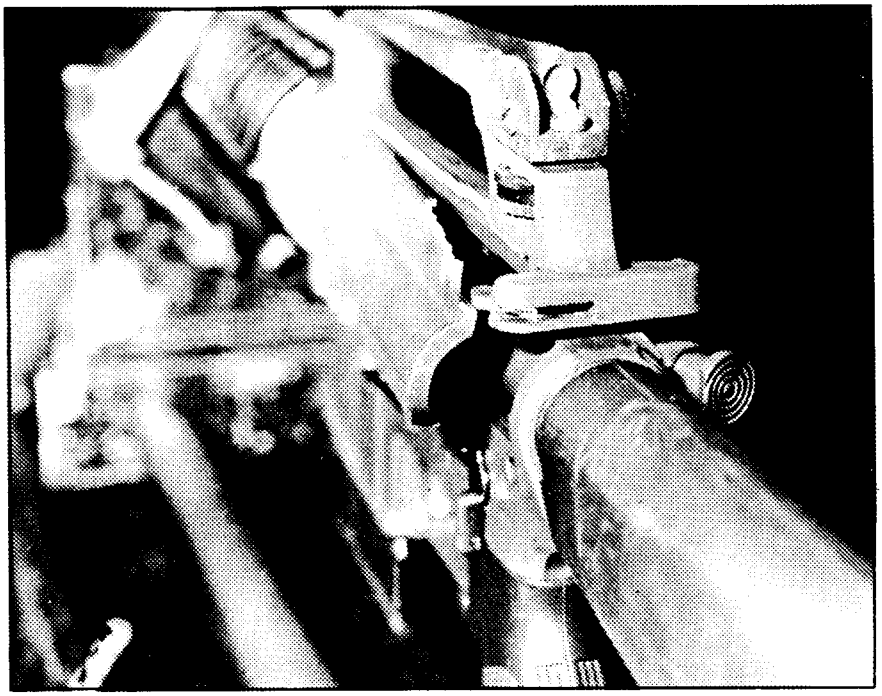
FIG 3
COLT M16A2 SHOWING DAMAGE TO UPPER RECEIVER
(LEFT VIEW) WITH PROJECTILE LODGED AT LEAD



8502AL

FIG 5 COLT M16A2 (REAR VIEW) SHOWING DAMAGE FROM PROJECTILE LODGED IN LEAD

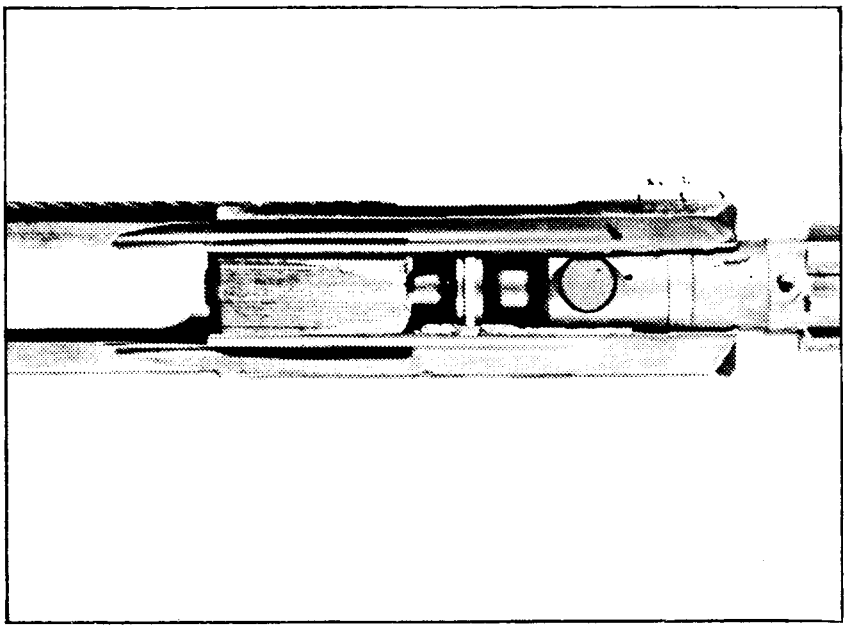


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FIG 6 COLT M16A2 (BOTTOM VIEW) SHOWING DAMAGE TO BOLT CARRIER FROM PROJECTILE LODGED AT LEAD

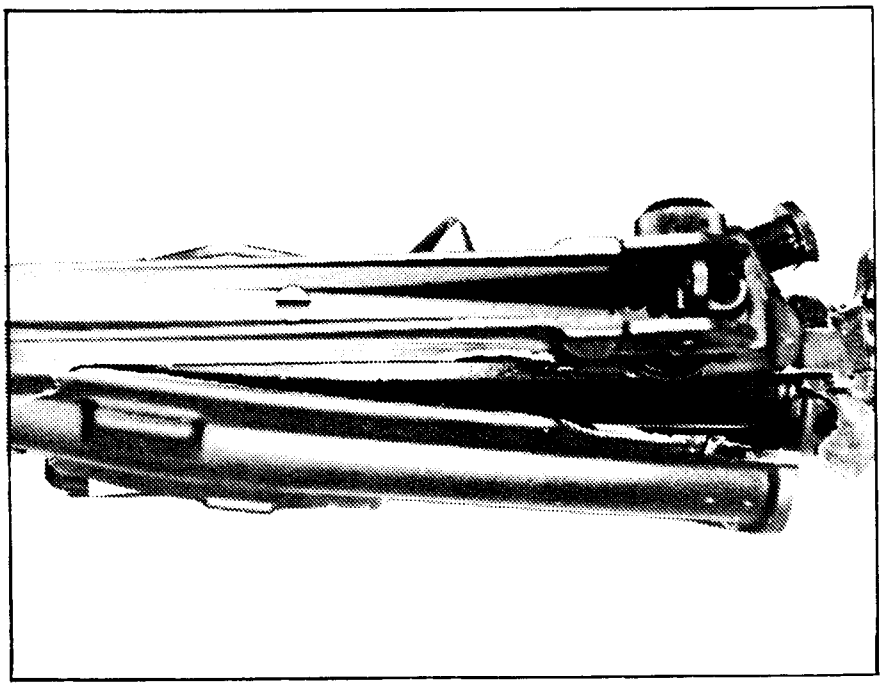

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FIG 7 COLT M16A2 (TOP VIEW)

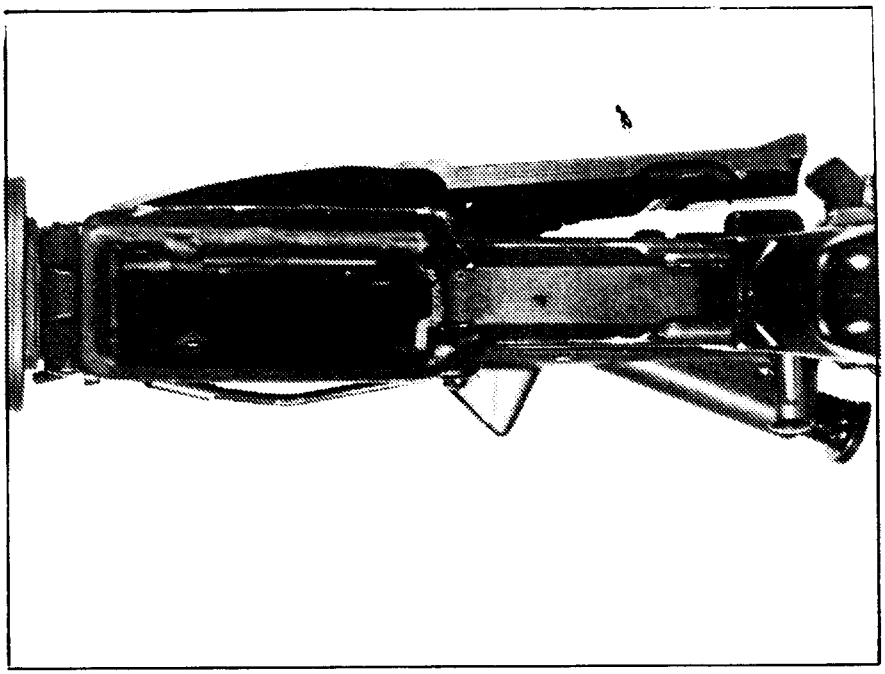

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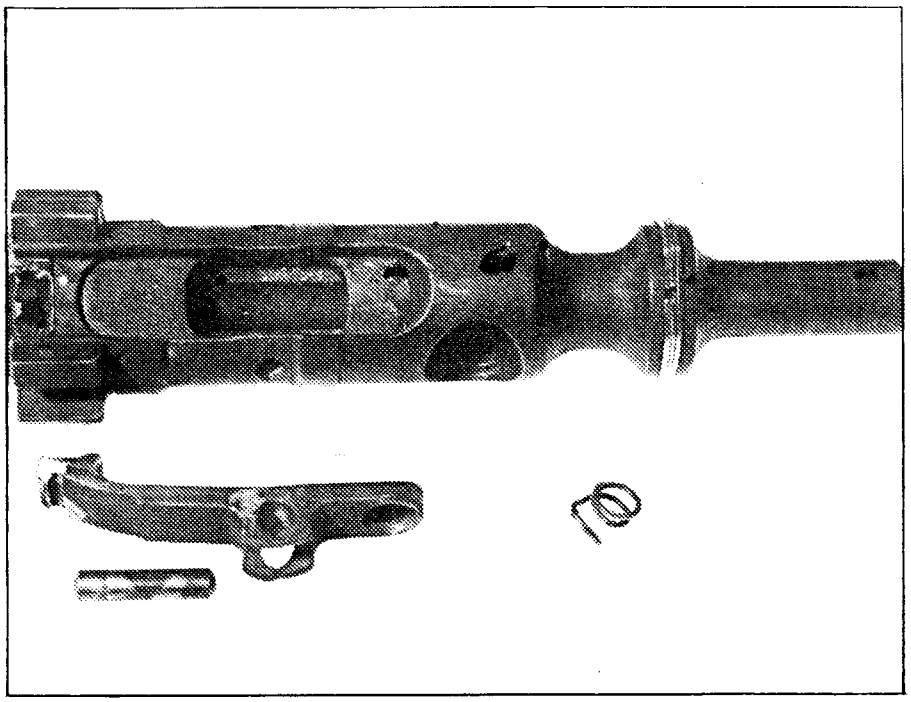
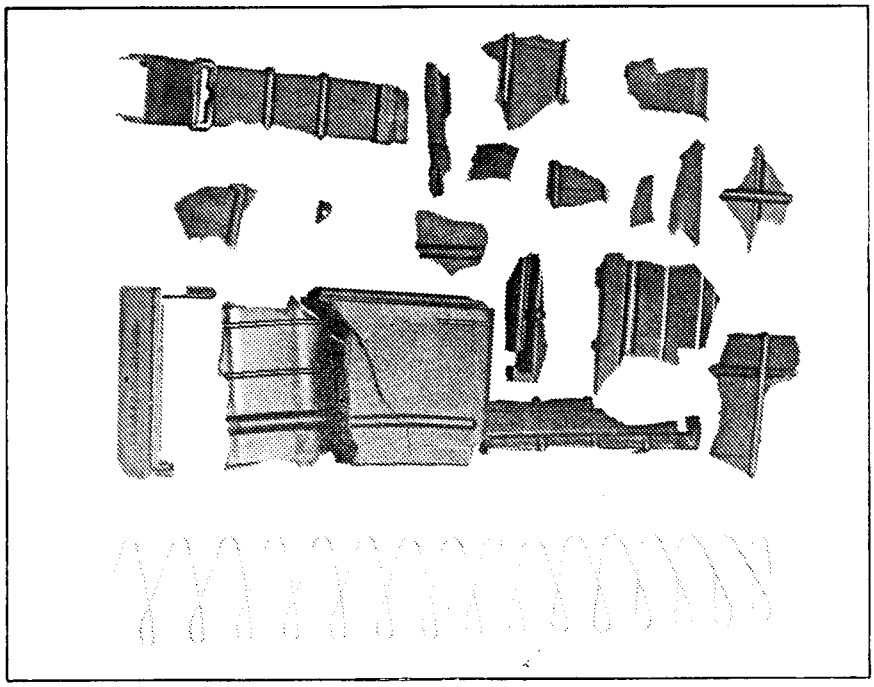
FIG 8 COLT M16A2 (BOTTOM VIEW)



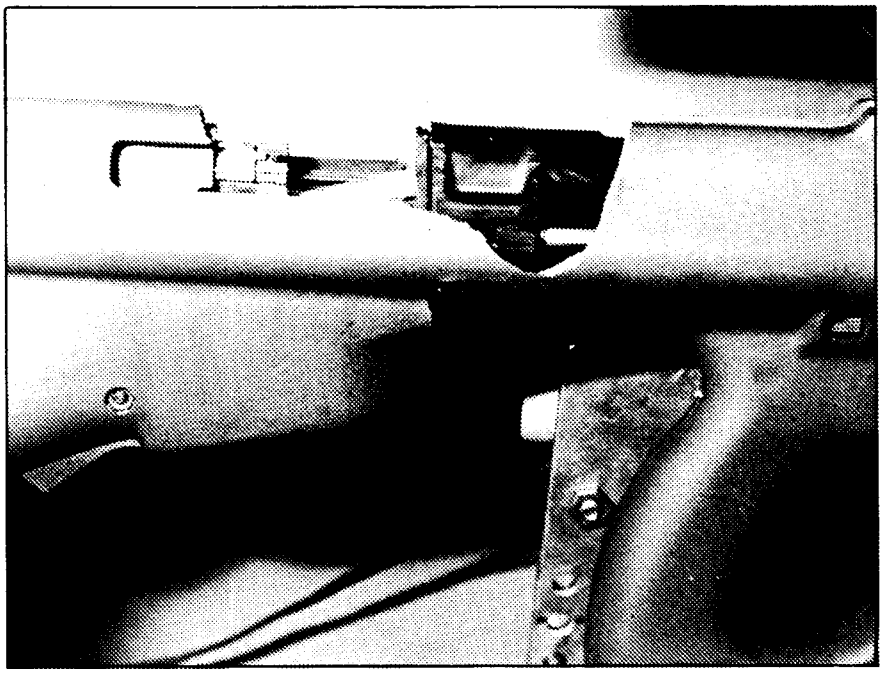
8502M

FIG 9 COLT M16A2 BOLT SHOWING DAMAGE TO EXTRACTOR AND EXTRACTOR SPRING AND PART OF CASE FROM PROJECTILE LODGED AT LEAD



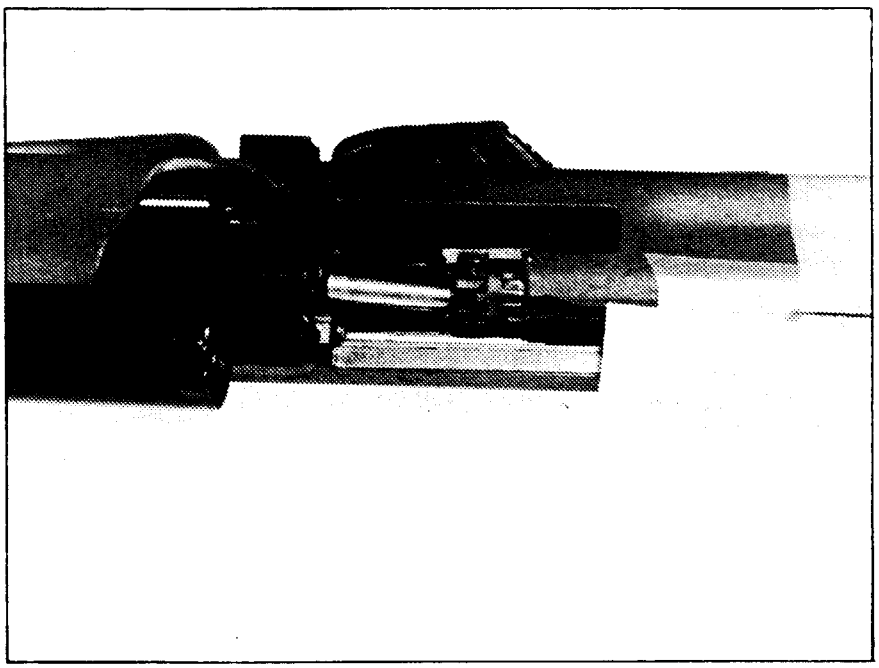
8502U

FIG 10 COLT M16A2 SHOWING DAMAGE TO MAGAZINE FROM OBSTRUCTION WITH PROJECTILE LODGED AT LEAD



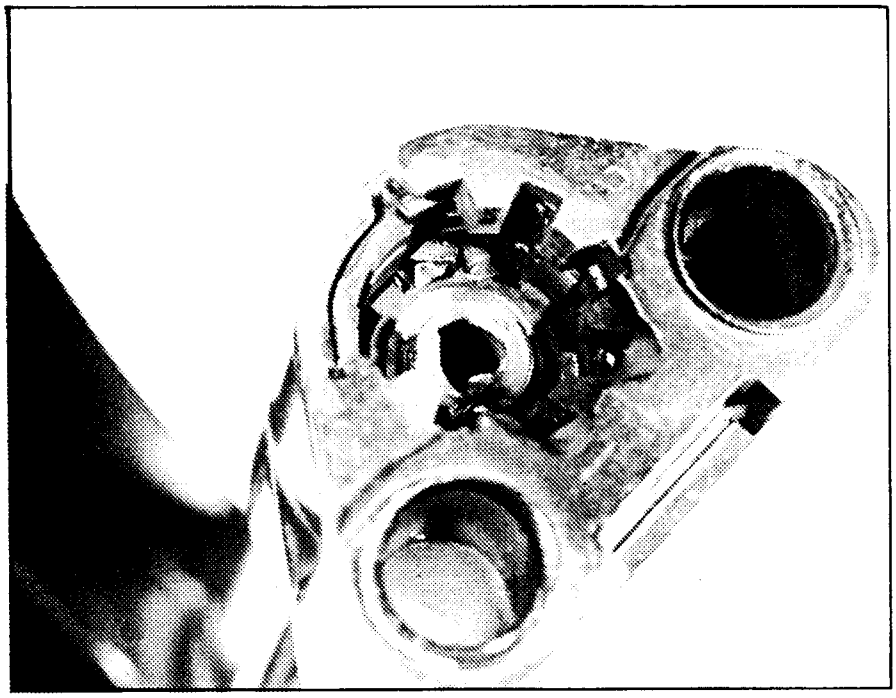
8502AH

FIG 11 STEYR AUG SHOWING STRUCTURAL DAMAGE (SIDE VIEW) WITH PROJECTILE LODGED IN LEAD



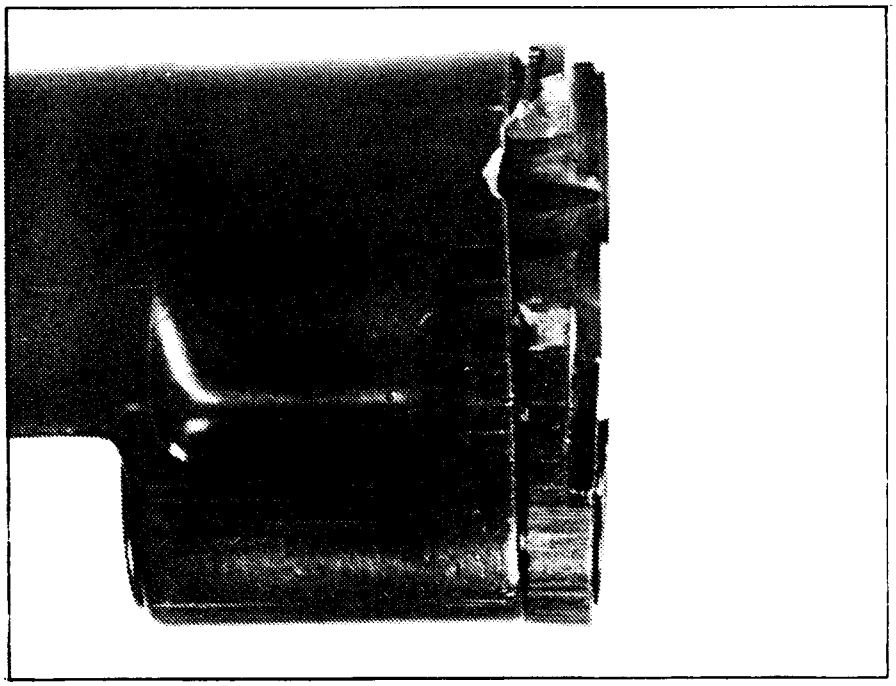
8502Q

FIG 12 STEYR AUG SHOWING STRUCTURAL DAMAGE (TOP VIEW) WITH PROJECTILE LODGED IN LEAD



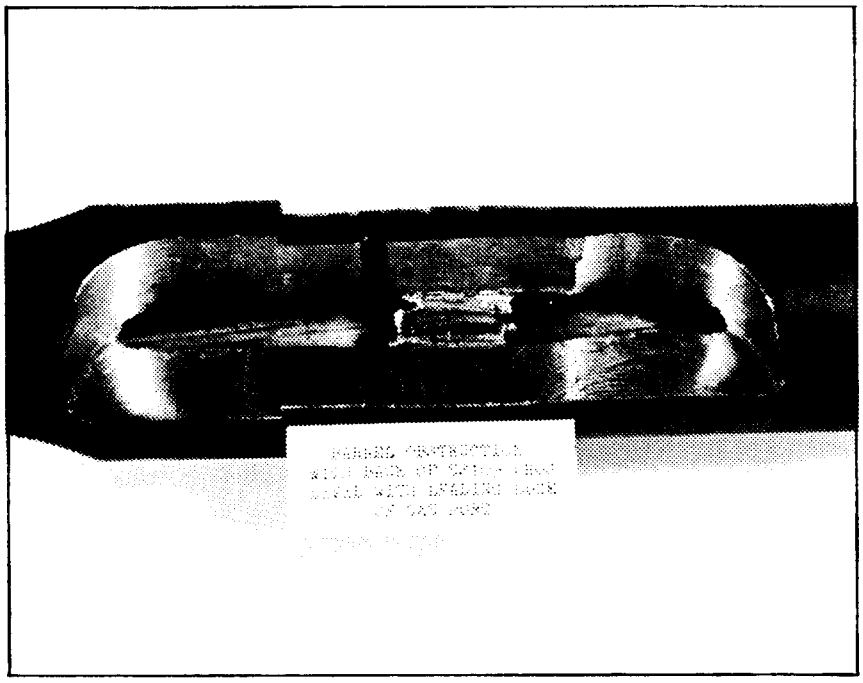
8502T

FIG 13 STEYR AUG SHOWING DAMAGE TO RECEIVER (REAR VIEW) FROM PROJECTILE LODGED AT LEAD



8502S

FIG 14 STEYR AUG SHOWING DAMAGE TO RECEIVER (SIDE VIEW) FROM PROJECTILE LODGED AT REAR



8502AX

FIG 15 COLT M16A2 SHOWING BULGE WITH OBSTRUCTION FORWARD OF GAS PORT

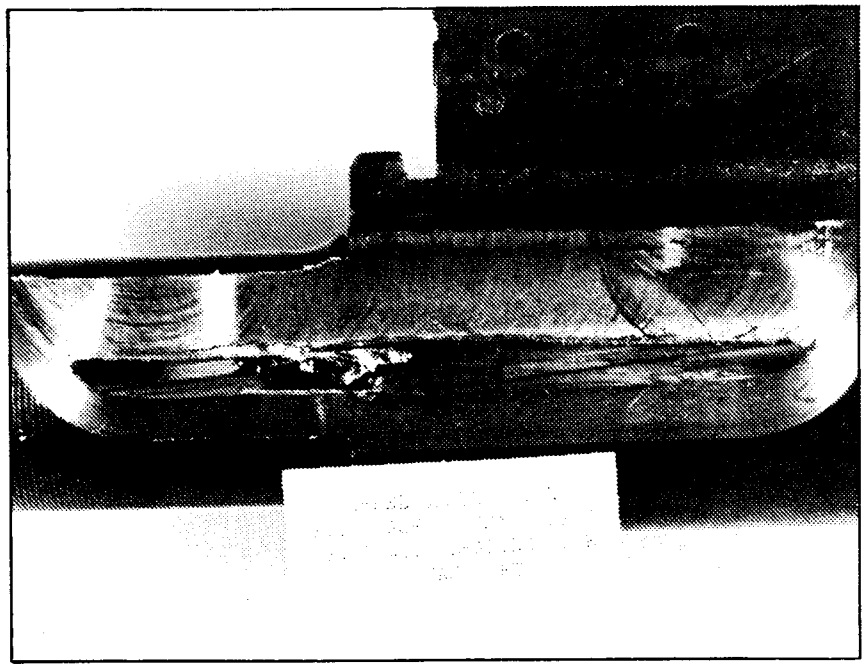


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FIG 16 STEYR AUG SHOWING BULGE WITH OBSTRUCTION FORWARD OF GAS PORT

CONCLUSION

12. Although the results of this test cannot be considered statistically based, the following observations can generally be made.

a. There is no hazard to the firer if a quantity of 10 cc of water is injected as an obstruction at the gas port. However the barrel will bulge on both COLT M16A2 and STEYR AUG.

b. There is no hazard to the firer if an SS109 projectile is lodged forward of the gas port. However the barrel will bulge forward of the gas port on both weapons.

c. There is a major hazard to the firer if an SS109 projectile is lodged at the lead and the effects on the weapons are catastrophic. (See Appendixes 1 and 2.)

APPENDIX 1

COLT M16A2 (C5) OBSTRUCTION BY PROJECTILE

LOCATED AT LEAD - POST FIRING EXAMINATION

APPENDIX 1 TO
ANNEX B TO
PART FOUR TO
EDE 17/85

COLT M16A2 (C5) OBSTRUCTION BY PROJECTILE LOCATED AT LEAD - POST FIRING EXAMINATION

1. Damage Observations

   a. Upper receiver/rear lug broken.

   b. LHS of upper receiver cracked and split from rear to front, holding by approximately 6 mm (believe section would have broken off completely but for obstruction of solenoid bracket).

   c. Dust cover blown completely off.

   d. Hinge pin for dust cover severely bent and distorted.

   e. Several small pieces of upper receiver blown off and lost.

2. Stripping Observations

   a. Weapon bent upward around upper receiver area.

   b. The case head blown off with body remaining in chamber.

   c. The case head including primer cap, was forged into the recess of the bolt head.

   d. Portion of case had blown out in area of extractor claw.

   e. Portion of extractor claw had been broken off and lost.

   f. Operating knob for holding open device blown off and lost.

   g. Cocking handle catch broken and piece lost.

   h. Extractor bent.

   i. Extractor spring grossly distorted.

   j. Underside of front portion of carrier (45 mm in length) blown out through magazine housing.

k. Plastic Magazine shattered into numerous pieces (at least 20), some found, some lost.

l. Magazine mortice in lower receiver distorted outward on LHS at least 5 mm.

m. At least three cartridges in the magazine were damaged. The top round was flattened by about one third of its diameter by a piece of the bolt carrier which exploded downward (see j).

APPENDIX 2

STEYR AUG (S4) OBSTRUCTION BY PROJECTILE

LOCATED AT LEAD - POST FIRING EXAMINATION

APPENDIX 2 TO
ANNEX B TO
PART FOUR TO
EDE 17/85

STEYR AUG (S4) OBSTRUCTION BY PROJECTILE LOCATED AT LEAD - POST FIRING EXAMINATION

1. Damage Observations

   a. The case ruptured in the chamber; a piece of brass lodged in the barrel locking lugs.

   b. The locking shoulders of the receiver were partially fractured and a radial crack appeared around the corner of these shoulders.

   c. Extractor fractured.

   d. Gas system appeared to operate due to partially fed round.

   e. Plastic butt stock shattered around ejection port.

   f. Magazine and following rounds undamaged.

   g. Butt stock split along weld.

   h. Ejector not operating freely.

   i. Barrel cannot be removed from receiver.

2. Stripping Observations

   a. Fracture of receiver locking lugs in radial direction.

   b. No apparent damage to trigger mechanism, functioning properly.

   c. Butt plate and sling swivel pin undamaged.

   d. Trigger bar in automatic fire position.

   e. Case removed by rod and found to be badly bulged. The extractor groove had been expanded.

   f. The chamber had also been expanded.

APPENDIX 2

g. The case had formed into the ejector groove. The extractor had pulled through the rim.

h. Ejector retaining pin had bent.

i. Ejector slightly bent.

j. Ejector spring fully compressed.

k. Extractor axis pin bent.

l. Extractor broken.

PART FOUR

ANNEX C

COOK OFF AND BARREL HEATING TEST

This Annex contains information about the Cook Off and Barrel Heating Test carried out at EDE's 25 metre range. The following are included in this Annex.

ANNEX C TO
PART FOUR TO
EDE 17/85

COOK OFF AND BARREL HEATING TEST

REFERENCES:

A. Evaluation Procedures for Future NATO Small Arms Weapon Systems D/14, para 2.19

B. EDE Firing Programme - Serial 19

INTRODUCTION

1. The Cook Off and Barrel Heating Test was carried out at EDE 25 metre range over the period 21 Mar - 24 Apr 85.

AIM

2. The aim of the test was to determine Cook Off and non Cook Off levels at a predetermined rate of fire and to assess the structural integrity of the weapons during high rates of fire and to evaluate the potential hazard to the weapon and firer in the event of inadvertent fire.

METHOD

3. The weapons were lubricated in accordance with the manufacturer's specifications with NSN 9150-01-053-6688 CLEANER, LUBRICANT, PRESERVATIVE (CLP).

4. The test weapon was placed in a fixed mount and connected via a solenoid to a remote firing device.

5. The barrel was then conditioned to 25.4°C to provide a standard datum within the range specified in Ref A, para 2.19.2.1 refers.

6. The start point for the test was to fire 180 rounds at the rate of 90 rounds in 60 seconds. (This required 6 magazines.) Immediately the seventh magazine containing one round was loaded and the round chambered, the time taken to cook off was recorded.

7. If the chambered round did not cook off in a 10 minute period the round was fired, the weapon unloaded and the test recommenced by increasing the number of rounds by half the magazine. This process continued until cook off occurred. The halving process was then reversed to obtain more accurate cook off levels for the weapon.

8. The weapons were inspected both before and after each test to enable monitoring of any faults.

9. The results of the test are shown in Table 1.

TABLE 1 - COOK OFF AND NO COOK OFF LEVELS FOR COLT M16A2 AND STEYR AUG

Weapon	No Cook Off	Cook Off	Cook Off Time
COLT M16A2	172 rounds	176 rounds	68 s
STEYR AUG	202 rounds	206 rounds	26 s

10. The results shown in Table 1 were achieved using a rate of fire of 90 rounds per minute; this number of rounds per minute was achieved by firing a full magazine fully automatically every 27 seconds. This method provided the time necessary to change magazines and return to the protected area.

11. The post firing inspection revealed a bulge in the COLT M16A2 barrel, in the vicinity of the flash eliminator.

12. The original COLT M16A2 used for previous adverse condition testing had to be withdrawn due to a number of mechanical problems. These could not be attributed wholly to this test.

13. The "COOKED OFF" Case of the COLT M16A2 showed a pierced (blown) primer.

14. Thermocouples fitted to various parts of each weapon show the changes in temperature after each magazine was fired. The charts recording these changes for the two Cook Off cycles shown in Table 1 are attached as figures 5 and 6.

15. Photographic records of the test are shown in figures 1 - 3.

CONCLUSION

16. Because "Cook Off' is a function of ambient temperature and rate of fire, very limited conclusions can be drawn from this test. If the ambient temperature effects can be negated (which to a large degree is possible), then it can be said that at normal operating temperature and firing at a rate of 90 rounds minute, no Cook Off will occur at:

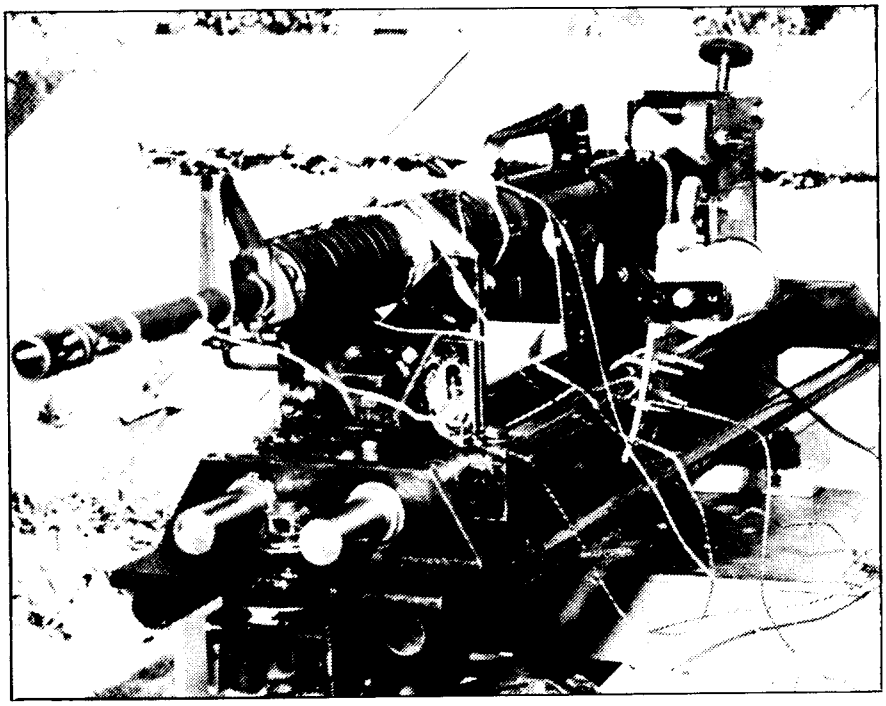
a. 172 rounds for COLT M16A2.

b. 202 rounds for STEYR AUG.

17. Little danger of injury to the firer is to be expected if Cook Off occurs with either weapon.

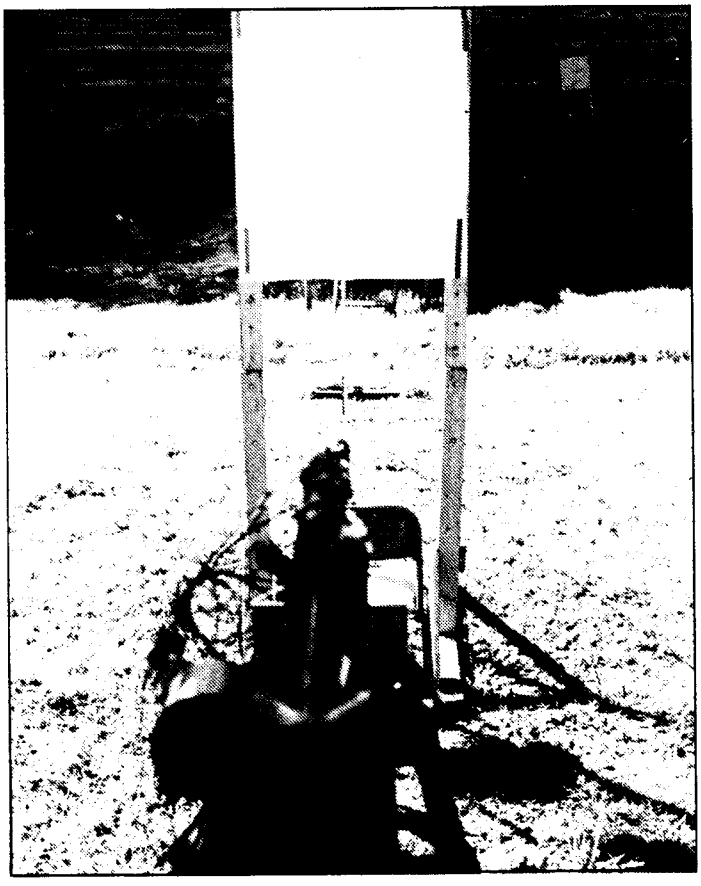
18. Damage to either weapon is minimal. The bulged barrel on the COLT M16A2 may be an isolated case and is unlikely to cause further damage to the weapon.

ANNEX C



G571318

FIG 1 COLT M16A2 SHOWING SOLENOID AND THERMOCOUPLES

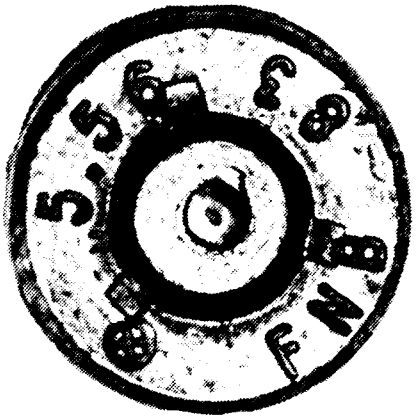


G570922

FIG 2 STEYR AUG SHOWING YAW CARD

ANNEX C

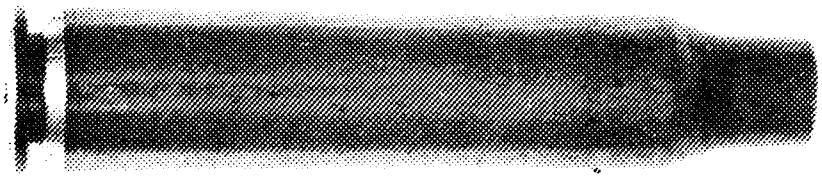
COOK OFF - 180 ROUNDS - 71 SECONDS TO COOK OFF. SERIAL 19, CYCLE 3A, 1 MAY 85



8503AL

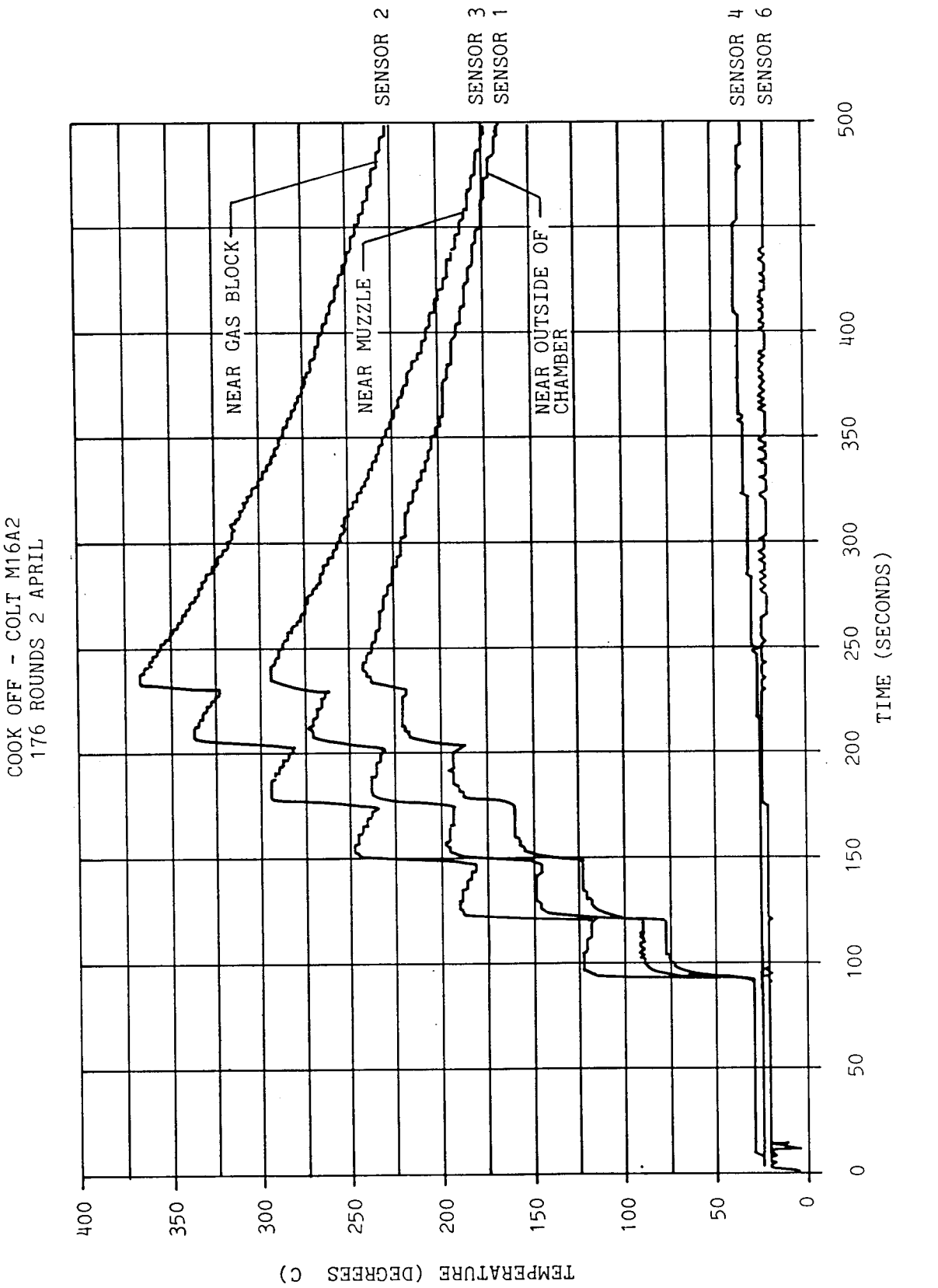
FIG 3 TYPICAL COOK OFF CASE SHOWING MUSHROOMING OF PRIMER INTO FIRING PIN HOLE (END VIEW)

COOK OFF - 180 ROUNDS - 71 SECONDS TO COOK OFF. SERIAL 19, CYCLE 3A, 1 MAY 85

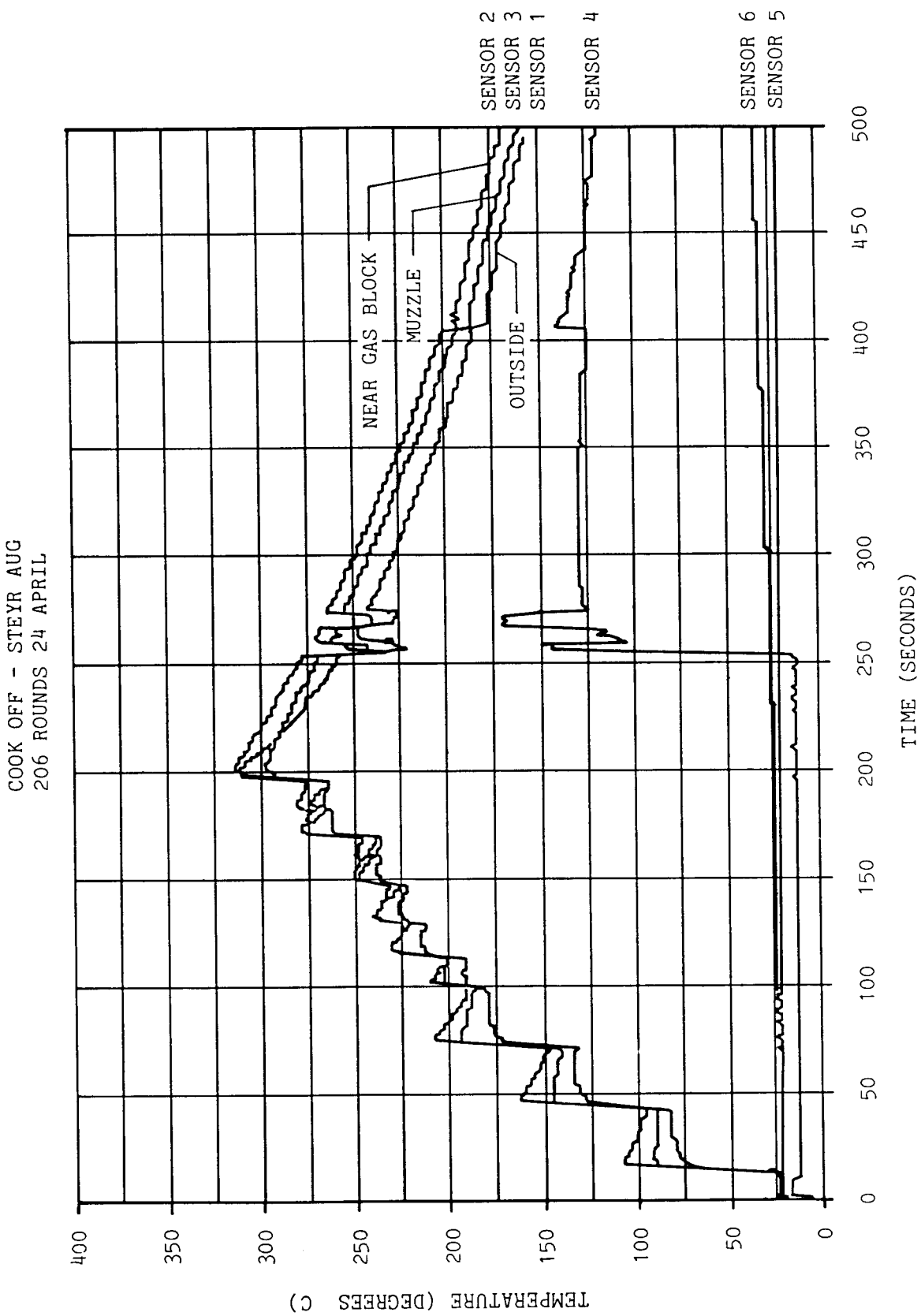


8503AM

FIG 4 TYPICAL COOK OFF CASE SHOWING MUSHROOMING OF PRIMER INTO FIRING PIN HOLE (SIDE VIEW)


COOK OFF - COLT M16A2
176 ROUNDS 2 APRIL
SENSOR 2
SENSOR 3
SENSOR 1
SENSOR 4
SENSOR 6
NEAR GAS BLOCK
NEAR MUZZLE
NEAR OUTSIDE OF CHAMBER
TEMPERATURE (DEGREES C)
400
350
300
250
200
150
100
50
0
0
50
100
150
200
250
300
350
400
500
TIME (SECONDS)

ANNEX C


SENSOR 2
SENSOR 3
SENSOR 1
SENSOR 4
SENSOR 6
SENSOR 5
NEAR GAS BLOCK
MUZZLE
OUTSIDE
COOK OFF - STEYR AUG
206 ROUNDS 24 APRIL
TIME (SECONDS)
0
50
100
150
200
250
300
350
400
450
500
TEMPERATURE (DEGREES C)
400
350
300
250
200
150
100
50
0

PART FOUR

ANNEX D

STATIC AND DYNAMIC (SAND AND DUST) TESTS

This Annex contains information about the Static and Dynamic (Sand and Dust) Tests carried out at EDE's 25 metre range. The following are included in this Annex.

STATIC AND DYNAMIC (SAND AND DUST) TESTS

REFERENCES: A. Evaluation Procedures for Future NATO Small Arms Weapon Systems D/14, para 2-18.4

B. EDE Firing Programme - Serial 25

INTRODUCTION

1. The Static and Dynamic (Sand and Dust) Tests were carried out at EDE 25 metre range over the period 15 Jan - 17 Jan 85.

AIM

2. The aim of the tests was to study comparative weapon performance after exposure to a sand and dust environment.

METHOD

3. The test weapons were cleaned and lubricated before each test with NSN 9150-01-053-6688 CLEANER, LUBRICANT, PRESERVATIVE (CLP) in accordance with the manufacturer's specifications.

4. Where applicable, adverse gas settings were used.

5. The Rifle 7.62 mm L1A1 was used as a control weapon.

6. All weapons were subjected to the same test on the same day.

7. The tests were divided into two parts:

a. Static Sand and Dust Test

(1) Each loaded weapon (no round in chamber) with the muzzle cover fitted and where applicable ejection cover closed was placed in the specially prepared test box, the dimensions of which conformed with Ref A and fixed in position.

(2) A mixture of sand and dust conforming to the specifications in Table 1 (Ref A refers) was blown over the test weapon after being poured into the blower at a rate of 2270 g per minute for 60 seconds. The blower was then stopped, the weapon turned upside down and the weapon was subjected to a further 60 seconds exposure at the same rate.

(3) The weapon was then removed from the test box and a period of 15 seconds was employed to clean the weapon by blowing, brushing with the bare hands, and shaking.

(4) The muzzle cap was then removed from the weapon and 20 rounds were fired:

(a) 10 rounds single shot.

(b) 10 rounds in service bursts.

TABLE 1 - PARTICLE SIZES OF SAND AND DUST MIXTURE

(Source: D/14, P165)

Sieve mesh width (mm)	Remaining		Total (%) thru Mesh
	R (g)	$\frac{R}{\sum R} \cdot 100(\%)$	
2.0	-	-	100.0
1.0	-	-	100.0
0.63	19.4	9.7	90.3
0.4	20.0	10.0	80.3
0.2	63.2	31.6	48.7
0.1	34.0	17.0	31.7
0.063	53.2	26.6	5.1
	10.2	5.1	-
Total $\sum R$	200.0	100.0	-

Note: A sample of 200.0 g = 100%.

b. Dynamic Sand and Dust Test

(1) Each weapon, again loaded with a 20 round magazine and with a round in the chamber was placed in an upright horizontal position.

(2) Seven additional magazines each containing 20 rounds were stored in basic pouches attached to the side of the test box.

(3) The weapon was then subjected to the blown sand environment used for the static test except that the flow rate was reduced to 1000 g per minute.

(4) Whilst being subjected to the sand and dust exposure each weapon fired 140 rounds as a 10 rounds single shot, 10 rounds burst series, every 20 seconds, giving a total test time of approximately 2½ minutes.

RESULTS

8. A summary of results is shown in Table 2.

TABLE 2 - SUMMARY OF RESULTS

Test	Weapon	Stoppages	Result
Static	COLT M16A2	Nil	Passed
Static	STEYR AUG	Nil	Passed
Static	RIFLE 7.62 mm L1A1	1 Failure to extract;[1] 3 Failures to eject[2].	Failed
Dynamic	COLT M16A2	Nil	Passed
Dynamic	STEYR AUG	Nil	Passed
Dynamic	RIFLE 7.62 mm L1A1	3 Failures to feed[3].	Passed

Notes: 1. The failures to extract resulted in the gas setting being moved from '2' to '0'.

2. The first failure to eject required changing the magazine with another that had been exposed. The second failure to eject required a change of magazine to a non exposed (clean) magazine. The third failure to eject resulted in failure of the test.

3. The three failures to feed occurred with a gas setting on '2' remedied by a gas adjustment to '0'.

9. The rates of fire during the dynamic test for both trial weapons are shown in Table 3 and Table 4. The Rifle 7.62 mm L1A1 has been excluded because of its inability to fire 'auto'.

TABLE 3 - COLT M16A2 RATES OF FIRE PER MAGAZINE - DYNAMIC TEST ONLY

Weapon	Magazine No	RPM
COLT M16A2	1	775
	2	748
	3	846
	4	754
	5	741
	6	720
	7	708

TABLE 4 - STEYR AUG RATES OF FIRE PER MAGAZINE - DYNAMIC TEST ONLY

Weapon	Magazine No	RPM
STEYR AUG	1	642
	2	667
	3	658
	4	667
	5	675
	6	675
	7	683

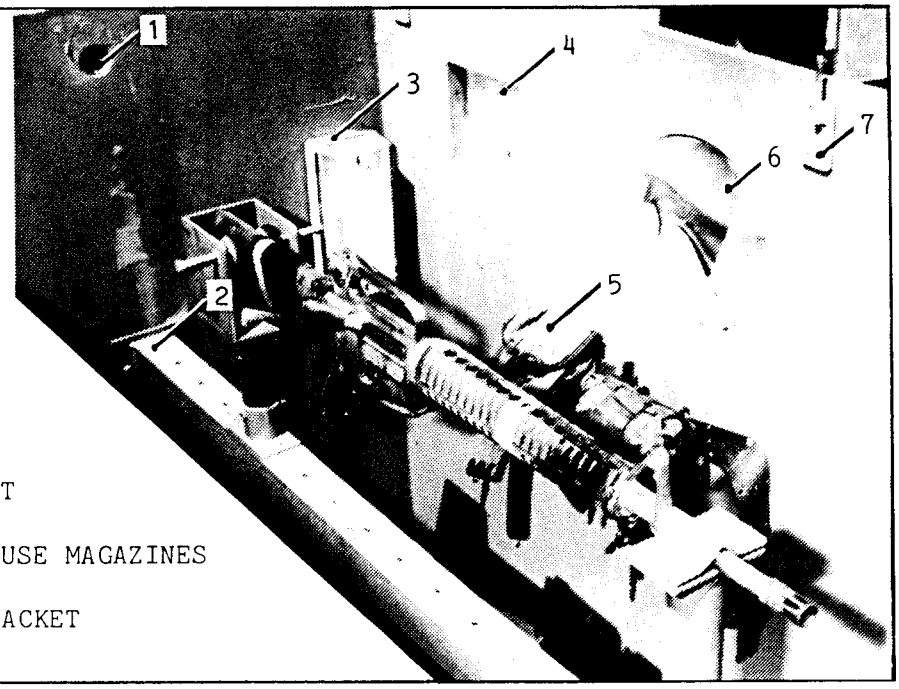
10. Photographic records of the test are shown in figures 1-4.

CONCLUSION

11. Both trial weapons performed satisfactorily during the test. It should be noted, however, that the external surfaces of the Steyr scope lens were sandblasted but had very little effect on visual acuity.

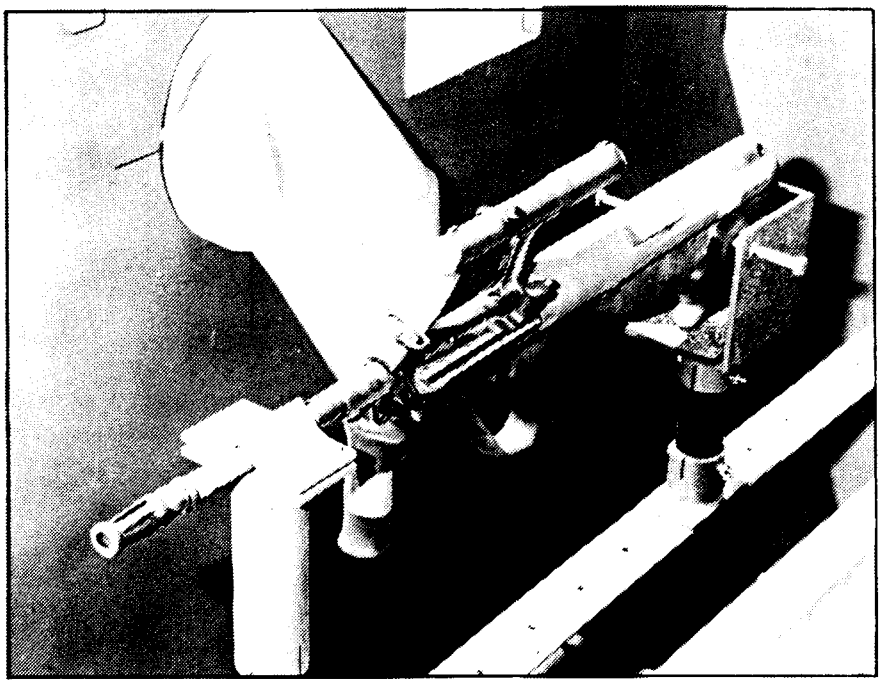
12. The performance of the Rifle 7.62 mm L1A1 control weapon was marginal even with the gas setting on '0'.

13. The use of a MAKITA Model PB-20 centrifugal blower produced a very even spread of sand/dust mixture over the floor of the test box indicating a superior environment to that furnished by a hand blower.



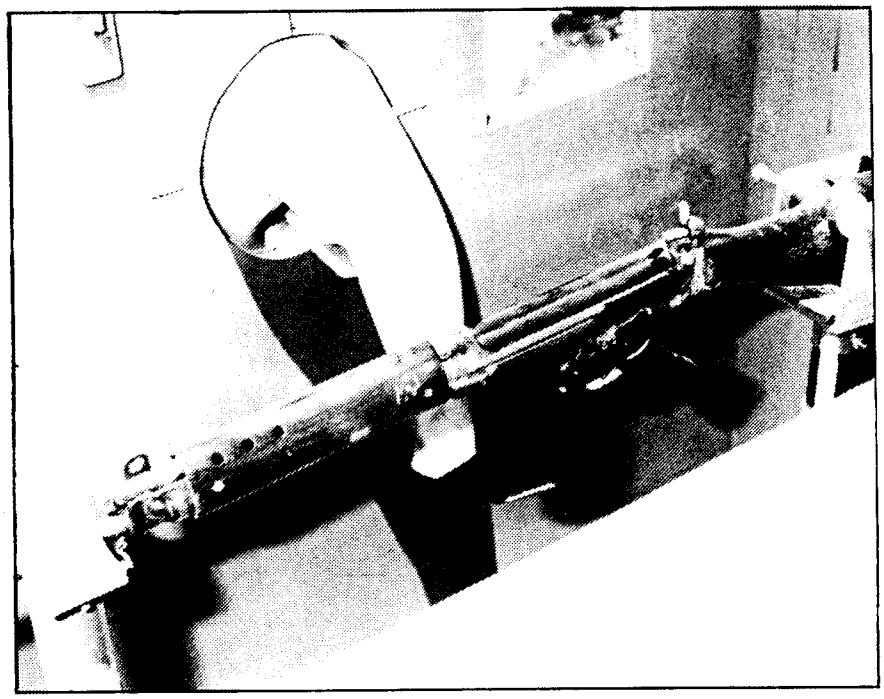
1. BLOWER INLET
2. WEAPON MOUNT
3. INTERNAL LIGHT
4. VIEWING PORT
5. WEBBING TO HOUSE MAGAZINES
6. GAUNTLET
7. LID FIXING BRACKET

FIG 1 COLT M16A2 SHOWING TEST BOX DETAILS 8505I



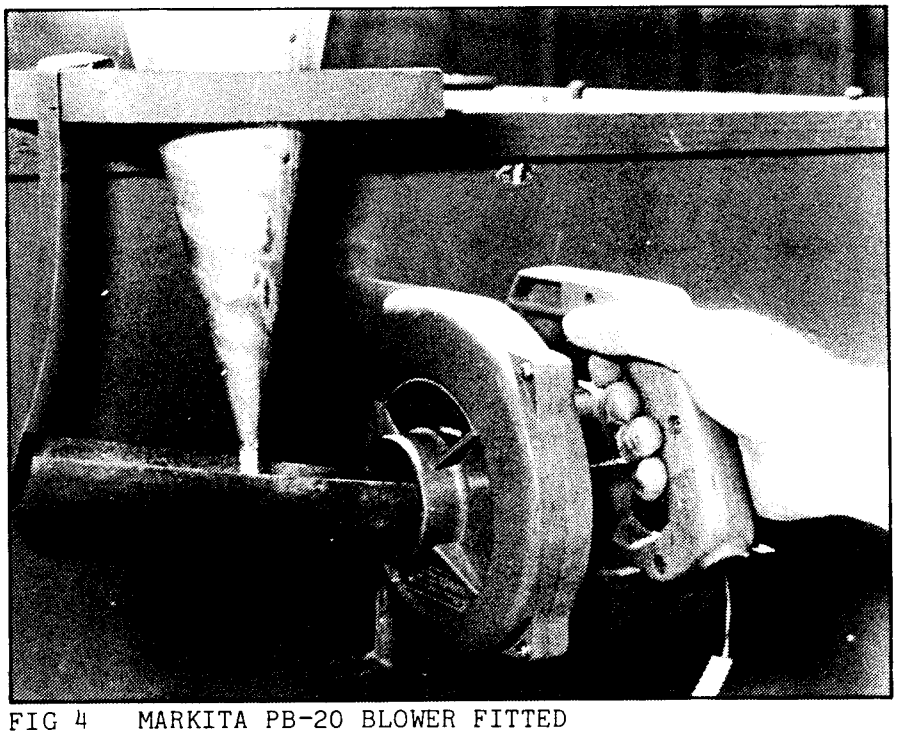
8505H

FIG 2 STEYR AUG WITH VIEWING PORT (LEFT HAND) IN BACKGROUND



8505F

FIG 3 RIFLE 7.62 mm L1A1 - CONTROL WEAPON



5811G

FIG 4 MARKITA PB-20 BLOWER FITTED TO TEST BOX

PART FOUR

ANNEX E

MUD TEST

This Annex contains information about the Mud Test carried out at EDE's 25 metre range. The following are included in this Annex.

ANNEX E TO
PART FOUR TO
EDE 17/85

MUD TEST

REFERENCES: A. Evaluation Procedures for Future NATO Small Arms Weapon Systems D/14, para 2-18-6.

B. EDE Firing Programme - Serial 22

INTRODUCTION

1. The Mud Test was carried out at EDE's 25 metre range over the period 22 Oct 84 - 30 Oct 84.

AIM

2. The aim of the test was to determine the functioning threshold of the weapons after immersion in mud baths of increasing density.

METHOD

3. The weapons were cleaned and lubricated in accordance with the manufacturer's specifications with NSN 9150-66-053-6688, CLEANER, LUBRICANT, PRESERVATIVE (CLP).

4. Each trial weapon loaded, with a full magazine, safety applied and a spare full magazine was immersed in mud baths of varying densities commencing at tank number 6, this being the start point for the test as laid down in Ref A.

5. Each weapon was then function tested by firing or attempting to fire 5 single shots followed by the remainder of the magazine in 3 - 5 round bursts.

6. If the weapon failed to function correctly, then the weapon's magazine was exchanged for the magazine that had also been immersed and the function test, vide para 4, was repeated.

7. If again, the weapon failed to function the magazine was replaced with one containing clean rounds and the test repeated.

8. If the weapon still failed to function it was deemed to have failed Tank Number 6. Reference A then required the weapon to be tested by the same procedure commencing at Tank 1 then progressing through tanks 3 to 5 until failure occurred.

9. Because none of the weapons passed Tank Number 6 the procedure vide para 8 was followed until failure to function was experienced.

10. Before immersion each tank was mechanically agitated to ensure an even distribution of all sediments.

11. The duration for each immersion was 60 seconds. During this time period the weapon and spare full magazine were agitated.

12. Immediately after the immersion period the weapons were removed from the bath and shaken for 30 seconds to remove excess mud as they were being transported to the firing point. This was necessary to keep the time between immersion and firing to the minimum (60 seconds).

13. The composition of the immersion tanks is shown in Table 1.

TABLE 1 - COMPOSITION OF MUD TANK BATHS

Bath Number	Ingredients		
	Clay (kg)	Sand (kg)	Water (L)
1	0.1	Nil	10
2	0.3	Nil	10
3	0.5	Nil	10
4	1.0	Nil	10
5	3.0	Nil	10
6	5.0	Nil	10
7	1.0	0.5	10
8	1.0	1.0	10
9	3.0	0.5	10
10	3.0	1.0	10
11	5.0	0.5	10
12	5.0	1.0	10

14. The Clay used in the test tanks was obtained at a depth and being of the non-sandy type, known by potters as "slip clay".

15. The sand used in the test tanks conformed to the specifications shown in Table 2.

16. Between successive immersions the weapons were again stripped, cleaned and lubricated in accordance with para 3.

TABLE 2 - PARTICLE SIZES OF SAND USED

Sieve mesh width (mm)	Remaining		Total (%) thru Mesh
	R (g)	$\frac{R}{\sum R} \cdot 100(\%)$	
2.0	-	-	100.0
1.0	-	-	100.0
0.63	19.4	9.7	90.3
0.4	20.0	10.0	80.3
0.2	63.2	31.6	48.7
0.1	34.0	17.0	31.7
0.063	53.2	26.6	5.1
	10.2	5.1	-
Total $\sum$ R	200.0	100.0	-

Note: A sample of 200.0 g = 100%.

RESULTS

17. A summary of results is shown in Table 3.

TABLE 3 - SUMMARY OF RESULTS FOR THE MUD TEST

Tank No	Weapon	No of Rounds Fired	Result	Remarks Ambient Temperature
6	STEYR AUG (AUS016) COLT M16A2 (8000381) RIFLE 7.62 mm L1A1 (AD71000719)	7 5 4	Failed Failed Failed	16°C 16°C 20°C
1	STEYR AUG (AUS016) COLT M16A2 (8000381) RIFLE 7.62 mm L1A1 (AD71000719)	30 30 30	Passed Passed Passed	25°C 25°C 23°C
2	STEYR AUG (AUS016) COLT M16A2 (8000381) RIFLE 7.62 mm L1A1 (AD71000719)	30 7 4	Passed Failed Failed	25°C 25°C 25°C
3	STEYR AUG (AUS016)	30	Passed	15°C
4	STEYR AUG (AUS016)	25	Failed	19°C

18. All failures to function were recorded as failures to feed.

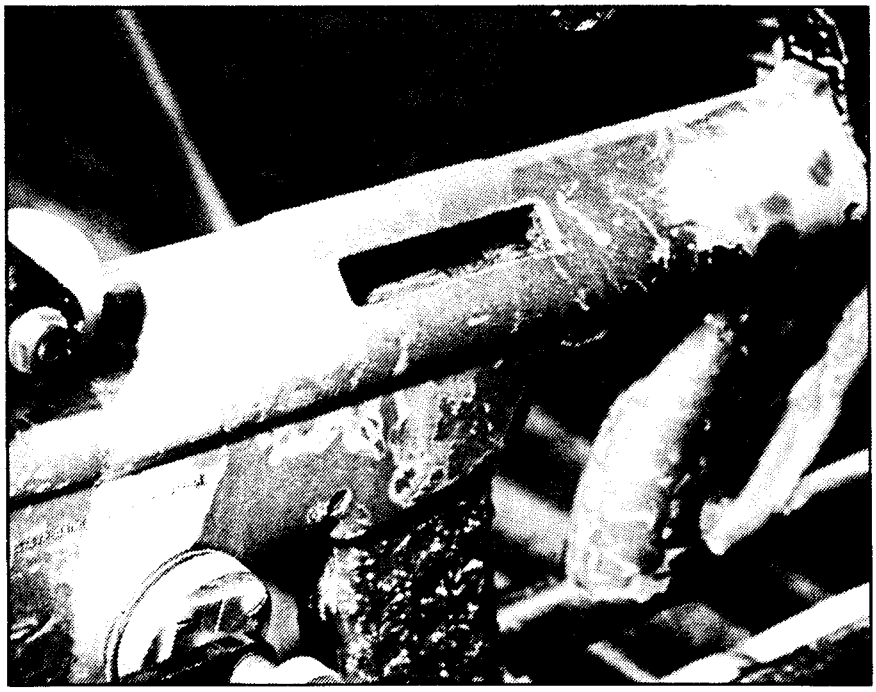
CONCLUSIONS

19. It is obvious that this is a severe test borne out by the fact that none of the weapons passed the D/14 start point (ref A refers) of Tank 6.

20. It is the opinion of the trial staff that this is a very ambient temperature related test as it was noted that the clay dried out rapidly at higher temperatures leaving a residue that was extremely difficult to remove and thus affecting all mechanical operations of all weapons. At lower ambient temperatures the clay mixture appears to provide additional lubrication.

8509AH

FIG 1 IMMERSION OF STEYR AUG INTO TANK 2



8506C

FIG 2 STEYR AUG AFTER IMMERSION

58109

FIG 3 COLT M16A2 AFTER IMMERSION IN TANK 6

PART FOUR

ANNEX F

ACCELERATED WATER SPRAY TEST

This Annex contains information about the Accelerated Water Spray Test carried out at EDE's 25 metre range. The following are included in this Annex.

ANNEX F TO
PART FOUR TO
EDE 17/85

ACCELERATED WATER SPRAY TEST

REFERENCES: A. Evaluation Procedures for Future NATO Small Arms Weapon Systems D/14, para 2.18.2

B. EDE Firing Programme - Serial 23

INTRODUCTION

1. The Accelerated Water Spray Test was carried out at EDE 25 metre range over the period 25-30 Jan 85.

AIM

2. The aim of the test was to determine the effect of heavy rainfall on the performance of the weapons. The water spray is designed to simulate 12 hours of heavy rainfall in about 84 minutes real time.

METHOD

3. The weapons were lubricated in accordance with the manufacturer's specifications with NSN 9150-01-053-6688 CLEANER, LUBRICANT, PRESERVATIVE (CLP), without any special precautions. CLP is a lubricant approved by both manufacturers.

4. The test weapon was placed in a fixed mount over which a series of shower heads were placed, these shower heads were connected via two PVC stop cocks to a fire hydrant. One stop cock was used as a shut off valve whilst the other was used to regulate the flow of water. The flow of regulated water was adjusted until a rate of approximately 1 cm per minute was achieved. This position once achieved was marked on the regulating cock so that the same flow rate could be achieved.

5. The firing/water exposure programme shown in Appendix 1 was then followed.

6. The water and air temperatures were taken at the beginning of each firing cycle; these temperatures are recorded in Table 1.

TABLE 1 - WATER AND AIR TEMPERATURES

Cycle Number	Weapon			
	COLT M16A2		STEYR AUG	
	Air Temperature	Water Temperature	Air Temperature	Water Temperature
1	20°C	20°C	30°C	21°C
1	20°C	20°C	31°C	21°C
2	21°C	19.5°C	33°C	21°C
2	22°C	19°C	34°C	21°C
3	20°C	19°C	34°C	21°C
3	Not taken	Not taken	34°C	21°C

7. Rainwater as specified in D/14 (ref A refers), was not readily available, the composition of the water used for the test is shown at Appendix 2.

RESULTS

8. TABLE 2 shows the rate of fire during the automatic firing phase.

TABLE 2 - RATE OF FIRE DURING AUTO FIRING PHASE

Weapon	Rate of Fire on Automatic		
	Cycle 1	Cycle 2	Cycle 3
COLT M16A2	734	632	Not Completed
STEYR AUG	659	651	657

9. During the test the following observations were made.

a. All visible traces of the CLP lubricant had disappeared very early in the test.

b. The COLT M16A2 failed the test through three failures to feed after firing 45 rounds of Cycle 3 ie, with the weapon muzzle vertically down.

c. The STEYR AUG was tested using both the standard and adverse gas setting. On standard gas setting it failed to pass the test, with three failures to feed after firing 3 rounds of Cycle 3 ie, with the weapon muzzle vertically down. On adverse gas setting the weapon passed the test.

d. The trigger on the COLT M16A2 was progressively harder to operate.

e. Bolts on both weapons need to be retracted to allow water to flow from the bore.

10. Photographic records of the test are shown in figures 1 and 2.

CONCLUSIONS

11. The user manual for either weapon system should contain a warning for retraction of the bolt, with the muzzle down, to allow water to drain from the weapon after being subjected to water immersion or heavy rain.

12. Weapons will need to be lubricated during or after being subjected to heavy rain otherwise stoppages are likely to occur.

13. The control weapon, Rifle 7.62 mm L1A1, passed the test but was difficult to cock.

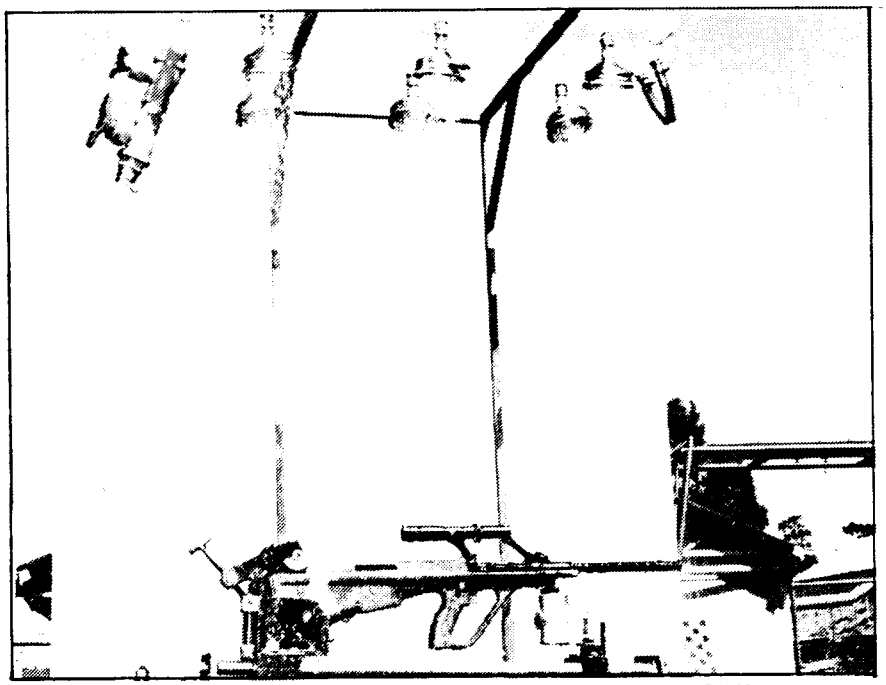


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FIG 1 STEYR AUG - SHOWING WATER SPRAY FACILITY

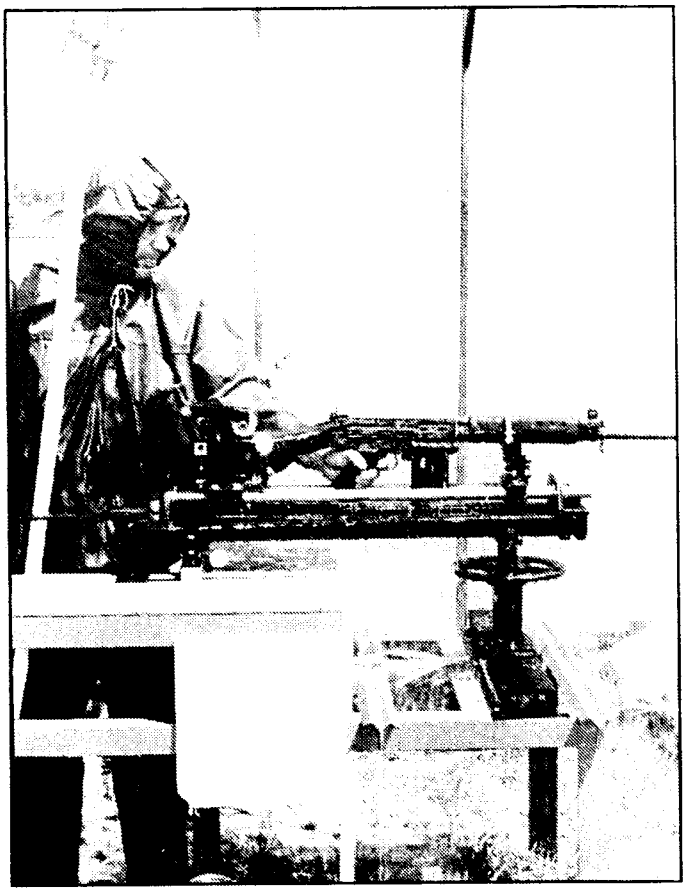

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FIG 2 RIFLE 7.62 mm L1A1 - THE CONTROL WEAPON

APPENDIX 1

WATER SPRAY TEST

APPENDIX 1 TO
ANNEX F TO
PART FOUR TO
EDE 17/85

WATER SPRAY TEST

PART I[1]

Test Condition	Exposure time (minutes)	Cumulative Exposure time (minutes)	Rain cm (ins)	Cumulative Rain cm (ins)
Weapon horizontal [2]				
(a) Bolt open and ejection opening cover open	5	5	5 (2.0)	5 (2.0)
(b) Loaded, bolt closed and ejection opening cover closed	5	10	5 (2.0)	10 (4.0)
(c) 100 rounds semi-automatically	4	14	4 (1.6)	14 (5.6)
(d) Bolt open and ejection opening cover open	5	19	5 (2.0)	19 (7.6)
(e) Loaded, bolt closed and ejection opening cover closed	5	24	5 (2.0)	24 (9.6)
(f) 100 rounds automatically (controlled burst and fully automatic)	4	28	4 (1.6)	28 (11.0)

Part II[1]

Test Condition	Exposure time (minutes)	Cumulative Exposure time (minutes)	Rain cm (ins)	Cumulative Rain cm (ins)
Weapon muzzle up [2]				
(a) Bolt open and ejection opening cover open	5	33	5 (2.0)	33 (13.0)
(b) Loaded, bolt closed and ejection opening cover closed	5	38	5 (2.0)	38 (15.4)
(c) 100 rounds semi-automatically	4	42	4 (1.6)	42 (16.8)
(d) Bolt open and ejection opening cover open	5	47	5 (2.0)	47 (18.8)
(e) Loaded, bolt closed and ejection opening cover closed	5	52	5 (2.0)	52 (20.8)
(f) 100 rounds automatically (controlled burst and fully automatic)	4	56	4 (1.6)	56 (22.4)

(Part II Cont'd)

Test Condition	Exposure time (minutes)	Cumulative Exposure time (minutes)	Rain cm (ins)	Cumulative Rain cm (ins)
Weapon muzzle down [2]				
(a) Bolt open and ejection opening cover open	5	61	5 (2.0)	61 (24.4)
(b) Loaded, bolt closed and ejection opening cover closed	5	66	5 (2.0)	66 (26.4)
(c) 100 rounds semi-automatically	4	70	4 (1.6)	70 (28.0)
(d) Bolt open and ejection opening cover open	5 [3]	75	5 (2.0)(3)	75 (30.0)
(e) Loaded, bolt closed and ejection opening cover closed	5 [3]	80	5 (2.0)(3)	80 (32.8)
(f) 100 rounds automatically (controlled burst and fully automatic)	4 [3]	84	4 (1.6)(3)	84 (33.6)

NOTES: 1. Throughout the test, firing is carried out with the weapon held horizontally.

2. Before attempting to fire, hold weapon with muzzle down, unlock bolt slightly and attempt to remove water accumulated in bore.

3. Or as required to finish programme with at least 81 cm (32 inches) cumulative rain total.

APPENDIX 2

MELBOURNE AND METROPOLITAN BOARD OF WORKS

TYPICAL ANALYSIS OF MELBOURNE WATERS

APPENDIX 2 TO
ANNEX F TO
PART FOUR TO
EDE 17/85

MELBOURNE AND METROPOLITAN BOARD OF WORKS
TYPICAL ANALYSIS OF MELBOURNE WATERS
(chemical values expressed in mg/L)

ph	7.0
Colour (Platinum-Cobalt)	4.0
Turbidity (FTU)	0.5
Silica (molybdate reactive)	5.5
Calcium	8.3
Magnesium	3.8
Iron	0.2
Manganese	0.003
Sodium	14.9
Potassium	1.5
Copper	< 0.05
Zinc	< 0.05
Chloride	28.0
Nitrate (as N)	0.6
Sulphate	13.0
Fluoride	0.9
Total alkalinity (as Ca CO_3)	16.3
Hardness (EDTA - as Ca CO_3)	36.4
Total residue	100
Specific conductivity (microsiemens/cm @ 20°C)	144

Operations Division
Water Quality Section

PART FOUR

ANNEX G

SALT WATER IMMERSION TEST

This Annex contains information about the Salt Water Immersion Test carried out at EDE's 25 metre range.

The following are included in this Annex.

ANNEX G TO
PART FOUR TO
EDE 17/85

SALT WATER IMMERSION TEST

REFERENCES: A. Evaluation Procedures for NATO Small Arms Weapon Systems D/14, para 2.18.3

B. EDE Firing Programme - Serial 24

INTRODUCTION

1. The Salt Water Immersion Test was carried out at EDE 25 metre range over the period 15 Feb 1985 - 25 Feb 1985.

AIM

2. The aim of the test was to determine the effects of immersion in salt water on the weapons and the effect of storing the weapon in a humid environment without cleaning, over a period of ten days with intermittent firing.

METHOD

3. Before immersion, the weapons were cleaned and lubricated with NSN 9150-01-053-6688 CLEANER, LUBRICANT, PRESERVATIVE (CLP).

4. Each loaded weapon was then immersed for 60 seconds in a saline solution containing 20% sodium chloride to 80% water by weight; also immersed for the same time was one full magazine while a clean fully loaded magazine was placed at the firing point.

5. After immersion the muzzle cap was removed and the weapons were then held muzzle down and the bolt retracted slightly to allow the salt water to drain from the weapons.

6. The weapons were then set up in the fixed mount and the following cycle was fired:

a. 20 Rounds single shot (s/s)

b. 20 Rounds in short bursts

c. 20 Rounds auto.

7. Four additional cycles as per paragraph 6 were fired on the 3rd, 5th, 8th and 10th days.

8. Between firings the weapons were submitted to the humidity storage schedule as shown in Table 1.

TABLE 1 - TEMPERATURE/HUMIDITY STORAGE SCHEDULE

Conditioning Time (hrs)	Temperature of Chamber °C			Relative Humidity %
	Increasing To	Steady At	Falling To	
2	40			90
16		40		90
2			21	95
4		21		95

9. Total rounds required to complete the test were 300.

RESULTS

10. The following results were recorded on the day as indicated.

Day 1 : COLT M16A2 - No problems
STEYR AUG - No problems
RIFLE 7.62 mm L1A1 (Control Weapon) - No problems.

Day 3 : COLT M16A2 - No problems
STEYR AUG - No problems
RIFLE 7.62 mm L1A1 (Control Weapon) - 4 failures to eject, 1 failure to extract.

Day 5 : All visible signs of CLP had disappeared from all weapons.
RIFLE 7.62 mm L1A1 (Control Weapon) - 1 failure to eject.

Day 6 : COLT M16A2 - Was hard to cock and necessitated the use of physical means to assist in initial cocking. The Bolt Assist had to be used to ensure that the bolt went into battery.

STEYR AUG - The hold open device failed to function when the magazines were emptied.

Both weapons completed the cycle of 60 rounds.

RIFLE 7.62 mm L1A1 (Control Weapon) - 3 failures to eject, 1 failure to feed, 1 failure to extract.

Day 10 : COLT M16A2 - The weapon could not be cocked, even with the aid of mechanical means. The weapon was then oiled through the ejection port and magazine mortice opening and cocking was again attempted without success. The weapon was then left for 40 minutes to allow the CLP to take effect, however, the weapon still could not be cocked. Therefore no rounds were fired on the final day.

STEYR AUG - The weapon was initially difficult to cock but fired the first 20 rounds single shot during which 5 light strikes were experienced (none consecutive). Shots 21, 22 and 23 resulted in light strikes so the firing pin was examined to see if it was broken and for safety reasons. The firing pin was found to be serviceable so the weapon was then reassembled and oiled through the ejection port in accordance with reference B. The firing cycle was recommenced and the weapon fired its full 60 rounds successfully. Shots 52 and 60 were trapped cases cleared by standard procedure.

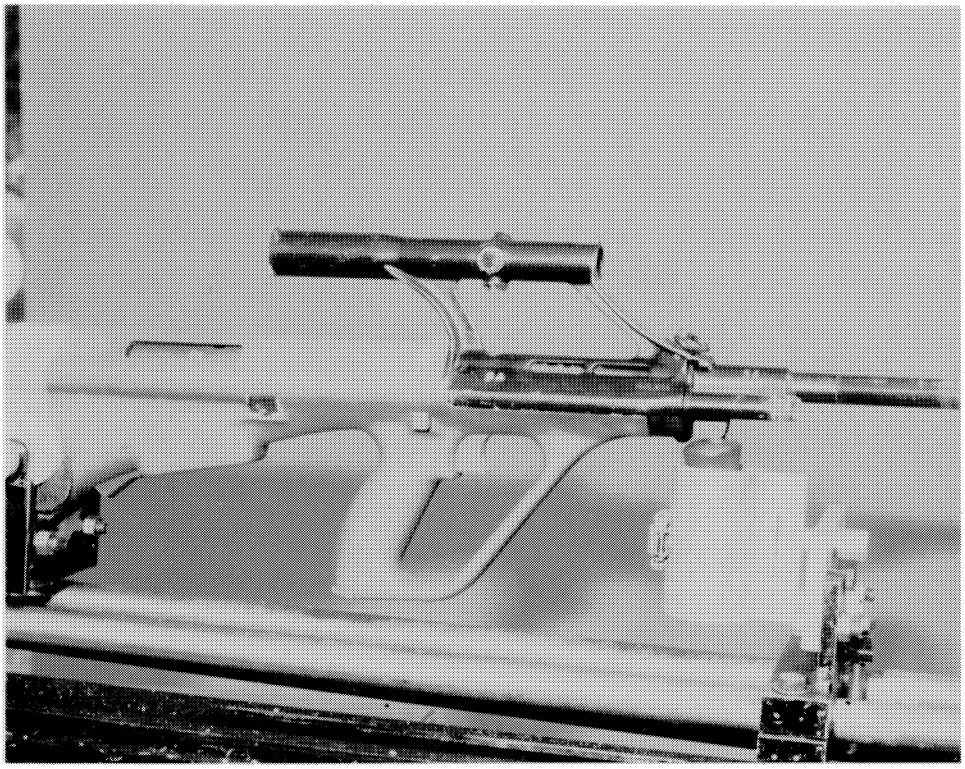
RIFLE 7.62 mm L1A1 (Control Weapon) - The cocking handle rusted solid. The bolt would not go forward under spring tension. Even when oiled, the weapon would not fire.

11. Photographic records of the test are shown in figures 1 - 6.

CONCLUSION

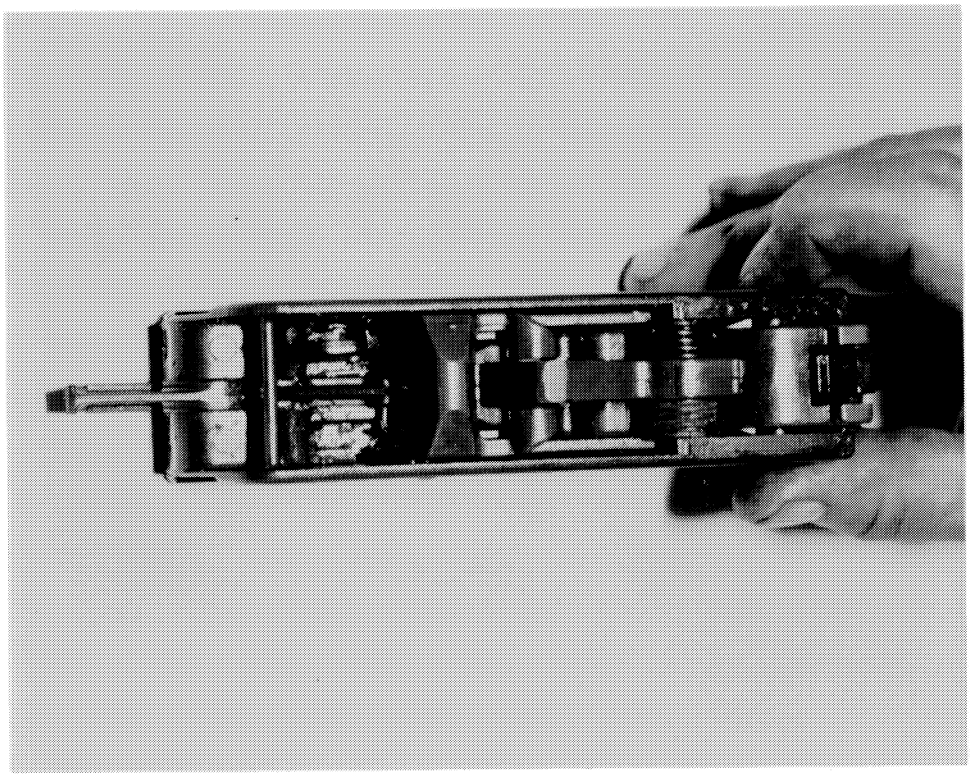
12. After the end of the 10 days, the COLT M16A2 was not in a serviceable condition and had not completed its 300 rounds. The STEYR AUG had completed the requirements of the test as laid down in Reference B and was still in a serviceable condition. The Rifle 7.62 mm L1A1 failed to meet the requirements of this test.

13. The pins, springs and holding open device of the STEYR AUG trigger mechanism should be made from materials less susceptible to salt water corrosion or alternatively the surface coating on the weapon needs to be improved.



C572-8

FIG 1 STEYR AUG SHOWING EXTERNAL CORROSION



C573-7

FIG 2 STEYR AUG SHOWING DETERIORATION OF SPRINGS IN TRIGGER MECHANISM

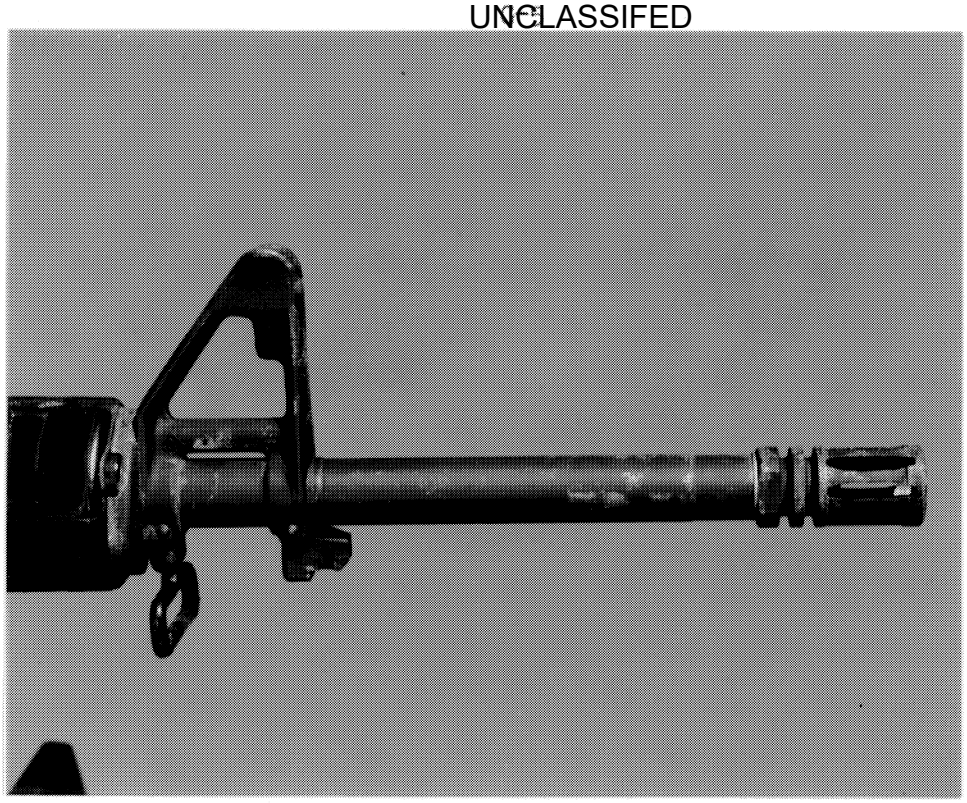


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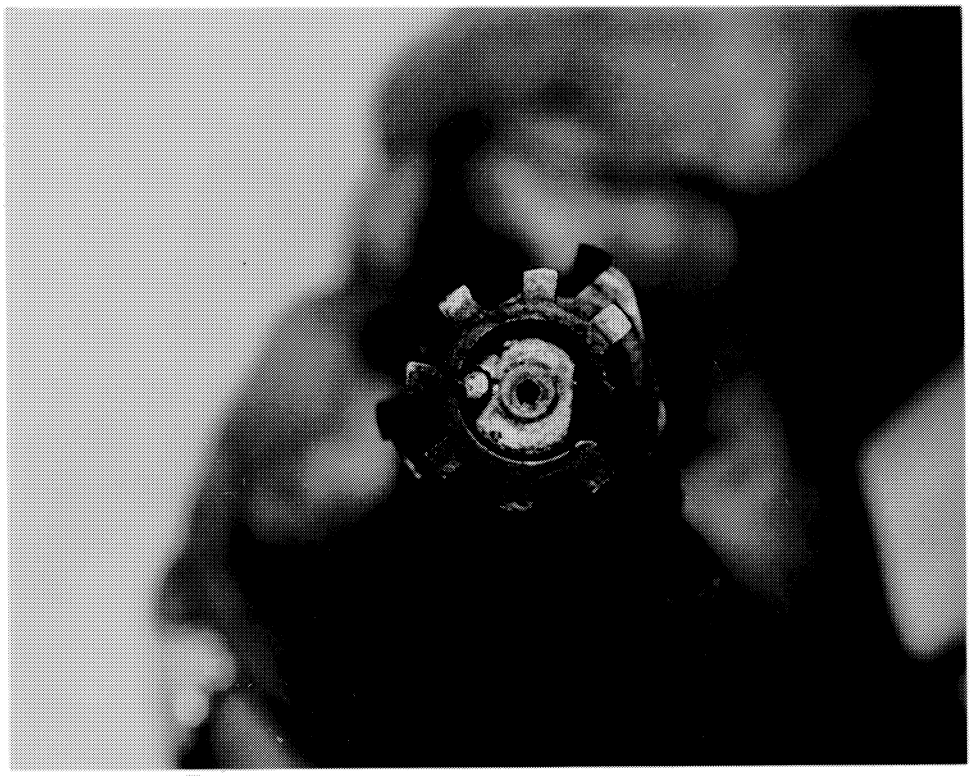
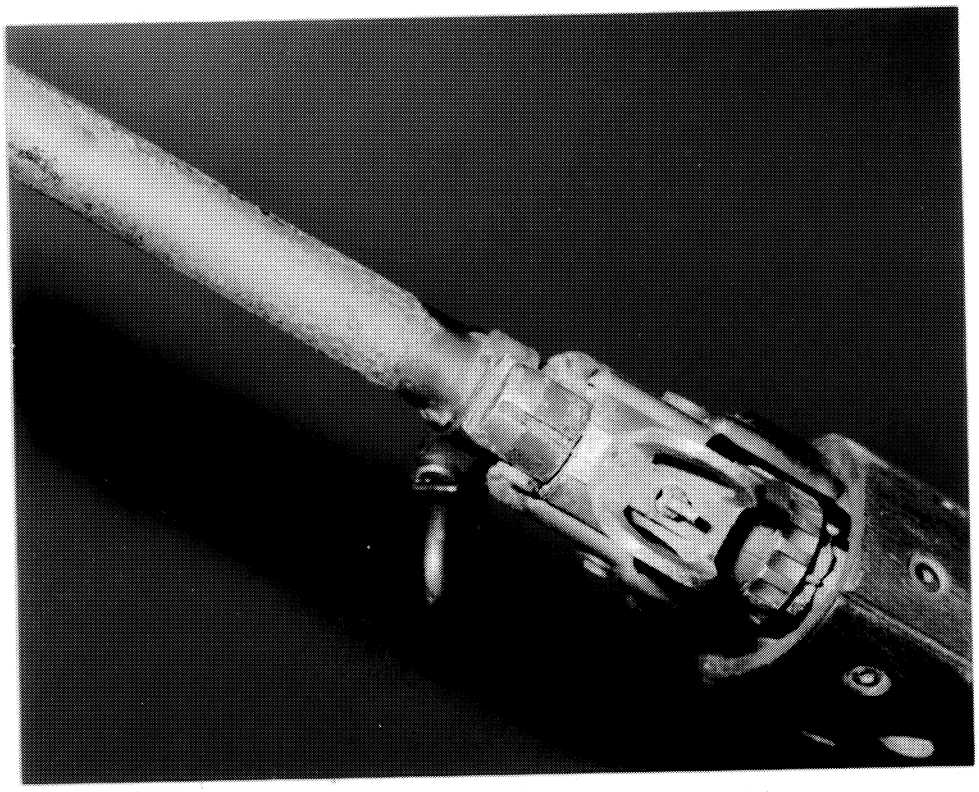
FIG 3 COLT M16A2 SHOWING EXTERNAL CORROSION



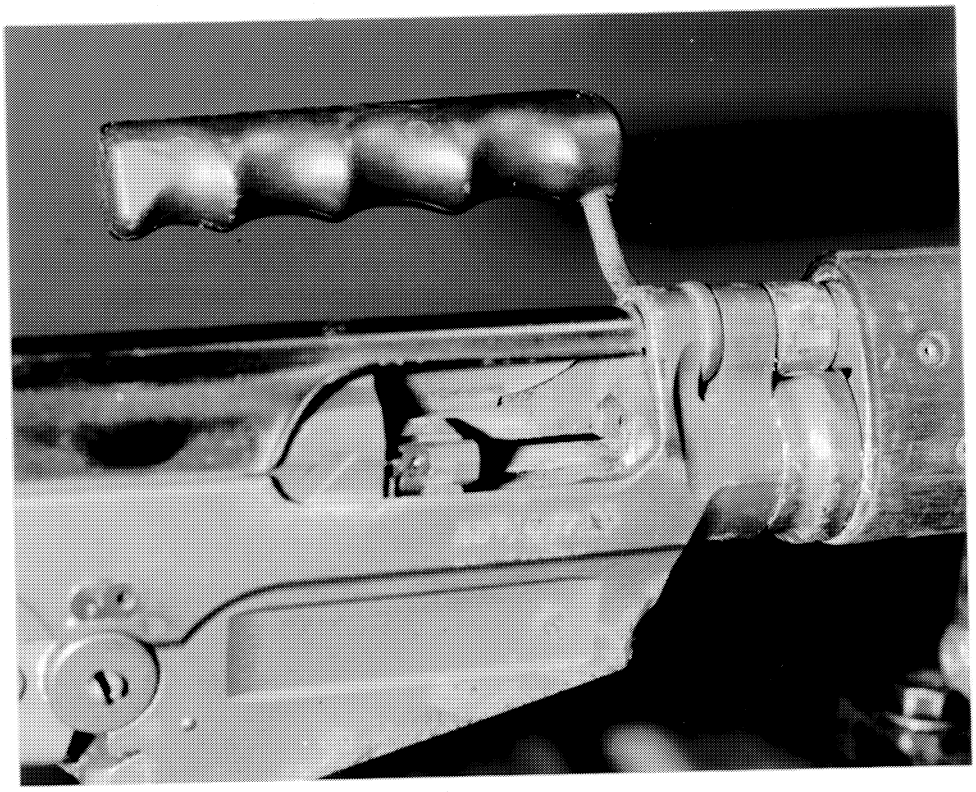
C573-16

FIG 4 COLT M16A2 SHOWING CORROSION ON FACE OF BOLT
THAT IS INOPERABLE



8508V

FIG 5 RIFLE 7.62 mm L1A1 SHOWING EXTERNAL CORROSION



8508AB

FIG 6 RIFLE 7.62 mm L1A1 SHOWING INTERNAL CORROSION

PART FOUR

ANNEX H

SAND DRAG TEST

This Annex contains information about the Sand drag Test carried out at EDE's 25 metre range. The following are included in this Annex.

ANNEX H TO
PART FOUR TO
EDE 17/85

SAND DRAG TEST

REFERENCES: A. Evaluation Procedures for Future NATO Small Arms Weapon Systems D/14, para 2-18-5.

B. EDE Firing Programme - Serial 25.

INTRODUCTION

1. The Sand Drag Test was carried out at EDE 25 metre range over the period 8 - 12 Oct 84.

AIM

2. The aim of the test was to determine the effects of sand on the functioning performance of the weapons by simulating the conditions to be expected when the user is crawling in sandy terrain.

METHOD

3. A weapon was deemed to have failed the sand drag test when the following conditions prevailed.

a. When the weapon failed to function after three immediate actions in one cycle, or

b. When the weapon failed to function after immediate actions in three consecutive cycles.

4. The Rifle 7.62 mm L1A1 was used as the control weapon.

5. The weapons were wiped dry of lubricant before commencing the test.

6. Each weapon was function tested by firing a full magazine, prior to being dragged. The first half of the magazine was fired in single shots and the remainder of the magazine in bursts of 2-3 rounds. (Rifle 7.62 mm L1A1 can only fire in single shots.)

7. Having proved the functioning of the weapons, they were then dragged on alternating sides until either the weapon failed to function or had completed 20 drags ie, 10 drags on each side.

8. Each weapon before being dragged was loaded with a full magazine, bolt forward, safety catch applied and muzzle cover fitted. The weapons were then located in the sand drag apparatus by allowing the side of the weapon to rest on the sand inclined at an approximate angle of 15 degrees. The apparatus clamps were then adjusted to hold the weapon in this repeatable position.

9. The sand used conformed to the specifications laid down in para 2-18-4 of reference A, the schedule is shown in Table 1.

TABLE 1 - PARTICLE SIZE OF SAND MIXTURE

(Source: D14, P165)

Sieve mesh width (mm)	Remaining		Total (%) thru Mesh
	R (g)	$\frac{R}{\sum R} \cdot 100(\%)$	
2.0	-	-	100.0
1.0	-	-	100.0
0.63	19.4	9.7	90.3
0.4	20.0	10.0	80.3
0.2	63.2	31.6	48.7
0.1	34.0	17.0	31.7
0.063	53.2	26.6	5.1
	10.2	5.1	-
Total $\sum$ R	200.0	100.0	-

Note: A sample of 200.0 g = 100%.

10. The sand in the apparatus was heated to +44°C before each drag by using an LP gas blowtorch, to ensure the contact area was free from moisture.

11. Each weapon was dragged the full 4.5 metre length of the apparatus before being removed, shaken and blown for 5 seconds to remove excess sand, before firing 5 single shots at 3 second intervals.

12. If the firing vide para 11 was successful, the weapon was returned to the apparatus and dragged similarly on the opposite side until the weapon had completed 10 drags on each side (a total of 20 drags) or failed the 5 round functioning test.

13. The rate of drag for all drags was approximately 1 m/s.

14. The immediate action (IA) drill in the event of the weapon failing to function was to remove the magazine, cock the action and press the trigger, this action was carried out three times before reloading and continuing the test.

RESULTS

15. A summary of stoppages is shown in Table 2. It should be noted that failures to extract with the COLT M16A2 should be considered major failures as in most cases this stoppage cannot be cleared by IAs and requires the use of a cleaning rod to effect extraction of the jammed spent case. This must be considered detrimental to in service requirements.

TABLE 2 - SUMMARY OF STOPPAGES

Weapon	Failure to Extract	Failure to Eject	Other
STEYR AUG	Nil	Nil	Nil
COLT M16A2 (Steel mag)	3	Nil	1 failure to feed, mag fell out
COLT M16A2 (Plastic mag)	2	Nil	Nil
RIFLE 7.62 mm L1A1 (Control Weapon)	Nil	1	Nil

Note 1: Failures to extract with the COLT M16A2 required the use of a cleaning rod to remove the spent case (almost as a rule).

16. A summary of results is shown in Table 3.

TABLE 3 - SUMMARY OF RESULTS

Weapon	Results
STEYR AUG	Passed
COLT M16A2 (Steel Mag)	Failed in cycles 14, 15 & 16
COLT M16A2 (Plastic Mag)	Passed
RIFLE 7.62 mm L1A1	Passed

17. Photographic records of the test are shown in figures 1 - 5.

18. Ejection paths for both weapons remained consistent through the tests.

CONCLUSION

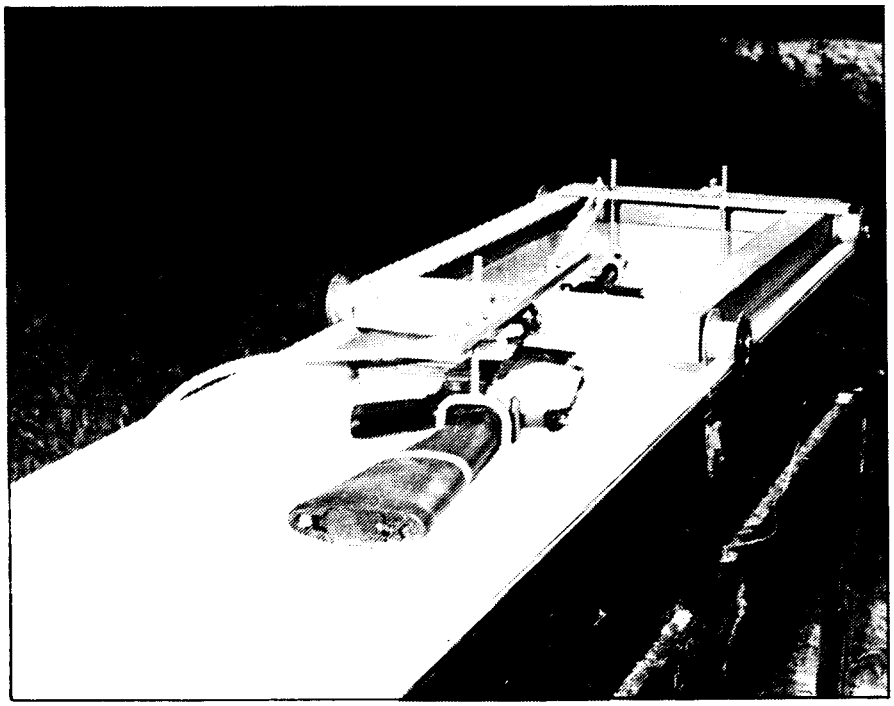
19. The STEYR AUG and the RIFLE 7.62 mm L1A1, the control weapon, successfully completed the test. The COLT M16A2 successfully completed the test using the plastic (THERMOLD) magazine but failed the test using the metal magazine.

20. It is worth noting the plastic magazine was extremely difficult to remove from the COLT M16A2 due to the ingress of sand into the magazine housing between that and the portion of the magazine where the fullering had ceased. The lack of fullering and the rib of the magazine prevented the sand from being shaken out.

21. The innovation of the ejection boss on the COLT M16A2 succeeds in its purpose but acts as a sand scoop forcing sand around the ejection opening and into the mechanism.

22. Because of the ingress of sand vide paras 11 and 12 the trigger mechanism on the COLT M16A2 became progressively more difficult to operate.

23. Failures to extract due to a portion of the case rim being torn out, with the COLT M16A2 require the use of a cleaning rod or like item to remove the spent case as they cannot be cleared by IAs in most instances. This is a serious problem from both an engineering and in service view.

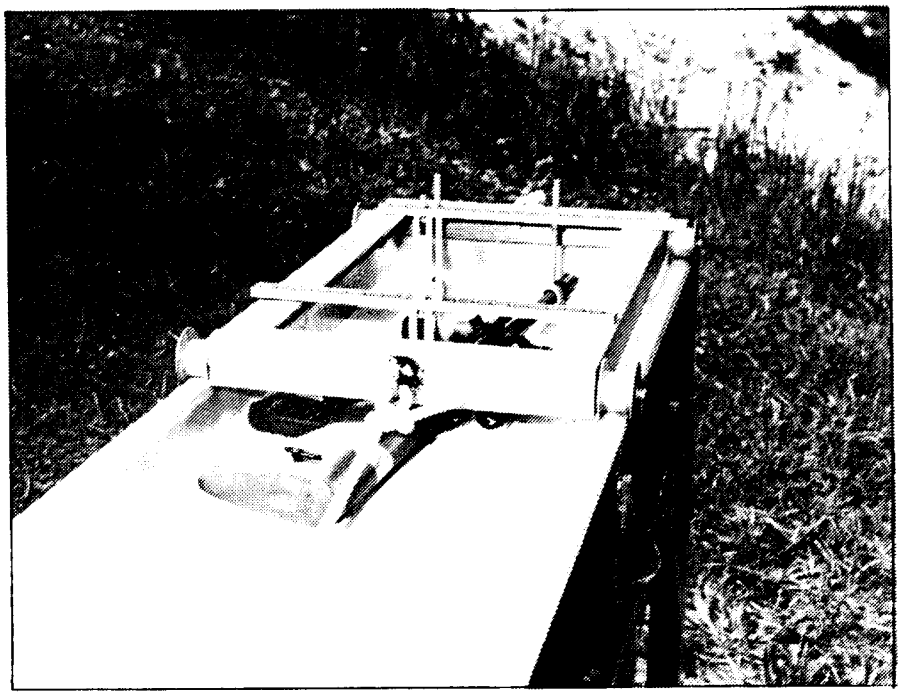


85090

FIG 1 COLT M16A2 RH SIDE DOWN

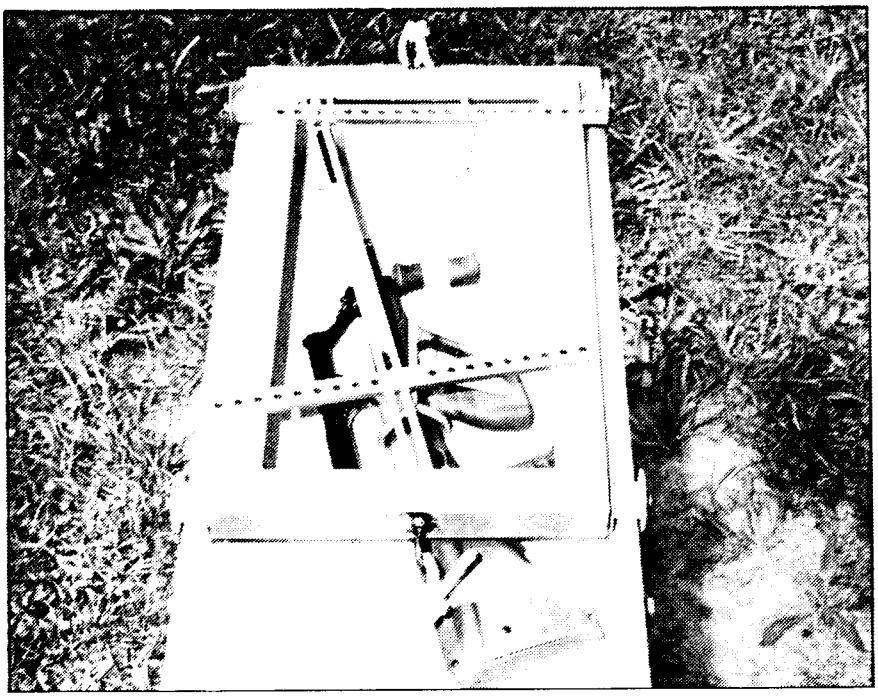
8509K

FIG 2 COLT M16A2 LH SIDE DOWN



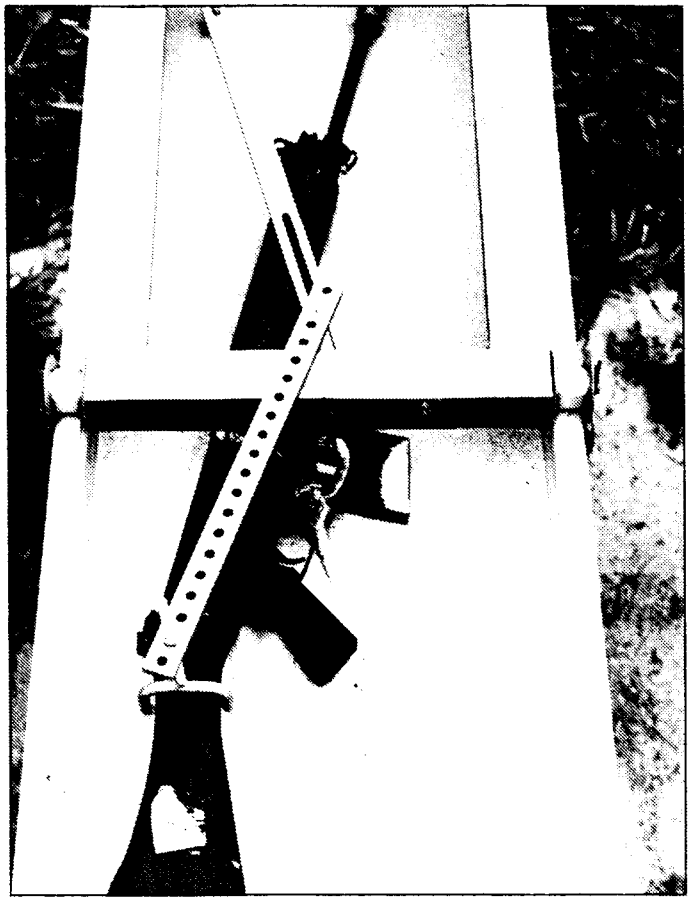
8509G

FIG 3 STEYR AUG RH SIDE DOWN



8509F

FIG 4 STEYR AUG LH SIDE DOWN



57038

FIG 5 RIFLE 7.62 mm L1A1 - THE CONTROL WEAPON

PART FOUR

ANNEX I

LOW TEMPERATURE TEST

This Annex contains information about the Low Temperature Test carried out at EDE's 25 metre range. The following are included in this Annex.

ANNEX I TO
PART FOUR TO
EDE 17/85

LOW TEMPERATURE TEST

REFERENCES: A. Evaluation Procedures for Future NATO Small Arms Weapon Systems D/14, para 2.14.1

B. EDE Firing Programme - Serial 26

INTRODUCTION

1. The Low Temperature (Cold) Test was carried out at EDE 25 metre range over the period 5 - 8 Feb 85.

AIM

2. The aim of the test was to determine the effects of extreme cold at a temperature lower than or equal to -46°C on functioning performance, endurance, lubrication and convenience of operation of the weapons.

METHOD

3. The weapons were lubricated as per the manufacturer's specifications with NSN 9150-01-053-6688 CLEANER, LUBRICANT, PRESERVATIVE (CLP) PX18 Operating range -53.9°C to +246.12°C.

4. The weapons, magazines and sufficient ammunition were placed in the conditioning chamber at -46°C for 12 hours. The weapons were removed in turn to fire 50 rounds as follows:

a. 10 Rounds single shot.

b. 20 Rounds in short bursts of 3 - 5 rounds.

c. 20 Rounds automatic.

5. The cycle in para 4 was repeated at two hourly intervals, during the day, with the weapons being returned to the chamber immediately after firing. The weapons were stored in the chamber at the required temperature overnight between firings.

6. A total of twelve cycles as laid down in para 4 were fired.

7. The Rifle 7.62 mm L1A1 was used as the control weapon.

8. Photographic records of the test are shown in figures 1 - 6.

RESULTS

9. A summary of results is shown below.

TABLE 1 - RATE OF FIRE DURING AUTO PHASE

Weapon	Rate of Fire on Automatic											
	CYCLE 1	CYCLE 2	CYCLE 3	CYCLE 4	CYCLE 5	CYCLE 6	CYCLE 7	CYCLE 8	CYCLE 9	CYCLE 10	CYCLE 11	CYCLE 12
COLT M16A2	787	768	782	774	FAILED TO FIRE							
STEYR AUG	795	820	827	824	814	803	799	830	802	810	808	792
RIFLE 7.62 mm L1A1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

10. The following problems were experienced:

a. The COLT M16A2 Weapon would not function at the beginning of Cycle 5 ie, after firing 200 rounds, a round was chambered but the firing pin failed to ignite the round on four consecutive occasions. The weapon was extremely hard to cock and the magazine catch was stiff.

b. The STEYR AUG Weapon had eleven failures to eject, all were remedied by immediate action (IA).

c. The RIFLE 7.62 mm L1A1 experienced three instances of failure to feed.

11. When the weapons were stripped after the test, the COLT bolt and carrier were choked with a paste like mixture of water and carbon making operation of the firing mechanisms difficult.

CONCLUSION

12. The COLT M16A2 failed the test by not being able to be fired at the beginning of Cycle 5 (ie, after completing 4 cycles of 50 rounds). The problem could not be remedied by IAs.

13. Both the STEYR AUG and the Rifle 7.62 mm L1A1 passed the test.

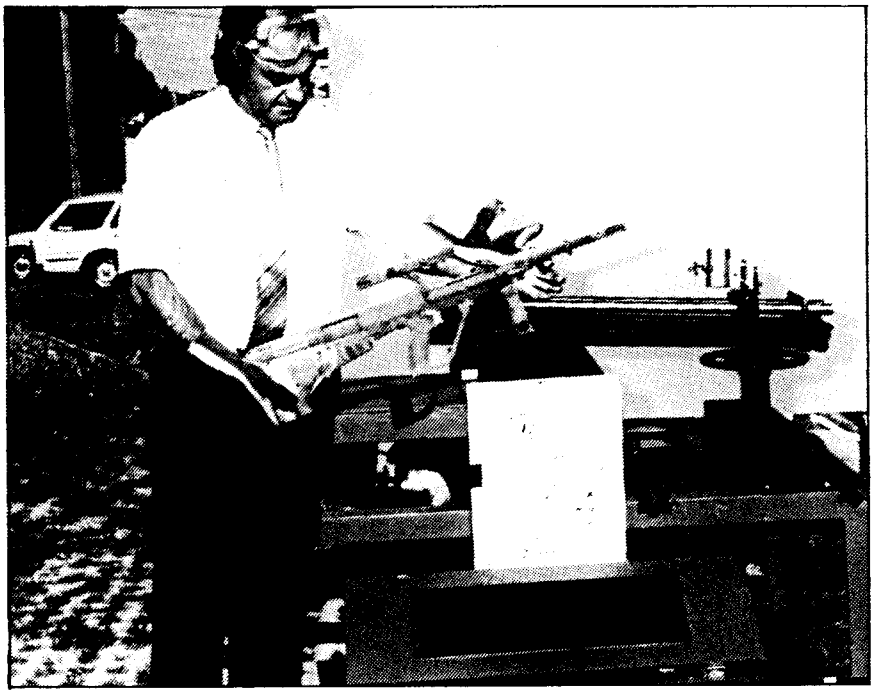
14. Lubrication should be kept to a minimum as emulsification of melted ice and oil takes place. The manufacturers specify minimal lubrication.

15. Gloves need to be worn, however no difficulty was experienced in the operation of any of the weapons.

16. It should be noted that this test departed from the requirements of D/14 (ref A), in that firings were done at ambient temperatures ranging from 18-29°C not from a test chamber maintained at -46°C (this facility not being available); this resulted in a higher degree of condensation forming on the weapons during and immediately post firing which resulted in ice forming on the weapons when the weapons were re-introduced to the Cold Chamber.

8510T

FIG 1 STEYR AUG DURING FIRING OF CYCLE 2

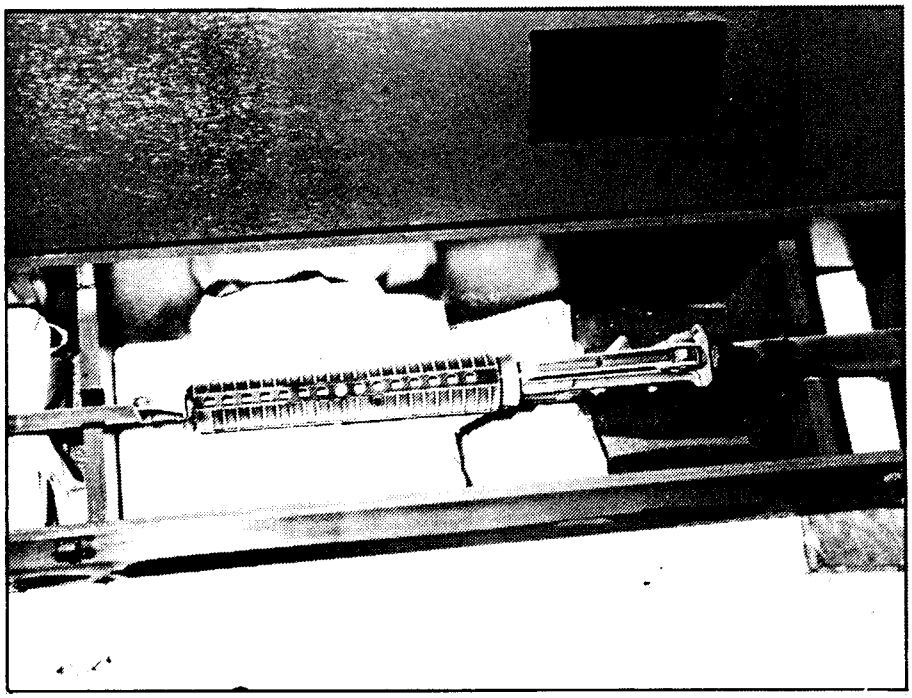


8510J

FIG 2 STEYR AUG BEFORE LAST CYCLE

8510B

FIG 3 COLT M16A2 DURING FIRING OF CYCLE 2

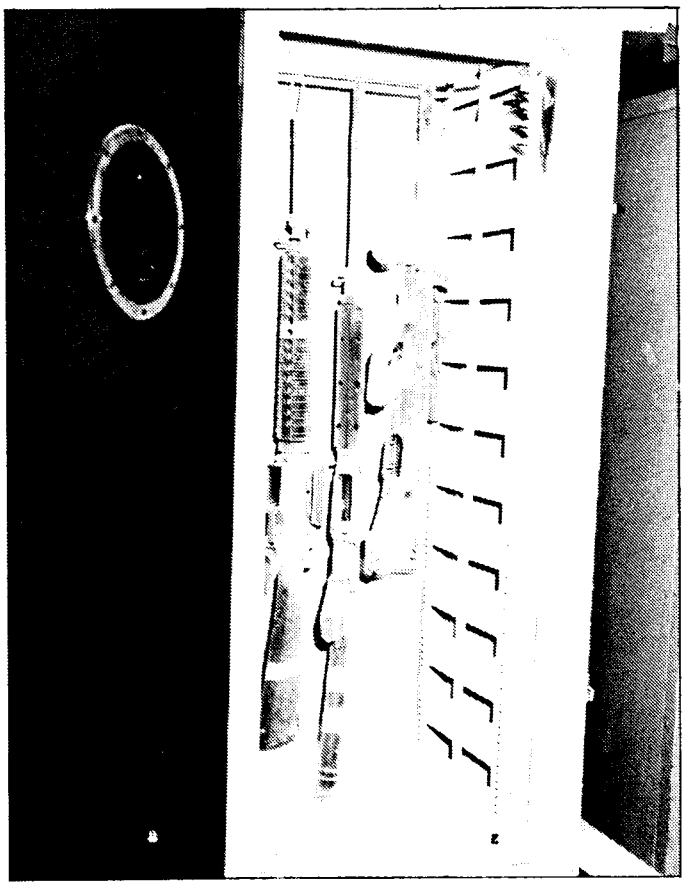


8510P

FIG 4 COLT M16A2 IN WEAPON TRANSIT BOXES CONTAINING DRY ICE

8510D

FIG 5 RIFLE 76.2 mm L1A1 DURING FIRING OF LAST CYCLE



8510Z

FIG 6 COLT M16A2 AND STEYR AUG IN COOLING CHAMBER

PART FOUR

ANNEX J

HIGH TEMPERATURE (HOT) TEST

This Annex contains information about the High Temperature (Hot) Test carried out at EDE's 25 metre range. The following are included in this Annex.

TABLE 1 RATE OF FIRE DURING AUTO PHASE

TABLE 2 STOPPAGES COLT M16A2 HOT TEST

TABLE 3 STOPPAGES STEYR AUG HOT TEST

TABLE 4 STOPPAGES RIFLE 7.62 mm L1A1 HOT TEST

ANNEX J TO
PART FOUR TO
EDE 17/85

HIGH TEMPERATURE (HOT) TEST

REFERENCES: A. Evaluation Procedures for Future NATO Small Arms Weapon Systems D/14, para 2.14.2

B. EDE Firing Programme - Serial 27

INTRODUCTION

1. The High Temperature (Hot) Test was carried out at EDE 25 metre range over the period 12-15 Feb 85.

AIM

2. The aim of the test was to determine the effects of extreme heat at a temperature higher than or equal to +52°C on the functioning performance, endurance, lubrication and convenience of operation of the weapons.

METHOD

3. The weapons were lubricated as per the manufacturer's specifications with NSN 9150-01-053-6688 CLEANER, LUBRICANT, PRESERVATIVE (CLP) PX18; operating range -53.9°C to +246.12°C.

4. The weapons, magazines and sufficient ammunition were placed in the conditioning chamber at +53°C for 12 hours. The weapons were removed in turn to fire 50 rounds as follows:

a. 10 rounds single shot.

b. 20 rounds in short bursts of 3 - 5 rounds.

c. 20 rounds automatic.

5. The cycle in para 4 was repeated at two hourly intervals during the day with the weapons being returned to the chamber for reconditioning to +52°C immediately after firing. The weapons were stored in the chamber at the required temperature overnight between firings.

6. A total of twelve firings as laid down in para 4 were fired.

7. The Rifle 7.62 mm L1A1 was used as the control weapon.

8. The test apparatus used was the same as that for the cold test.

RESULTS

9. A summary of results is shown below.

TABLE 1 - RATE OF FIRE DURING AUTO PHASE

Weapon	Rate of Fire on Automatic											
	CYCLE 1	CYCLE 2	CYCLE 3	CYCLE 4	CYCLE 5	CYCLE 6	CYCLE 7	CYCLE 8	CYCLE 9	CYCLE 10	CYCLE 11	CYCLE 12
COLT M16A2	774	784	796	789	822	828	827	826	827			
STEYR AUG	749	763	763	820	814	778	822	840	824	828	829	815
RIFLE 7.62 mm L1A1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

10. The stoppages that occurred during the test are shown in Table 2 - 4 inclusive.

TABLE 2 - STOPPAGES COLT M16A2 HOT TEST

Stoppage	CYCLE 1	CYCLE 2	CYCLE 3	CYCLE 4	CYCLE 5	CYCLE 6	CYCLE 7	CYCLE 8	CYCLE 9	CYCLE 10	CYCLE 11	CYCLE 12
Failure to extract[2]	2	7	1[1]	4	-	2	2[1]	3	1	4	not fired	not fired
Failure to eject	-	-	1	1	-	-	-	-	-	1	not fired	not fired

Note 1: Oiled through ejection opening prior to commencement of Cycle 3 and 7.

Note 2: All failures to extract could not be cleared by IAs - a cleaning rod had to be used from muzzle end.

Note 3: M16A2 continued after Cycle 2 failures to obtain information as to its comparative performance to other contenders.

TABLE 3 - STOPPAGES STEYR AUG HOT TEST

Stoppage	CYCLE 1	CYCLE 2	CYCLE 3	CYCLE 4	CYCLE 5	CYCLE 6	CYCLE 7	CYCLE 8	CYCLE 9	CYCLE 10	CYCLE 11	CYCLE 12
Failure to extract	-	-	-[1]	-	-	1[2]	-[1]	-	-	1	1	4
Failure to eject	-	-	-	-	-	-	2	-	3	1	2	1

Note 1: Oiled through ejection port prior to commencement of Cycle 3 and 7.

Note 2: Failure to extract in cycle 6 required the use of a cleaning rod. All other failures were cleared by IAs.

TABLE 4 - STOPPAGES RIFLE 7.62 mm L1A1 HOT TEST

Stoppage	CYCLE 1	CYCLE 2	CYCLE 3	CYCLE 4	CYCLE 5	CYCLE 6	CYCLE 7	CYCLE 8	CYCLE 9	CYCLE 10	CYCLE 11	CYCLE 12
Failure to extract	-	-	-[1]	-	-	[1][2]	-[1]	-	-	-	-	-
Failure to eject	-	-	-	-	-	-	-	-	-	-	-	-

Note 1: Oiled through ejection opening prior to commencement of Cycle 3 and 7.

Note 2: Cleared by IA.

CONCLUSION

11. Neither of the contender weapons handled this test well. The lack of power with the 5.56 mm NATO cartridge is apparent when compared with the number of stoppages experienced with the 7.62 mm NATO cartridge used by the Rifle 7.62 mm L1A1, the control weapon.

12. Failures to extract with the COLT M16A2 which can not be cleared by IAs should be considered major failures requiring the use of some external equipment to effect extraction.

13. Failures to extract with the STEYR AUG that cannot be cleared by IAs are not considered major as the barrel of the weapon can be removed and the case removed manually.

14. The COLT M16A2 handguards were not able to be held without gloves after firing each cycle.

ENGINEERING DEVELOPMENT ESTABLISHMENT

THE ENGINEERING EVALUATION

ON

THE INDIVIDUAL WEAPONS

FOR

THE SMALL ARMS REPLACEMENT PROJECT - ASR 48.8

DEFENCE TRIAL DIRECTIVE 8/513

VOLUME THREE

PART FIVE

MISCELLANEOUS TESTS AND INFORMATION

This Part details the aims, methodology, results and conclusions, where applicable, of the tests carried out.

The Part also contains details of test instruments and apparatus used during the Trial.

ANNEX A	-	Left and Right-handed Firing
ANNEX B	-	Recoil by Ballistic Pendulum
ANNEX C	-	Blank Firing
ANNEX D	-	Durability Tests
ANNEX E	-	Bullet Trap Grenades (MECAR Rifle Grenades) M272 and M265
ANNEX F	-	40 mm M203 Grenade Launcher
ANNEX G	-	Test Instruments and Apparatus used during the Trial

PART FIVE

ANNEX A

LEFT AND RIGHT-HANDED FIRING

This Annex contains results and information regarding Left and Right-Handed Firing. This Annex also contains:

ANNEX A TO
PART FIVE TO
EDE 17/85

LEFT AND RIGHT-HANDED FIRING

REFERENCE: A. EDE ENGINEERING EVALUATION PROGRAMME - SERIAL 4

INTRODUCTION

1. The Engineering Evaluation Programme calls for the weapons to be fired by both left and right-handed firers.

AIM

2. The relative ease of operation of the weapons for both left and right handed firing was to be determined.

DISCUSSION

3. The weapons used were:

a. COLT M16A2.

b. COLT M16A2 variant.

c. STEYR AUG 1.

4. The COLT M16A2 ejects to the right. The upper receiver of the weapon has a case deflector cast into it in order to deflect the case forward of the firer's face.

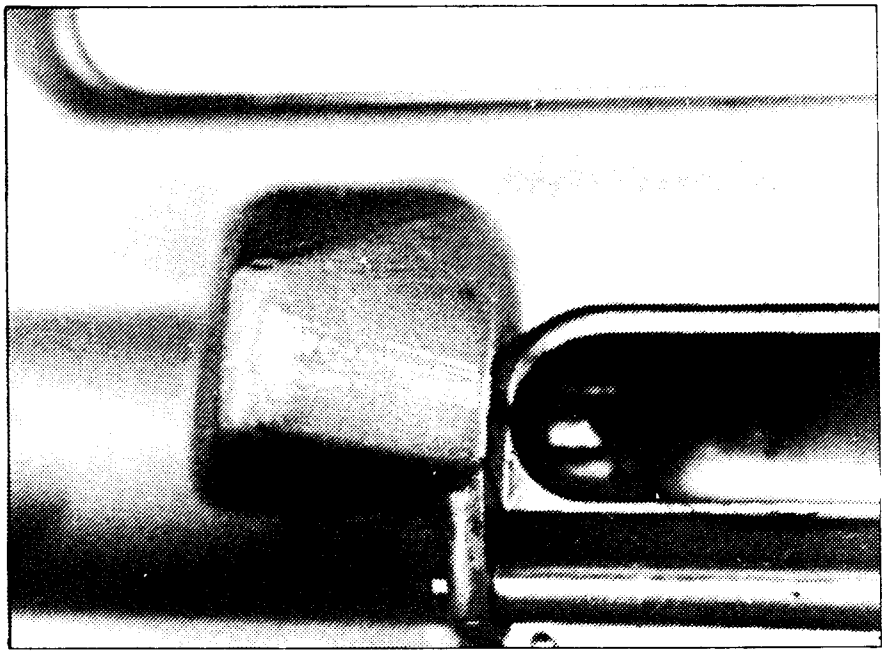


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FIG 1
COLT M16A2 CASE DEFLECTOR

5. The COLT M16A2 Variant also ejects to the right but it does not possess the case deflector.

6. The STEYR AUG 1 is convertible to either left or right-hand firing with the insertion of a left or right-hand bolt assembly. The ejection port not in use is simply closed by a plastic insert.

7. The following activities were monitored:

a. Loading and unloading.

b. Cocking.

c. Operation of firing mode selector (change lever, etc).

d. Immediate Actions (IAs).

e. Ergonomics.

f. Ejection path.

8. The test was conducted using both normal and adverse gas settings where applicable.

METHOD

9. The weapons were lubricated as per the manufacturer's specifications using NSN 9150-01-053-6688 CLEANER, LUBRICANT, PRESERVATIVE (CLP).

10. The firer was fitted out with basic military webbing which included basic pouches, water bottles (2 off), small back pack (full), bush hat and aural protectors.

11. The programme outlined in Table 1 was conducted, any difficulties noted being recorded.

TABLE 1 - LEFT AND RIGHT HANDED FIRING PROGRAMME

Cycle	Right or Left	Firing Position	Gas Setting	Type of Fire
1	Right Hand	Lying Unsupported	Normal	15 Rds Single Shot
2	Left Hand	Lying Unsupported	Normal	15 Rds Single Shot
3	Right Hand	Kneeling	Normal	15 Rds Single Shot
4	Left Hand	Kneeling	Normal	15 Rds Single Shot
5	Right Hand	Instinctive (Hip)	Normal	15 Rds Single Shot
6	Left Hand	Instinctive (Hip)	Normal	15 Rds Single Shot
7	Right Hand	Standing Unsupported	Normal	15 Rds Service Bursts
8	Left Hand	Standing Unsupported	Normal	15 Rds Service Bursts
9	Right Hand	Lying Unsupported	Normal	30 Rds Service Bursts
10	Left Hand	Lying Unsupported	Normal	30 Rds Service Bursts
11	Right Hand	Kneeling	Normal	30 Rds Service Bursts
12	Left Hand	Kneeling	Normal	30 Rds Service Bursts
13	Right Hand	Instinctive (Hip)	Normal	30 Rds Service Bursts
14	Left Hand	Instinctive (Hip)	Normal	30 Rds Service Bursts
15	Right Hand	Standing Unsupported	Normal	30 Rds Service Bursts
16	Left Hand	Standing Unsupported	Normal	30 Rds Service Bursts
17[1]	Right Hand	Lying Unsupported	Adverse	30 Rds Service Bursts
18[1]	Left Hand	Lying Unsupported	Adverse	30 Rds Service Bursts

NOTE 1: STEYR only.

12. Simulated IAs were carried out 3 - 4 times during each cycle.

ANNEX A

RESULTS

13. The STEYR produced no problems when firing left or right-handed except for a slight brushing of the firer's arms during cycle 6. The ejection path ranged from 2 - 2.5 m between 2 o'clock and 3 o'clock when firing right-handed and between 7 o'clock and 10 o'clock when firing left handed.

14. The time to convert the bolt assembly by a trained operator was less than 30 seconds.

15. The COLT showed an unfavourable ejection pattern into the firer's chest and forearm when firing from the waist standing in both single shot and burst modes left-handed.

16. The COLT VARIANT also ejected the cases into the inner forearm on single shots and bursts when fired left-handed; ejection path 1.5 - 3 m between 2 o'clock and 3 o'clock.

17. The COLT VARIANT ejected close to the firer's face when fired prone and left-handed.

18. The change lever on the COLTS was difficult to operate left-handed. The operation left-handed is not as smooth or instinctive as it is for a right-handed shooter.

SUMMARY

19. The STEYR performed far superior to the COLTS when fired left-handed. The COLTS pose problems when fired from left-handed positions other than from the shoulder standing and prone positions.

20. The COLT VARIANTS were worse than the standard COLT due to no case deflector on the upper receiver.

CONCLUSION

21. The STEYR is superior to the COLT when correctly converted to left-handed shooting with a change of bolt and ejection opening. However, should a left-handed shooter try to shoot a right-handed STEYR left-handed the ejection path is dangerous and can throw an empty case into his face.

RECOMMENDATION

22. EDE would recommend a soldier should be made to shoot the STEYR right-handed to avoid the hazard if a left-handed shooter accidentally fires an unconverted weapon.

PART FIVE

ANNEX B

RECOIL BY BALLISTIC PENDULUM

This Annex also contains the following figures and tables:

ANNEX B
TO PART FIVE TO
EDE 17/85

RECOIL BY BALLISTIC PENDULUM

REFERENCE: A. Evaluation Procedures for Future NATO Small Arms Weapon Systems D/14 Para 2-16

B. EDE Firing Programme Serial 12

INTRODUCTION

1. The measurement of recoil by ballistic pendulum was carried out at EDE 25 metre range on 5 September 1984.

AIM

2. The aim of this test was to establish the recoil energy of each weapon system.

METHOD

3. Each weapon fired a number of shots to enable the recoil to be traced 5 times. Muzzle velocities were recorded by the use of a chronograph to capture at least three velocities per cycle of 5 traces.

4. Each weapon was weighed with an empty magazine to obtain the mass of the rifle.

5. The weapons were then placed in the cradle of the ballistic pendulum and the total was weighed to obtain the mass of the system.

6. The period of the pendulum was measured by averaging the time taken for 20 oscillations of the pendulum and found to be 3 seconds. This was confirmed by calculation.

Weapons Used

7. The weapons used are shown in Table 1.

TABLE 1 - WEAPON SYSTEMS USED IN BALLISTIC PENDULUM

Firing Cycle	Wpn	Weapon Type	Attachment
1	S5	STEYR AUG	Bayonet Attachment - No Bayonet
2	S5	STEYR AUG	Bayonet and Bayonet Attachment
3	SV2	STEYR AUG VARIANT	
4	SV2	STEYR AUG WITH 365 mm BARREL	
5	C4	COLT M16A2	No Bayonet
6	C4	COLT M16A2	With Bayonet
7	CV2	COLT M16A2 VARIANT	

Ballistic Pendulum/Weapon Configuration

8. The method of attachment of each weapon is shown in Fig 1 to Fig 4.

RESULTS

9. The recoil energy results are shown in Table 2.

TABLE 2: RECOIL ENERGY

Serial	Weapon Ident	Weapon Type	Recoil Energy (Joules)
1	S5	STEYR AUG WITH BAYONET ATTACHMENT	3.36
2	S5	STEYR AUG WITH BAYONET ATTACH & BAYONET	3:07
3	SV2	STEYR AUG VARIANT	3.76
4	SV2	STEYR AUG VARIANT WITH 365 mm BARREL	3.72
5	C4	COLT M16A2	4.31
6	C4	COLT M16A2 WITH BAYONET	3.98
7	CV2	COLT M16A2 VARIANT	5:32

10. Ballistic Pendulum Calculations; weights used and recoil traces for each weapon type were recorded and are held by EDE but are not included in this report.

11. The tests conformed with the requirements of Reference A.

CONCLUSION

12. The STEYR has a slightly smaller recoil energy than the COLT. This is to be expected, however, as it has a slightly larger mass.

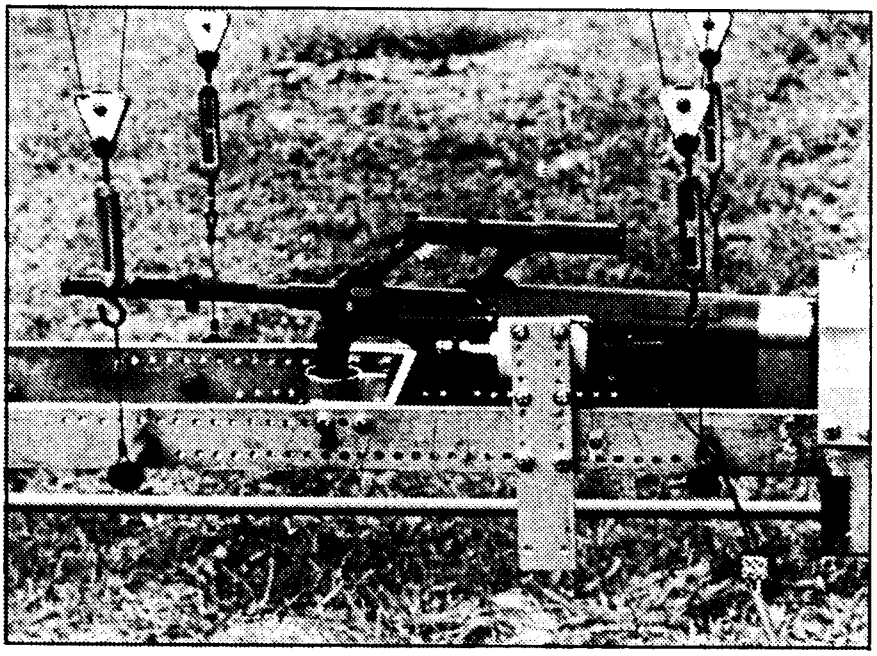

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FIG 1 STEYR AUG IN BALLISTIC PENDULUM

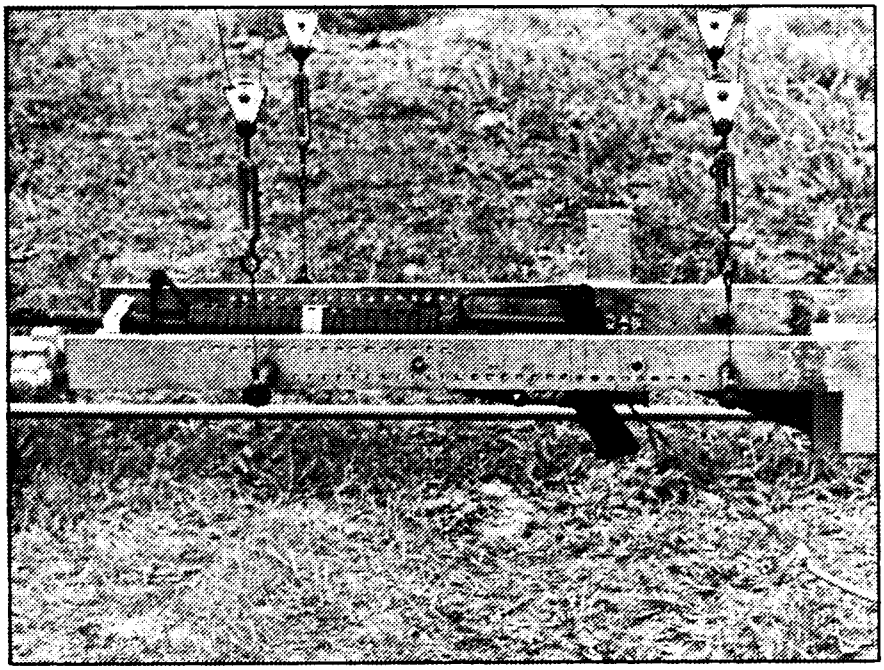

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FIG 2 COLT M16A2 IN BALLISTIC PENDULUM

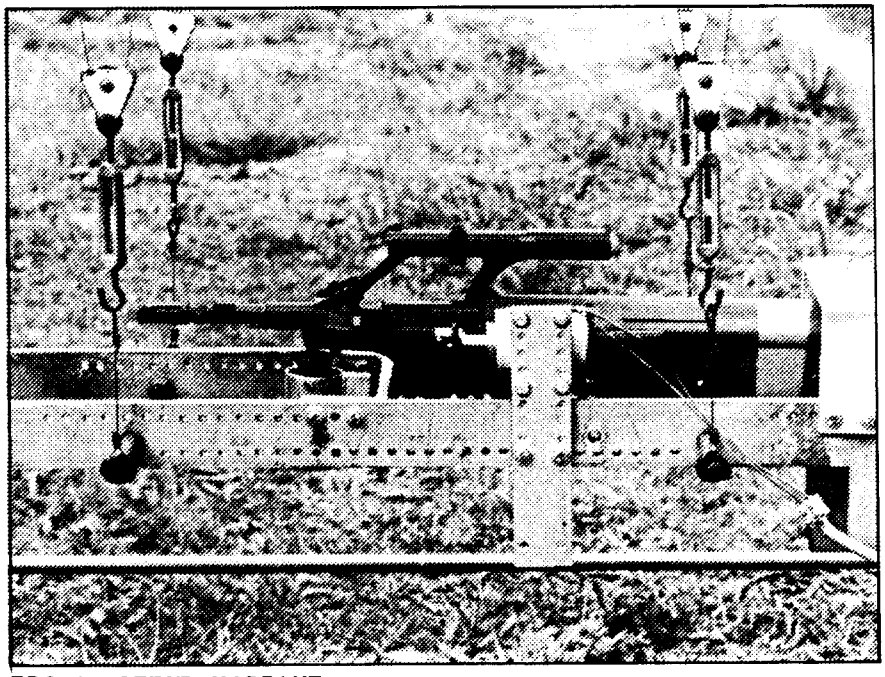

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FIG 3 STEYR VARIANT

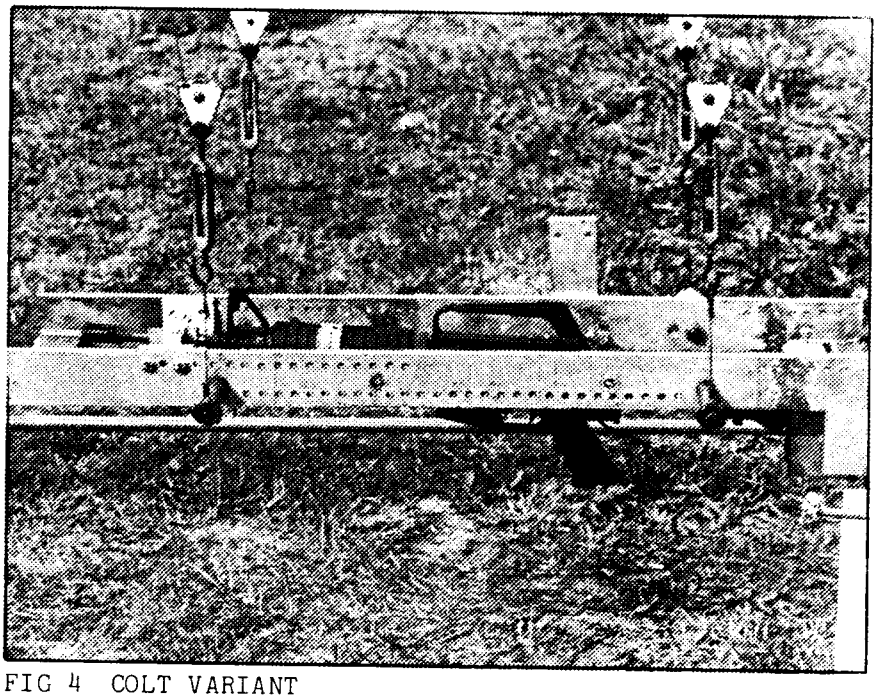

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FIG 4 COLT VARIANT

PART FIVE

ANNEX C

BLANK FIRING

This Annex reports on the Blank Firing carried out during the trial.

ANNEX C TO
PART FIVE TO
EDE 17/85

BLANK FIRING

REFERENCE: A. EDE ENGINEERING EVALUATION PROGRAMME - SERIAL 13

INTRODUCTION

1. A blank firing trial was carried out to ascertain the performance of a weapon system firing blank ammunition. It is important for the training role of the weapon to be able to fire this ammunition in a reasonably realistic fashion.

AIM

2. This test was conducted in order to compare the performance of the two weapon systems under consideration when using a blank firing attachment (BFA) and using two different kinds of blank ammunition namely, M200 blank and FN Star.

PROCEDURE

3. The programme followed with both weapons is tabulated in the EDE Engineering Evaluation Programme.

4. This same programme was followed using both kinds of ammunition.

RESULTS

5. a. Using the M200 blank ammunition, no major problems were experienced with either weapon system.

   b. Using the FN Star blank ammunition the COLT experienced no major problems.

   c. Using the FN Star ammunition the STEYR would not function and even when set to an adverse gas setting could only manage 5 rounds before malfunctioning.

6. As a result of the previously stated problem with the STEYR, the company was consulted upon which a modified BFA was used to complete the same programme with no major problems. This modified BFA, provided by STEYR possessed a smaller orifice and more gas was therefore available for use in the mechanism.

DISCUSSION

7. Although no major problems were experienced with either weapon using the M200 ammunition, both weapons became very dirty and required the use of the bolt assist.

8. Many light strikes were recorded, many of which occurred after the 200 round mark, and can be directly ascribed to the dirty state of the weapon.

9. Also relating to the same problem was the fact that the bolt of the COLT failed to stay to the rear at the finish of the magazine. This related to the dirty weapon and the fact that the carrier was not moving far enough to the rear because of the build up of carbon on the mechanism.

10. Another fact worth mentioning is that firing the STEYR with blank ammunition was unrealistic as the noise level was far below that of firing a real bullet.

CONCLUSION

11. Both weapon systems became very dirty but had no major problems using the M200 ammunition.

12. The COLT performed to about the same standard using the FN Star ammunition as it did to the M200, however, the STEYR did not function using the standard BFA with this ammunition.

13. The STEYR went on to give a satisfactory performance with the FN Star ammunition when the modified BFA, as recommended by STEYR, was used.

RECOMMENDATION

14. That M200 blank ammunition, (or something with similar specifications), be adopted as the blank ammunition as both weapons return a satisfactory performance using this ammunition with the standard blank firing attachment.

PART FIVE

ANNEX D

DURABILITY TESTS

This Annex contains information about the mechanical stresses to which the weapons were subjected.

Information is included in Appendixes as follows:

APPENDIX 1 MECHANICAL STRESSES DURING TRANSIT

APPENDIX 2 DROP TESTS

APPENDIX 1

UNCLASSIFED

APPENDIX 1
ANNEX D TO
PART FIVE TO
EDE 17/85

MECHANICAL STRESSES DURING TRANSIT

REFERENCES:

A. EDE ENGINEERING EVALUATION PROGRAMME - SERIAL 14

B. DEF STAN 07-55 - ENVIRONMENTAL TESTING OF SERVICE MATERIEL

C. EVALUATION PROCEDURES FOR FUTURE NATO SMALL ARMS WEAPON SYSTEMS D/14, PARA 2.20

INTRODUCTION

1. The above references call for the weapons to be subjected to varying mechanical stresses.

AIM

2. The aim of the tests is to simulate that type of handling to which the weapons will be subjected when in transit and in the hands of troops.

3. The tests are designed to simulate 4800 km of ground transport and three hours of air transport.

METHOD

4. The method of testing was as follows:

a. Random Vibration

5 to 500 Hz, one hour for each of the three perpendicular axes of the weapon being tested.

b. Jolting

1000 jolts for each of, muzzle up and muzzle down positions at the three temperatures required ie, -31.5°C, 21°C and 54°C.

c. Bouncing

Three hours of bouncing required with equal time being allotted to each supporting surface.

5. All the above methods of the test were performed with the weapons conditioned at the following temperatures:

a. -31.5°C.

b. 21°C.

c. 54°C.

6. The weapons, C7 and S7, were prepared as follows:

a. Empty chamber.

b. Uncocked.

c. Safety catch applied.

d. Containing full magazines with dummy rounds.

RESULTS

7. Both weapons completed the tests without any physical damage. The weapons were disassembled, inspected, and found to be in sound condition.

8. A function test was performed with both weapons and no incidents or malfunctions occurred.

CONCLUSION

9. From the results, both weapons passed the test. No preference or order of merit can be drawn between the weapons.

APPENDIX 2

DROP TESTS

DROP TESTS

REFERENCES: A. EDE ENGINEERING EVALUATION PROGRAMME - SERIAL 14

B. EVALUATION PROCEDURES FOR FUTURE NATO SMALL ARMS WEAPON SYSTEMS D/14, PARA 2.20.

INTRODUCTION

1. Drop tests were carried out at EDE in order to determine the capabilities of the weapon systems to remain in serviceable condition after dropping onto a hard surface. In particular the following points were desired:

a. The effect of dropping on the accuracy.

b. The effect of dropping on the physical condition.

METHOD

2. Each weapon was cocked, charged with 29 live rounds (SS109) and one M200 blank in the chamber with the safety catch applied.

3. A thirty round function check and a five round 25 m accuracy diagram was fired before and after each drop.

4. Points of damage were noted and recorded on video.

5. Each weapon was dropped from a height of 1.5 m onto a concrete surface in all positions.

RESULTS

HORIZONTAL TOP UP

6. Both weapons landed on their magazines causing superficial scratching of the magazine base. Function was not affected in either case.

7. The handguards of the COLT fell off with no serious damage and were refitted prior to firing. Accuracy seemed to be unaffected.

HORIZONTAL TOP DOWN

8. Both weapons were dropped onto their sights with only superficial damage being sustained. No noticeable change of accuracy.

HORIZONTAL RHS UP

9. Both weapons experienced superficial damage. Functioning of both weapons was unimpaired and no change in accuracy could be detected.

HORIZONTAL LHS UP

10. Again the COLT handguards fell off with some damage to their rear end being sustained. The handguards were refitted prior to firing and no change in accuracy was noticed.

VERTICAL BUTT DOWN

11. Superifical damage was sustained by both weapons. The COLT ejection cover was opened as a result of the drop. There was no change in accuracy.

12. The STEYR ejected the chambered round and loaded the next round in the magazine, ie, the weapon re-cocked itself. Accuracy seemed unaffected.

VERTICAL MUZZLE DOWN

13. The COLT sustained a bent windage knob which was difficult to operate but it was still functionable.

14. The STEYR magazine catch broke but the weapon was still serviceable. Both weapons showed no change in accuracy.

CONCLUSION

15. Both system weapons suffered superficial damage during the tests. The magazines still functioned well with minor external damage. No change in accuracy was noticed.

16. Both systems performed equally and for this test no preference can be made.

PART FIVE

ANNEX E

BULLET TRAP GRENADES (MECAR RIFLE GRENADES)

M272 AND M265

This Annex contains details and results of M272 and M265 BULLET TRAP GRENADES used during the trial. The following form part of this Annex.

ANNEX E TO
PART FIVE TO
EDE 17/85

BULLET TRAP GRENADES (MECAR RIFLE GRENADES) M272 and M265

REFERENCE: EDE ENGINEERING EVALUATION PROGRAMME - SERIAL 20

INTRODUCTION

1. The Mecar system includes fragmentation, armour piercing, smoke, signal and illumination rifle grenades. The grenades fit over the muzzle of any modern infantry weapon using a 22 mm flash suppressor, and do not require an additional attachment. The "bullet trap universal" type (BTU) may be fired from the rifle using standard SS109 ammunition.

2. The bullet trap is designed to 'catch' and contain the bullet as it leaves the muzzle, and allow the propellent gases to 'drive' the grenade.

AIM

3. The evaluation of the Mecar bullet trap grenade was carried out in order to compare the suitability of the contender infantry weapons to accept such a grenade system.

DISCUSSION

4. The test procedure was based on the evaluation procedures for future NATO small arms weapons systems AC/225 (PANEL 111) D/14 (1980).

Description of the Bullet Trap

5. The bullet trap consists of three components situated at the head of the tail section.

6. The arrangement of these three components can be seen in the photograph shown in figure 1.

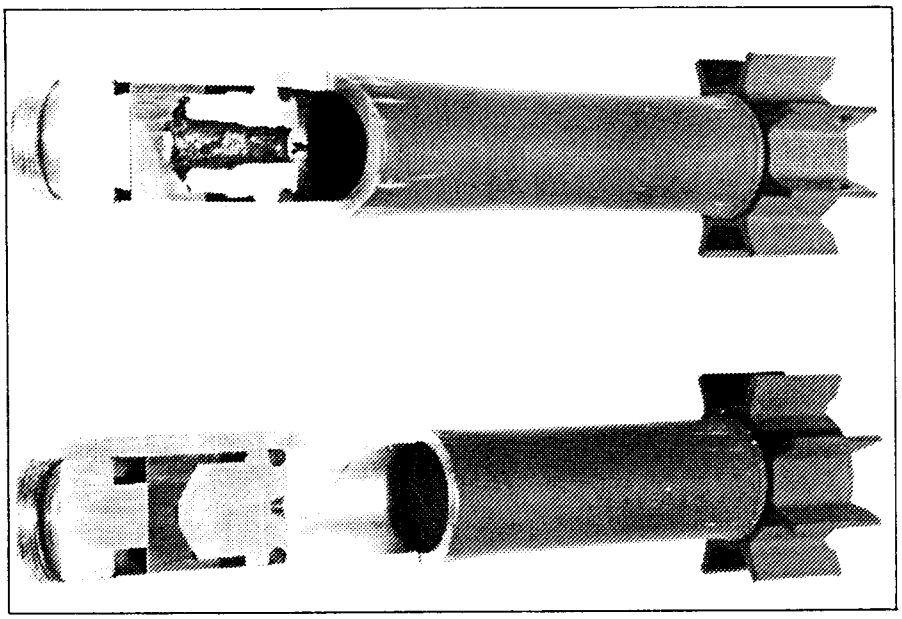

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FIG 1 SECTIONED FIRED AND UNFIRED GRENADES

7. The first of the three components is an aluminium cylinder with a cone shaped head and a small hole at its rear. This cylinder has a smaller diameter than the inside diameter of the grenade tube except for a small ring towards its rear which is present to position the cylinder in the centre of the grenade tube. The hole in its base is present to position the incoming projectile in the centre of the slug.

8. The second component is a hard ferrous button with an inverted cone shaped base to accommodate the head of the aluminium slug, and a flat face at the other end. The purpose of the inverted cone is to ensure that the projectile is channelled to the centre of, and contained within the trap.

9. The third component consists of a mushroom shaped aluminium plug, the stem of which rests against the flat surface of the previous component, and the head of which utilises the thread of the tail section as a solid stop base for the trap.

10. When the bullet is fired, it first penetrates the aluminium cylinder, tearing its way through the soft metal until its passage is arrested by the hard ferrous button. The remainder of the kinetic energy of the projectile is then dissipated by the cold forming (pressing) of the stem of the aluminium mushroom.

11. (See figure 2 for the result of the projectile's passage.)

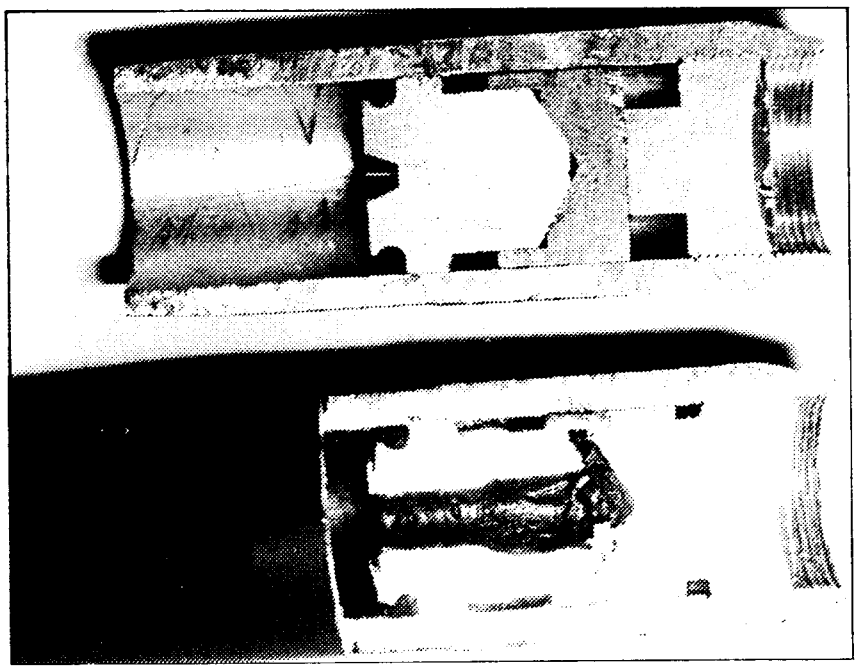

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FIG 2 COMPARISON OF FIRED AND UNFIRED SECTIONED GRENADES

12. In this way, most of the initial kinetic energy of the bullet is transformed into heat, with a small proportion being used to initiate the passage of the grenade, and the remainder dissipated in the cold forming of the aluminium inserts of the trap.

Safety of Design

13. Fired bullet trap grenades have been sectioned and inspected for any potential safety hazard, no evidence of projectiles exiting the trap or debris being ejected from the tail tube could be found.

Aiming Grids

14. The grids provided with the consignment of grenades were not interchangeable between the weapons being tested. Aiming grids must be matched to each specific weapon ammunition system.

15. The difference in the aiming grids provided for the STEYR and the COLT can be seen in figure 3 - with the STEYR sight being considerably larger than that for the COLT.

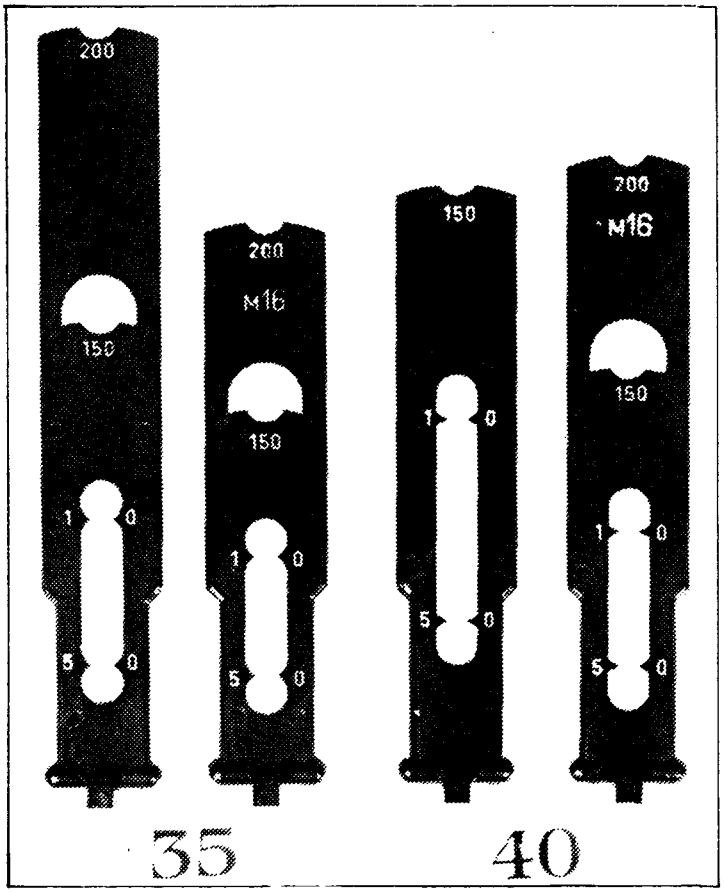

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FIG 3 AIMING GRIDS FOR USE WITH COLT M16A2 AND STEYR AUG

Recoil Energy

16. Recoil energy was measured using the ballistic pendulum, with the results shown in Table 1.

TABLE 1 - RECOIL MEASUREMENTS

Trial	Grenade Type	STEYR			COLT		
		Recoil Distance mm	Muzzle Velocity m/s	Recoil Energy J	Recoil Distance mm	Muzzle Velocity m/s	Recoil Energy J
1	M272	410	60	47.5	435	62	57.46
2	M272	400	60	45.21	420	58	56.12
3	M272	400	59	45.21	420	60	56.12
1	M265	405	57	46.34	460	59	67.32
2	M265	405	56	46.34	430	59	58.82
3	M265		56		440	59	61.59

NOTES:
1. AVERAGE STEYR M272 - 45.97 J M265 - 46.34 J
2. AVERAGE COLT M272 - 56.57 J M265 - 62.58 J
3. M272 ARMOUR PIERCING, M265 HE ANTI-PERSONNEL

17. Calculations indicate that the recoil energy is about 50 joules (36.8 ft lbf), which is approximately 10-12 times greater than for a normal round fired from the same weapon.

18. Hand held firings have indicated that this is not excessive if the correct firing technique is employed.

RESULTS

19. As can be seen looking at the results tabulated in Appendix 1, the consistency of the bullet trap grenade is quite good, however, in some cases the accuracy leaves something to be desired. On further study, it seems that the bad or wayward accuracy measurements are recorded mostly using the provided STEYR sight, while quite reasonable results were obtained when using the STEYR with the provided M16 sight.

20. These observations led to another test, results shown in Table 2, where two STEYR AUG1s, one with a 1 in 7" twist and the other with a 1 in 9" twist barrel, and a COLT M16A2 were again fired with bullet trap grenades - all using the M16 sight.

TABLE 2 - MECAR 40 mm RIFLE GRENADE (M272)

Cycle	Weapon	Grenade	Ammunition	Muzzle Velocity (m/s)	Impact	
					Azimuth (m)	Range (m)
1	STEYR 9"	40 mm	SS109	53.9	2.6 left	-11.7
2	STEYR 9"	40 mm	SS109	56.1	2.6 left	-14.7
3	STEYR 9"	40 mm	SS109	55.4	2.6 left	-18.8
4	STEYR 7"	40 mm	SS109	55.1	2.6 left	-13.3
5	STEYR 7"	40 mm	SS109	55.2	2.6 left	-13.3
6	STEYR 7"	40 mm	SS109	54.7	2.6 left	-13.3
7	COLT	40 mm	SS109	59.6	0.3 left	1.3
8	COLT	40 mm	SS109	60.5	0.6 right	4.2
9	COLT	40 mm	SS109	58.8	0.0	-2.9

NOTES:
1. STEYR 9" refers to STEYR AUG 1 with 1 in 9" twist.
2. STEYR 7" refers to STEYR AUG 1 with 1 in 7" twist.
3. Velocities are in m/s.
4. A negative figure in the range column refers to impact point short of the point of aim.
5. A positive range refers to impact point over the point of aim.

21. The results indicate that there is little difference between the two STEYRs, and only a small difference with the COLT. From TABLE 3, 4 and 5 it can be seen that COLT travels slightly further, however, if muzzle velocities in this test are studied, it is evident that the COLT has a 3-4 m/s advantage over the STEYR, and hence its 8-12 metre distance advantage. One reason for this muzzle velocity advantage could be attributed to the longer flash eliminator of the COLT.

TABLE 3 - 25 m AVERAGE MUZZLE VELOCITY

	35 mm RIFLE GRENADES (M265)	40 mm RIFLE GRENADES (M272)
STEYR AUG 1	60 m/s	56 m/s
COLT M16A2	60 m/s	59 m/s

TABLE 4 - 25 m AVERAGE MUZZLE VELOCITY BALL ROUND

STEYR AUG 1	930 m/s
COLT M16A2	932 m/s

TABLE 5 - RANGE TO STRIKE (M272)

Weapon	Grenade	QE°	Ammunition	Impact Point (M)
STEYR AUG 1	40 mm	45°	SS109	212
COLT M16A2	40 mm	45°	SS109	207

22. However, the interesting point to note is that although the STEYR fired with the M16 sight was slightly inaccurate, falling some 12-16 metres short of the POA, this does not account for the difference in the STEYR and M16 aiming grids shown in Figure 3.

CONCLUSION

23. The Mecar rifle grenade is suitable for use with both weapon systems, generally providing a consistent and accurate grenade system. However, the aiming grid for the STEYR would require some extra calibration and development to achieve its best results.

APPENDIX 1

BULLET TRAP GRENADE - ACCURACY TEST RESULTS

Results. This Appendix contains information of the Bullet Trap Grenade Results. The following figures are included in this Appendix.

FIG 1 BULLET TRAP GRENADE - ACCURACY TEST RESULTS (OFF SHOULDER)

FIG 2 BULLET TRAP GRENADE - DIRECT FIRE TEST RESULTS (BENCH REST)

FIG 3 BULLET TRAP GRENADE - ACCURACY TEST RESULTS (OFF SHOULDER)

FIG 4 BULLET TRAP GRENADE - DIRECT FIRE TEST RESULTS (BENCH REST)

APPENDIX 1 TO
ANNEX E TO
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EDE 17/85

BULLET TRAP GRENADE - ACCURACY TEST RESULTS (OFF SHOULDER)

TEST PARAMETERS

Date:	2/5/85
Range:	150 m
Ammunition:	SS109
Grenade Type:	M272 (RFL40)
Weather:	Sunny 20°C, 3-4 m/s headwind
Mount:	Off shoulder/lying down

TOTAL SPREAD

STEYR AUG	STEYR Sights 3 m
	M16 Sights 6.8 m
COLT M16A2	M16 Sights 8.7 m

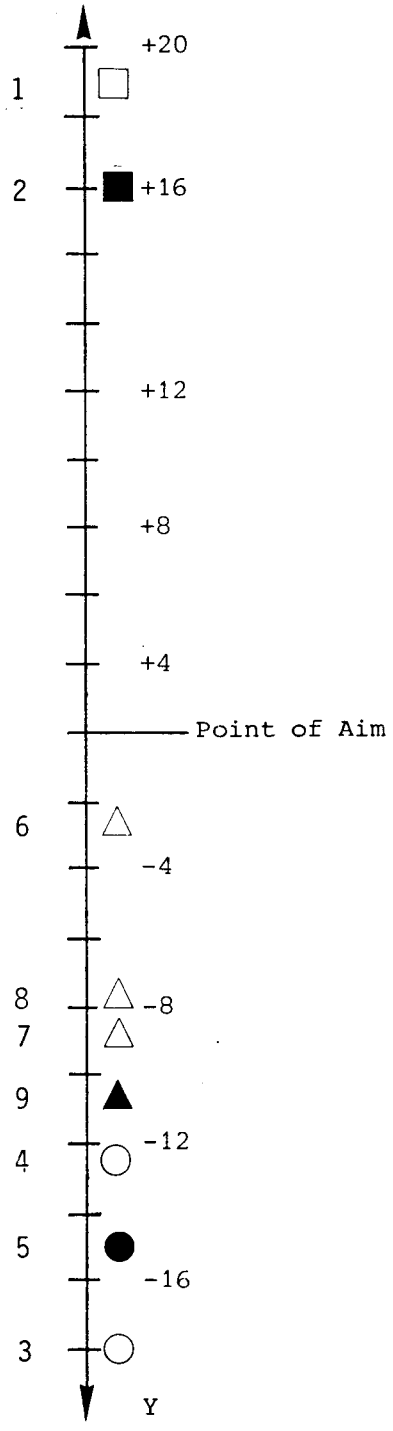
APPENDIX 1

LEGEND

Code	Shot No	Details			
		Weapon Used	Sights Used	POA	Fired By
■	1	STEYR AUG	STEYR	Top of torso target.	Firer 1
□	2	STEYR AUG	STEYR	Base of torso target.	Firer 1
▲	3,4	STEYR AUG	M16	Top of torso target.	Firer 1
△	5	STEYR AUG	M16	Top of torso target.	Firer 2
●	6,7,8	COLT M16A2	M16	Top of torso target.	Firer 1
○	9	COLT M16A2	M16	Top of torso target.	Firer 2

RANGE: 150 m (FALL OF SHOT IN BEATEN ZONE)

* Spread on azimuth negligible.



Metres

FIG 1 BULLET TRAP GRENADE - ACCURACY TEST RESULTS (OFF SHOULDER)

APPENDIX 1

BULLET TRAP GRENADE - DIRECT FIRE TEST RESULTS (BENCH TEST)

TEST PARAMETERS

Date:	2/4/85
Range:	150 m
Ammunition:	SS109
Grenade Type:	M265 (RFL35)
Weather:	Fine 19°C, 3-4 m/s tailwind
Mount:	Bench
POA:	2 m high on target

LEGEND

Code	Shot No	Details	
		Weapon Used	Sight Used
●	1,2	STEYR AUG	STEYR
○	3,4	COLT M16A2	M16
△	5	COLT M16A2	STEYR

RANGE: 150 m (Fall of shot in beaten zone)

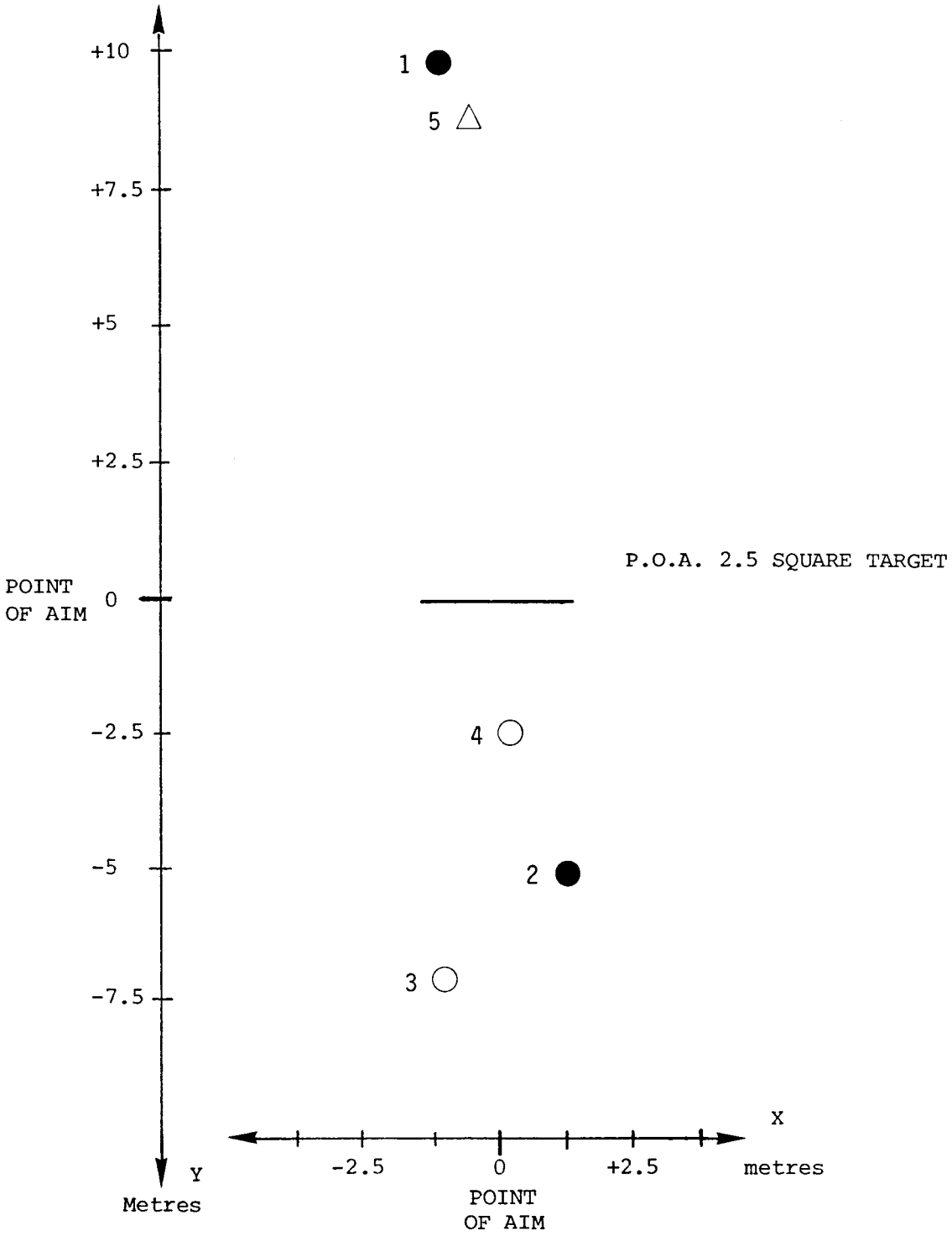


FIG 2 BULLET TRAP GRENADE - DIRECT FIRE TEST RESULTS (BENCH REST)

BULLET TRAP GRENADE - ACCURACY TEST RESULTS (OFF SHOULDER)

TEST PARAMETERS

Date: 30/4/85
Range: 150 m
Weapon: M16A2 (C7)
Ammunition: SS109
Weather: Fine 20°C, 2-2½ m/s headwind
Mount: Off shoulder

LEGEND

Code	Shot No	Details		
		POA	Grenade Type	Mount
■	1,2,3	450 mm height on torso target	M265 (RFL 35)	Fixed
○	4,5,6 8,9,10,11	Base of torso target	M265 (RFL 35)	Fixed
●	7,12,13,14	Base of torso target	M272 (RFL 40)	Fixed
▲	15,16	Base of torso target	M272 (RFL 40)	Off shoulder

Range 150 m (Fall of shot in beaten zone)

* Spread on azimuth negligible

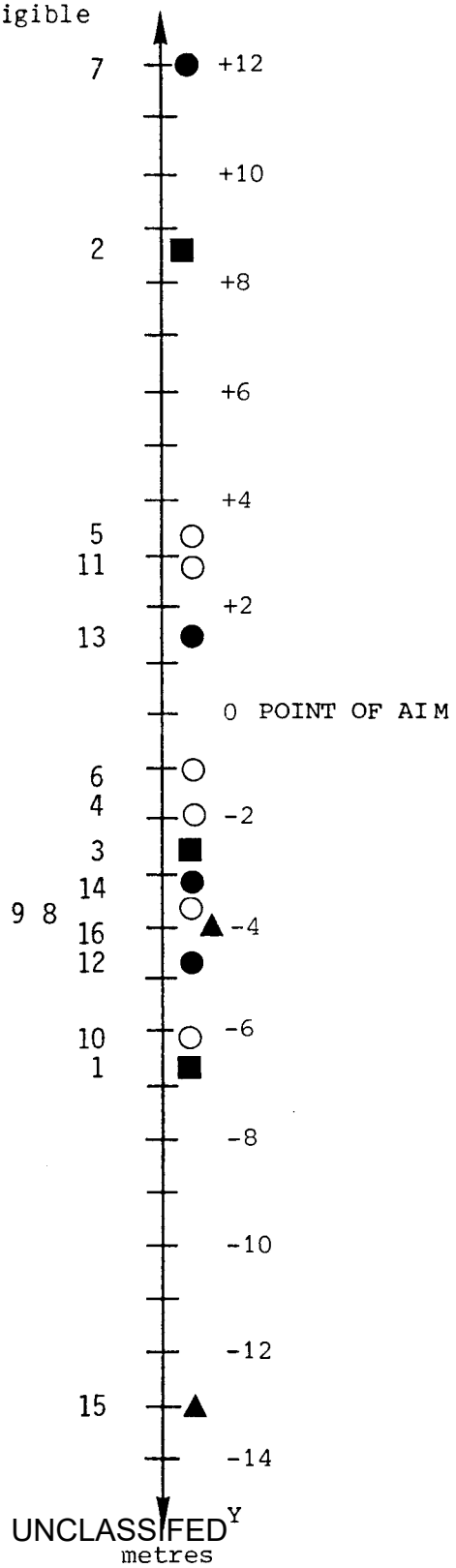


FIG 3 BULLET TRAP GRENADE - ACCURACY TEST RESULTS (OFF SHOULDER)

BULLET TRAP GRENADES - DIRECT FIRE TEST (BENCH REST)

TEST PARAMETERS

Date:	2/4/85
Type of Test:	Direct Fire
Range:	50 m
Mount:	Bench
Ammunition:	SS109
Grenade Type:	M265 (RFL 35)
Weather:	Fine 20°C, 3-4 m/s headwind

LEGEND

○ M16A2 (C7)

● STEYR AUG (S7)

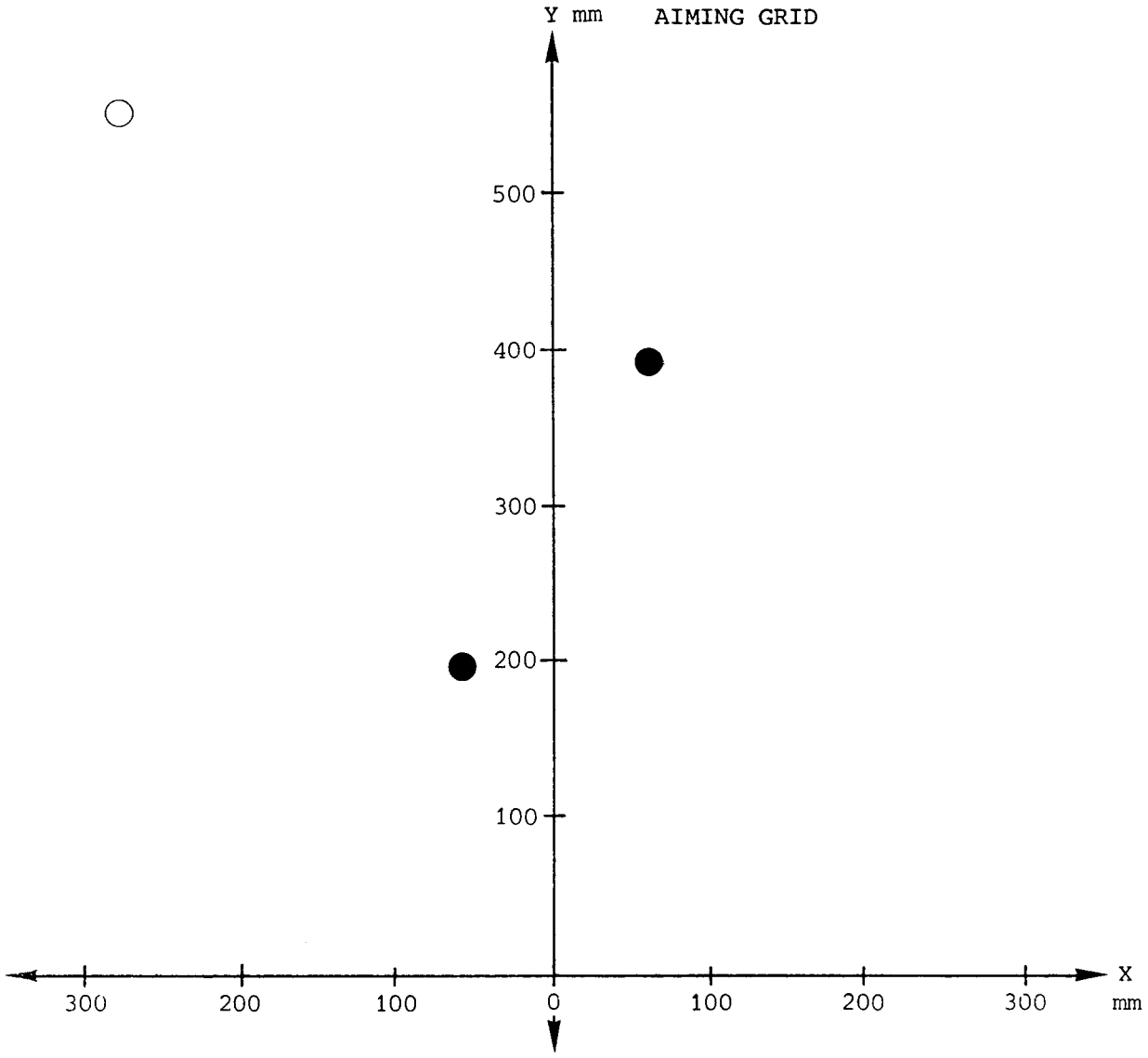


FIG 4 BULLET TRAP GRENADE - DIRECT FIRE TEST RESULTS (BENCH REST)

PART FIVE

ANNEX F

40 mm M203 GRENADE LAUNCHER

This Annex contains details and results when using the 40 mm M203 GRENADE LAUNCHER. The following tables are included in this Annex.

TABLE 1 ACCURACY RESULTS: DISTANCE TO STRIKE

TABLE 2 RANGE RESULTS: MAXIMUM RANGE FOR MAXIMUM ELEVATION

ANNEX F TO
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40 mm M203 GRENADE LAUNCHER

REFERENCE: A. EDE ENGINEERING EVALUATION PROGRAMME - SERIAL 20

INTRODUCTION

1. The M203 grenade launcher is designed to fit onto a weapon and be able to fire 40 mm grenades while still allowing the weapon to function in a normal manner.

AIM

2. To compare the performance of both contender weapon systems firing the M203 grenade launcher.

METHOD

3. With the M203 attached to both weapons, accuracy firings were completed at 150 m and the results recorded. In addition to this, some range firing tests were completed at different angles of departure.

RESULTS

4. The raw data recorded is shown in Tables 1 and 2. It must be noted that only the range measurements are shown here as the deviations in azimuth were negligible compared to the total firing range.

5. The tests for maximum range indicate a range of between 400 and 450 m.

6. Tests completed involving firing the rifle in a normal manner both with the M203 attached, and also with the rifle in its normal state, show that the MPI of the COLT shows little variation whereas the STEYR tends to wander around. In addition to this, the mean radius of the COLT was only slightly increased, while that of the STEYR was increased considerably. Reasons for the above phenomena can be directly related to the weight distribution of the STEYR. That is, because the centre of gravity of the STEYR with the M203 attached is toward the muzzle, it is difficult to hold in a steady position necessary for accurate aiming. This problem does not exist in the COLT where the rifle with the attached M203 is a well balanced, easy to handle weapon.

DISCUSSION

7. During the course of this trial, there were many comments relating to the ergonomics of this weapon system.

a. The COLT was difficult to fire with the magazine still attached to the weapon, however, was relatively easy to carry, aim and handle.

b. The STEYR had a centre of gravity toward the muzzle of the weapon, and hence was quite difficult to hold in the aiming position, as well as being difficult to carry and handle when not in use.

8. There were sighting problems with both weapons.

a. The COLT had a maximum sighting range of 150 m when fired from the shoulder, and above this range the weapon had to be fired with the butt under the armpit. This led to other problems, as when sighting at the maximum range of 250 m, the tip of the muzzle obstructed the field of view and hence obscured the target.

b. The STEYR had a maximum sighting range of 100 m when fired from the shoulder, and above this range had to be fired with the butt under the armpit. The STEYR did not have the COLT's problem at 250 m, but was much more difficult to aim because of the position of the centre of gravity which made the weapon quite muzzle heavy.

9. The quadrant sight could be easily installed on the COLT by a screw on attachment to the normal sight. The STEYR had no such attachment and therefore would require some development if this weapon system was to be adopted.

10. One problem that was noticeable with the quadrant sight was that it was not possible for the firer to rest his cheek on the butt when sighting with both weapon systems. This made it more difficult to keep the total system still for accurate sighting.

CONCLUSION

11. The M203 grenade launcher had several ergonomic problems. On top of these, it did not display a particularly good consistency in regard to accuracy with either weapon system.

RECOMMENDATION

12. EDE considers the bullet trap grenade to provide a more accurate and consistent weapon system, combining the flexibility of not having to carry an extra specific weapon with its additional weight and also provides a more versatile ammunition system for the relative costs.

TABLE 1 - ACCURACY RESULTS : DISTANCE TO STRIKE

		Distance to Strike	
Test	POA	STEYR AUG	COLT M16A2
1	150 m	135 m	135 m
2	150 m	147.2 m	147.2 m
3	150 m	143 m	

TABLE 2 - RANGE RESULTS:

MAXIMUM RANGE FOR MAXIMUM ELEVATION

Test	Weapon Elevation	Range
1	45°	450 m
2	30°	400 m

POA = Point of Aim

PART FIVE

ANNEX G

TEST INSTRUMENTS AND APPARATUS

USED DURING THE TRIAL

This Annex contains details of the equipment used in all aspects of the SARP trial.

The following are included in this Annex.

FIG 1	RANGE EQUIPMENT LAYOUT ACCURACY AND ENDURANCE
APPENDIX 1	BRIEF OUTLINE OF OPERATION OF PROJECTILE LOCATION SYSTEM
FIG 1	'T' BAR, FITTED TO TARGET MECHANISM
FIG 2	RANGE CONFIGURATION FOR AMMUNITION AND WEAPON ANALYSIS

ANNEX G TO
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TEST INSTRUMENTS AND APPARATUS USED DURING THE TRIAL

1. This Annex contains details of the equipment used in all aspects of the SARP trial and FIG 1 shows the layout for all ancillary equipment and its position in relation to the Control Caravan at Merritt Rifle Range, Williamstown, Victoria.

2. Gauging Apparatus

a. For barrel measuring the following pieces of equipment were used:

(1) Mitutoyo Digamatic Indicator.

(2) Dietest Split probe extension.

(3) Dietest Split probe (Model NO: 023).

(4) Mitutoyo miniprocessor DP-1.

(5) Local pattern barrel measuring stand (Drawing Number: DE(INT)70-0).

b. Local pattern incremental head space gauges (increment - 0.025 mm) (Drawing Number: DE100460000)

c. Bore examination apparatus:

(1) Sony video camera.

(2) Sony video cassette recorder.

(3) Sony monitor.

(4) Fibrescope: Scientific Instruments.

(5) Endoscope : Endolux HSW (Hawke-Sass, Wolf).

d. All other gauges used as specified in weapon manuals and provided with the weapons from the manufacturer.

3. Conditioning Cabinets

Two types of conditioning cabinets were used:

a. For Weapons: Contherm day/night chamber.

b. For Ammunition: CO_2 driven cabinet.

4. Thermocouples

a. Hand held thermocouples, Jenko digital thermometers by Extech Equipment.

5. Anemometer and Associated Equipment

a. Rimco: Standard Wind Direction Unit.

b. Rimco: Standard Anemometer.

c. Rimco: Wind speed and direction indicator (Catalogue Number 489000).

6. Barometer

Aneroid Type B985.

7. Communcation Equipment

Radio Transceiver - Vicom Model SU109.

8. Range Vehicles

a. Caravan - See layout diagram (Fig 1).

b. Trailer - (Including fixed mechanical rest).

9. Adverse Condition D14 Test Equipment

a. Dynamic/Static sand test box.

This box was also used for the toxicity test by completing a few minor alterations:

(1) plug up some small holes

(2) turn box upside down

b. Sand Drag 'tank'.

c. Salt water immersion tank.

d. Series of 12 Mud test tanks.

e. Ballistic Pendulum.

f. Water Spray Attachment to fixed mount.

All the above equipment except where otherwise specified is manufactured as per D14 requirements.

g. Remote Firing Apparatus:

This device consisted of a solenoid which is attached to the weapon so that when activated, the solenoid would depress the trigger. In addition to this, the device consisted of a remote switch (remote to the weapon), which can be triggered either manually or automatically triggered by the high speed cine camera.

ANNEX G

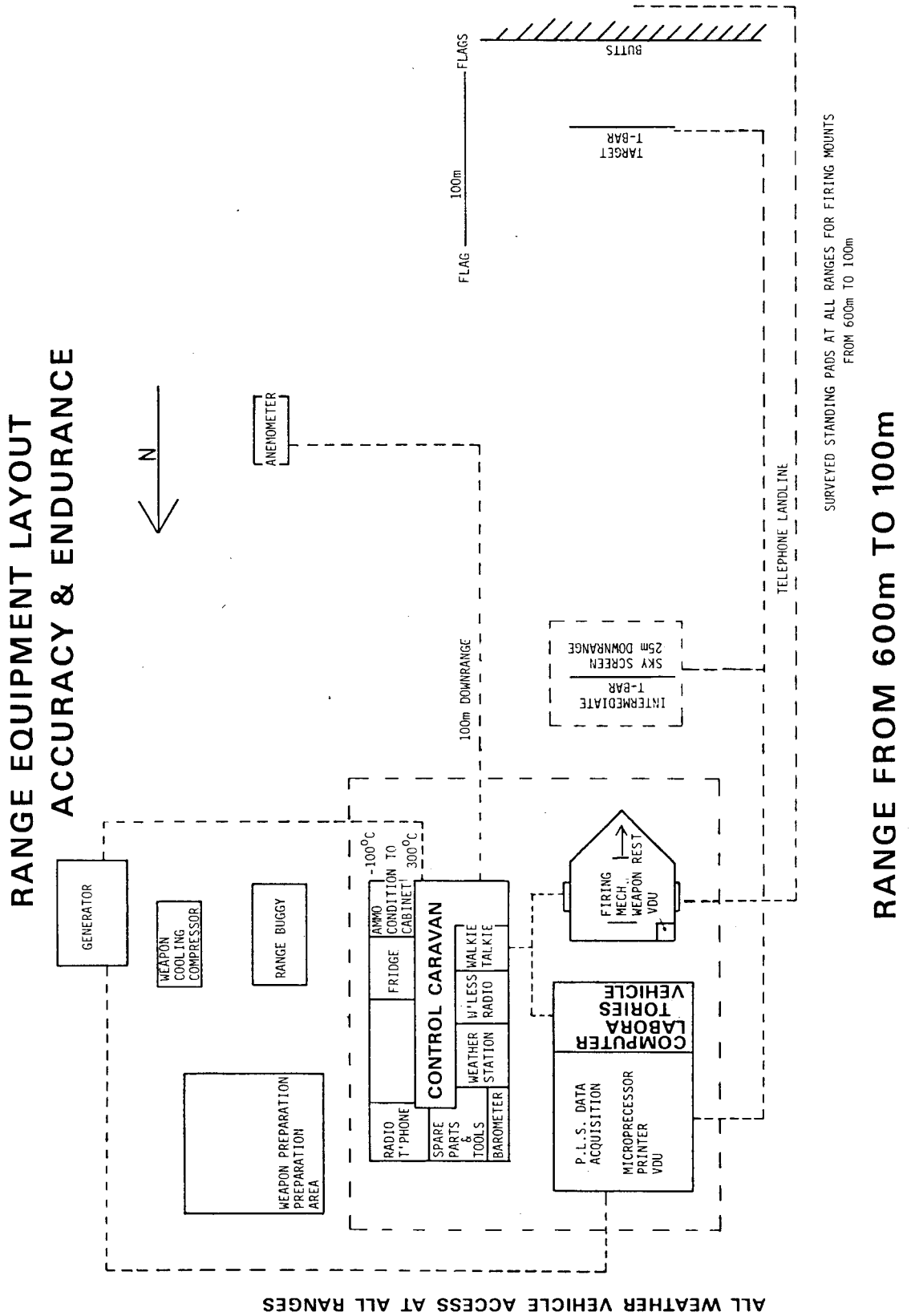

FIG 1 RANGE EQUIPMENT LAYOUT ACCURACY AND ENDURANCE

APPENDIX 1

OPERATION OF PROJECTILE LOCATION SYSTEM

This Appendix contains the following figures.

APPENDIX 1 TO
ANNEX G TO
PART FIVE TO
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BRIEF OUTLINE OF OPERATION OF PROJECTILE LOCATION SYSTEM

1. The Projectile Location System (PLS) uses an array of sensors which detect the shockwave created by the passage of a supersonic projectile. The time of arrival of the shockwave at each sensor is recorded, together with the air temperature. This data is used to calculate the remaining velocity and the x and y co-ordinates of the projectile.

2. A one metre T-bar is mounted on a Series 5 Infantry Target Mechanism which is fitted with a target. Another T-bar is mounted on an adaptor plate designed to carry a zeroing target. The latter may be placed between the weapon and the target when the Ammunition and Weapon analysis programme is in use. This T-bar configuration enables the location and velocity of the projectile to be measured at an intermediate point in the trajectory as well as at the target.

3. Remote Timing and Control Modules (RTCM) are used to collect timing data from the T-bars and transmit it in serial form to the computer via a twisted, shielded pair, data cable. The RTCM at the target also relays target control commands from the computer to the target mechanism.

4. A Serial Data Link Isolation Interface (SDLII) is the interface between the HP9915 computer and the RTCMs down range. The HP9915 computer analyses the timing data from the RTCMs and displays firing information on video display units. This information includes:

a. Alpha-numeric data entered by the operator via the keyboard.

b. The x and y co-ordinates and remaining velocity of each shot.

c. The displacement of the mean point of impact from the point of aim.

d. The size of the group.

5. A hardcopy of the firing information may be obtained from the printer or it can be saved on floppy disc for use at a later date.

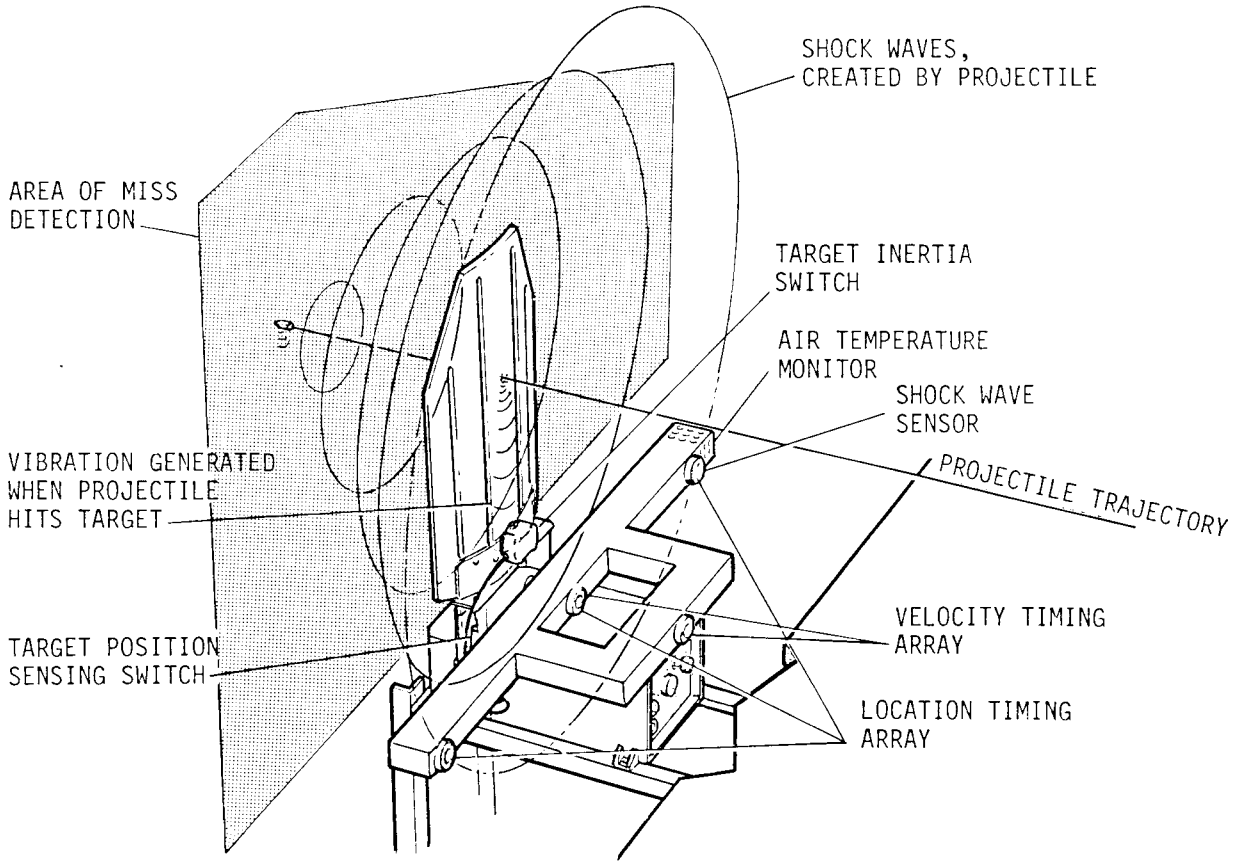

FIG 1 INFANTRY 'T' BAR, FITTED TO TARGET MECHANISM

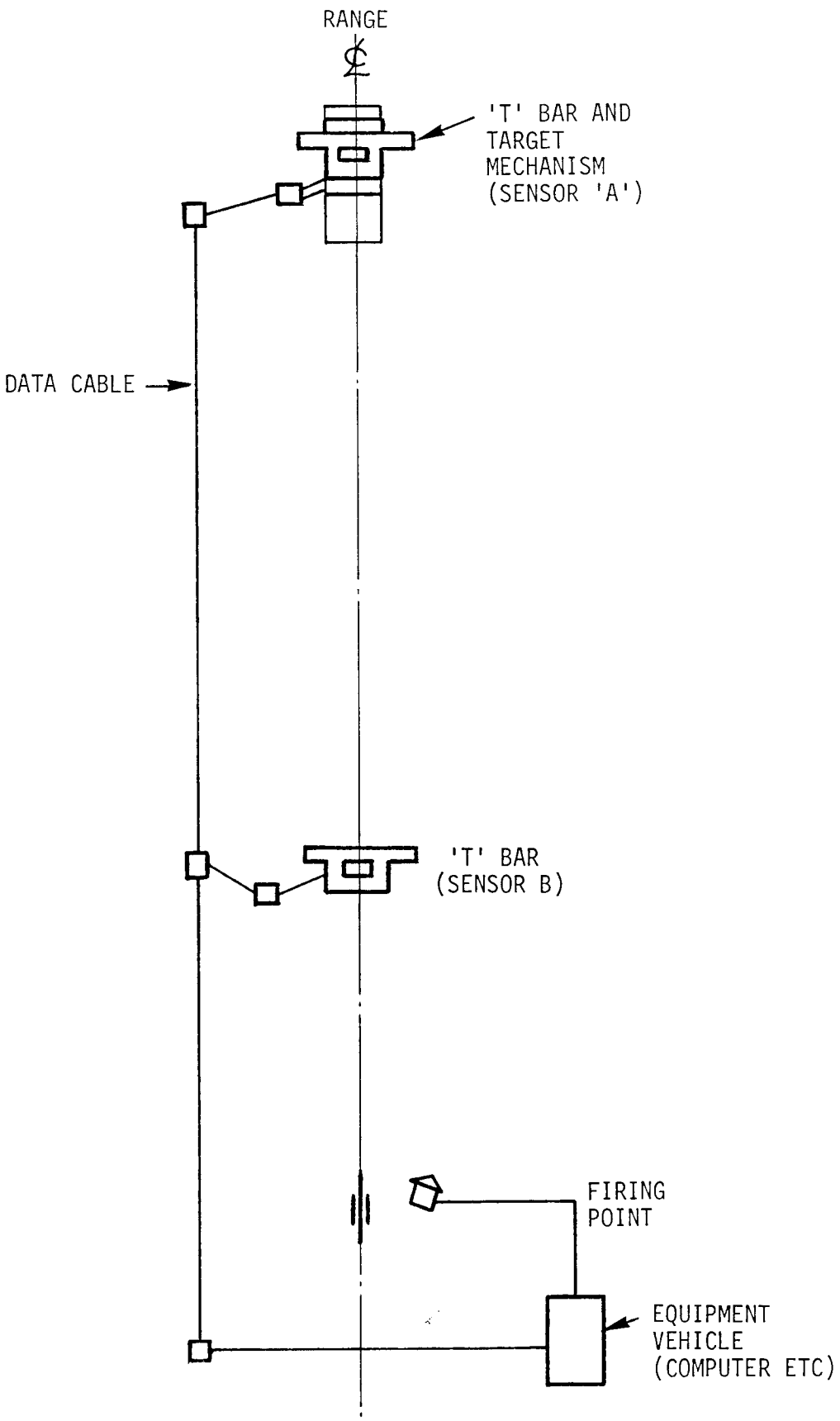

FIG 2 RANGE CONFIGURATION FOR AMMUNITION AND WEAPON ANALYSIS

DOCUMENT CONTROL DATA

1.a. AR No	1.b. Establishment No EDE 17/85	2. Document Date Aug 85	3. Task No AS 8402
4. Title Small Arms Replacement Project (SARP) Final Report		5. Security a. document (R) b. title (U) c. abstract (R)	6. No Pages 374 7. No Refs 4
8. Author(s) LTCOL M.H. Chivers (Ret'd)		9. Downgrading Instructions Review in three years.	
10. Corporate Author and Address Engineering Development Establishment Maribyrnong Victoria		11. Authority (as appropriate) a. Sponsor : DTRIALS b. Security : DTRIALS c. Downgrading: DTRIALS d. Approval : DTRIALS	
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16. Abstract

The Individual Weapons evaluated were, the COLT M16A2 and the STEYR AUG-A1. The testing was carried out in accordance with NATO D/14 procedures where applicable.

The results clearly demonstrated that from an engineering viewpoint the performance of the STEYR was significantly superior to the COLT in most respects; particularly in terms of endurance and adverse conditions.

The STEYR AUG-A1 is recommended as the system most closely satisfying the requirements of ASR 48.8, and is considered suitable for introduction into service without modification.