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Operations Officer
Land Test and Evaluation Agency
Army Headquarters

AUSTRALIAN ARMY

ENGINEERING DEVELOPMENT ESTABLISHMENT

THE ENGINEERING EVALUATION ON THE INDIVIDUAL WEAPONS FOR THE SMALL ARMS REPLACEMENT PROJECT - ASR 48.8 DEFENCE TRIAL DIRECTIVE 8/513

EDE PUB 17/85
(VOLUME 1 OF 3)

Prepared and issued under my direction.

(G.T. Salmon)
Brigadier
Commander

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FOR

THE SMALL ARMS REPLACEMENT PROJECT - ASR 48.8

DEFENCE TRIAL DIRECTIVE 8/513

by

LTCOL M.H. CHIVERS (RET'D) SAC PTSC

EDE SARP PROJECT OFFICER

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CONTENTS

VOLUME THREE

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SUMMARY

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.

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VOLUME ONE

PART ONE

SUMMARY OF ENGINEERING EVALUATION OF

INDIVIDUAL WEAPONS

CONTENTS - PART ONE

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References:

A. Defence Trials Directive 8/513

B. ASR 48.8 - Small Arms Post 1985

C. DAP SARP 528/83 (1005-7-134) dated 21 Jul 83

D. AC/225 (Panel III) D/14 (Revised)

BACKGROUND

1. Reference B states a requirement to equip the Australian Defence Force with new small arms. This range of weapons includes an individual weapon (IW) of 5.56 mm, with a 1 in 7 twist of rifling, capable of firing an SS109 type ammunition. The IW is to replace the 7.62 mm L1A1 and 5.56 mm M16A1 rifles. A variant of the IW will replace the 9 mm F1 SMG and some 9 mm pistols.

2. DTRIALS was requested by Army Office to conduct a Defence Trial to evaluate the contender IW as part of the Small Arms Replacement Project

(SARP). Army Office gave approval for EDE to participate as the engineering evaluation trials agency. This requirement was specified in Defence Trials Directive 8/513 dated 11 May 1984.

3. Australia had not been privy to the original NATO small arms trials or able to obtain detailed information due to the Commercial in Confidence implications. Because of this, and also because one of the IW contenders had not originally been available for those earlier trials, it was clear that EDE would have to cover all the main features and requirements laid down in the NATO Evaluation Procedures, D/14, to achieve sufficient information to make a critical judgement.

4. The size of the task placed on EDE required the recruiting and training of suitable staff, both civilian and military, the acquisition of considerable specialized test equipment. This included video and computer equipment and the design and manufacture of adverse condition equipment, and purchase of hot and cold chamber installations. It also required the equipping of the Williamstown Range with suitable hardstandings at ranges out to 600 metres for the installation of the Projectile Locating System developed by EDE in conjunction with Australasian Training Aids, and the provision of generators and mobility equipment for use with this on the range.

5. These preparations involved financial and other lengthy problems. Although these were eventually overcome by everyone's efforts, they delayed both the commencement of the trial and its completion. In spite of this, the twelve months that the evaluation took equates very favourably both in time and detailed information obtained with the original NATO trials.

AIM

6. To present the results of the engineering evaluation by EDE of the IW contenders in accordance with the objectives of Defence Trials Directive 8/513 (Ref A).

7. The objectives of the evaluation were to:

a. Evaluate and compare the performance of the contending IW against the relevant requirements of ASR 48.8 (Ref B).

b. Determine the order of merit for the IW contenders.

c. Identify and provide cost estimates of any modifications required to make the weapons suitable for introduction into service.

d. Conduct additional tests associated with defective items as required by DTRIALS during the trial.

8. The engineering trials were to be conducted, as far as possible, using the procedures outlined in D/14 (Ref D).

DISCUSSION

9. From the contender weapons submitted, two systems were selected as most likely to satisfy the ASR in respect of performance, reliability, maintainability, manufacture, and the minimum of technical risks involved. The two systems tested were:

a. The Colt, Rifle, 5.56 mm M16A2, (1/7 twist).

b. The Steyr, Assault Rifle, AUG A1 5.56 mm, (1/7 twist).

10. Five weapons of each system were subjected to the engineering tests, three used for the endurance firing and two for the adverse conditions. It is appreciated that this is a small sample statistically, but in the event the results achieved were consistent for each system. The exceptions were; one Colt went to a barrel accuracy life of 6,000 rounds compared with approximately 5,000 rounds achieved by the other two and one Steyr went 10,000 rounds trouble free in all respects. The general trends with both weapons however, were consistent. The adverse condition tests, because of their character, tend to be very clear cut in results, and there is no doubt that the results achieved are an accurate and fair comparison of the weapon systems. The results achieved showed no great discrepancy from those we have been able to obtain from overseas, particularly under adverse conditions.

11. All of the tests conducted were recorded on video, as were all the shots fired during the endurance firing. This proved a considerable asset in identifying causes and effects of stoppages and failures. It also clarified ergonomic problems during endurance firing, showing clearly the ability of the firer to retain his aim with the Steyr, whereas he tended to lose his aim with the Colt due to the recoil effect and the handguard temperature during heating cycles.

12. The Projectile Locating System (PLS), proved invaluable both in time saving and accurate recording. It eliminates all manual recording, and automatically records all shots fired either for accuracy diagrams, jump or other requirements in numbered sequence. It shows these results as a visual display, as well as calculating all the data required, ie, velocity, displacement of shots, standard deviations, mpi, and energy at all ranges required between the muzzle and the target.

13. The apparatus achieves this information from the bullet shock wave through transducers mounted on special frames that can be placed at any location under the bullet trajectory. These signals are transmitted by underground cable to the firing point where a mobile laboratory vehicle,

housing the computer system, immediately analyses them and prints out the results or stores them for printing at the end of the day.

14. One advantage of this system that has not been available before is that if an automatic burst is fired, of say twenty rounds, the visual diagram numbers the shots in sequence and therefore establishes the pattern produced by automatic fire from a particular weapon. This enables the characteristics of barrel vibrations, weapon oscillations, spring and buffer effects to be considered.

15. One of the chief causes of delay during the endurance firing was the weather, in particular the maximum velocity limit of a cross wind that could be accepted. Bearing in mind that each endurance cycle was of one thousand rounds (these were fired against a metronome timer to the firer's ear) between cold and hot diagrams, it was essential the condition for the cold diagrams at the commencement, and hot diagrams at the end of the cycle, were similar. In addition, each weapon had to be cooled after the hot diagrams and the cold diagrams repeated, requiring a total period of one hour under similar conditions.

16. To achieve reasonable progress it was necessary to accept a maximum cross wind velocity of 3 m/s. Anemometers were placed down range, and wind velocity recorded in a command caravan and passed to the PLS computer for each diagram. By this method the effect of a cross wind in relation to the accuracy recorded could be identified.

17. The endurance range is situated about 15 km from EDE. This meant that at the end of each firing day, when one weapon of each system would have been fired to achieve similar firing conditions, they were returned to EDE where they were critically examined. All bore dimensions were measured and recorded for input to the computer, bores photographed and decoppered, and weapons cleaned and prepared for the next cycle 48 hours later.

18. The adverse conditions testing took place at EDE on the 25 metre range. This meant that the two major testing activities, endurance and adverse conditions, could be carried out simultaneously. The adverse conditions team also had the full backup of the EDE Mechanical Laboratories, who carried out the mechanical rough handling of the weapons in accordance with D/14 (Ref D), to ascertain how they stood up to various stress conditions. They also carried out all spring and crack testing. In addition, the EDE photographic section was able to provide highspeed cine and other facilities on location.

19. The main lesson from the conduct of the Engineering Trial was the length of time required to carry it out. EDE had stressed in a preliminary study (A400) carried out in 1970 and a subsequent advisory study before the commencement of this trial, that because of the critical work involved in an engineering trial and the specific detail required from the various

tests and instrumentation, that twelve months was the minimum time required for completion.

20. EDE was however requested to complete the task in 6 months, and although an interim report was produced in this time, the total time taken, which included certain additional tests required by Army, was twelve months. This equates very favourably with the duration of overseas trials of this magnitude, considering that in the case of EDE, many of the facilities had to be developed.

METHOD

21. The Engineering Evaluation trials were conducted in accordance with the EDE Evaluation Trials Programme shown in Annex A of Part 2 of this report. In addition, an engineering appraisal of the contending weapons has been carried out and is included in this part of the report.

22. The trials programme was carried out by three separate trials teams as follows:

a. An endurance trial team to conduct the endurance evaluation at Williamstown Rifle Range, supported by personnel from the Mechanical Laboratories to operate the PLS and related computer equipment. This team was self contained and kept all the computer printouts of accuracy results, firing logs and incident reports which were consolidated into the EDE Weapons Section computer and weapon log books on their non firing day each week. This team also included an Army video camera operator and photographer who recorded and logged all firings and incidents, and maintained a video library at EDE. Two full time Army Reserve soldiers carried out all the firings, the day to day trial preparation of the weapons, and examinations on the range. They also recorded all temperatures with a portable thermocouple during all stages of firing.

b. An adverse conditions trial team, which was responsible for all adverse conditions equipment design and preparation in accordance with D/14 (Ref D). It carried out all firings and record keeping for this portion of the trial. It was supported by the EDE Photographic Section, who took high speed cine, video and still photography. Mechanical Laboratories assisted with the provision of personnel for the recording of velocities, rate of fire and maintenance of the various climatic chambers.

c. A small team responsible for both supervising and carrying out certain specific tests such as grenade firing, recoil, noise, flash and drop tests and supervision of the mechanical stress tests carried out by Mechanical Laboratories.

23. Overall supervision and support was provided as follows:

a. The whole trial was supervised and coordinated by the EDE SARP Project Officer supported by a Technical Officer.

b. A Small Arms coordination Engineer was responsible for resolving the day to day problems occurring from the tests, the backup and repair of test equipment and instrumentation, and the supervision of results being fed into the computer.

c. A Metrology Section was formed and equipped with the necessary instrumentation including sophisticated bore measuring gauges and optical barrel viewing and video equipment. This Section received all the weapons after each particular firing cycle for critical examination, maintenance of log books and recording of all barrel and gauge measurements. This Section was supervised by a specialist RAEME Warrant Officer.

d. A preparation and cleaning room was established to which all weapons went after examination to prepare them for the next firing cycles. This was manned by full time Army Reserve personnel and supervised by a RAEME Warrant Officer.

ENGINEERING APPRAISAL

24. A critique of the basic design features of the two contender IW is given to present an overall comparison as follows.

COLT M16A2

25. The COLT M16A2 uses a unique closed gas system whereby the propellant gases are taken from the barrel gas port via a tube directly to the bolt carrier which has a mating spigot. This is sometimes referred to as the LJUNGMAN system.

26. The bolt carrier provides the chamber and cylinder in which the bolt head operates as a piston. The bolt is caused to rotate by means of a cam stud moving in a cam groove of the carrier to provide locking and unlocking. The bolt is unlocked by the expanding propellant gases driving the carrier rearwards and locked by the return spring driving it forward.

27. The carrier is provided with gas exhaust holes in the direction of the ejection opening for spent gas when the bolt is unlocked. These exhaust holes sometimes throw debris in the firer's face.

28. This system reduces the mass and movement of the working parts and moves their location closer to the firer's shoulder, and hence the centre of gravity of the weapon further rearwards.

29. This system has three main disadvantages as follows:

a. It has no gas adjustment for adverse conditions.

b. It requires at least base workshop repair to change barrels.

c. It requires special manufacturing techniques and testing during assembly, since once assembled no gas adjustment is possible. This affects both durability and maintainability requirements. It probably makes the weapon a throw away system based on barrel accuracy life limits.

d. The system is difficult to keep clean, and satisfactory performance depends on frequent cleaning.

30. These factors contribute to the poor adverse condition performance of the weapon and necessitate the use of a cleaning rod to extract any spent case stuck in the chamber.

STEYR AUG

31. The STEYR AUG configuration is sometimes called a "Bull Pup" design because of its snub nose appearance as opposed to more conventional designs. It is a short stroke, gas operated system with a straight through reaction of the barrel with the firer's shoulder. The centre of gravity, magazine and breech opening, trigger mechanism, firing mechanism and main working part masses are behind the pistol grip in the butt stock. This ensures minimum displacement of the weapon during firing and the maximum stability and control at automatic fire.

32. Because of this basic design (first seen in the UK EM2, 0.280 in experimental rifle), the line of sight is high relative to the barrel, and because of the rearward location of the barrel, the possible sight base for an iron sight would be too short for accurate longer range firing. This is overcome in the Steyr as it was in the EM2 by using a low magnification optical sight, providing an infinite sight base and a wide field of view.

33. The STEYR AUG which is shown at Fig 1 has a number of unique and original design features as follows:

a. Plastic materials are used for most of the trigger and firing mechanism components. These components include the sear, bents, hammer, automatic firing lever, disconnector lever and drop safety, and are all self contained in a plastic frame, only the springs and axis pins are of metal. The frame slides into a plastic recess in the butt stock which locates the axis pins. The butt stock is also of plastic and does not act as a load bearing component for the moving parts of the breech mechanism.

b. The moving parts are attached to twin rods passing through a central housing which is also the load carrying receiver. This is manufactured from an aluminium casting, providing an integral carrying handle and housing for the optical sight. All the functional components, working parts, barrel and gas piston, operating rods and furniture mate into this central component. This design provides a simple assembly, which permits control of tolerances and symmetry without complicated machinery and production.

c. One of the most interesting design features of the housing body is that it contains a common steel sleeve for the interlocking of the barrel and breech block on a single common axis. This permits not only simple manufacture but also assembly and disassembly in seconds of the working parts and the barrel.

d. Because of these features, and the control of tolerances, the standard optical sight complete with the housing body may be exchanged for an alternative but identically fitting body. This body may be fitted with alternative telescopes or night aiming devices without any loss of zero. Similarly, these features allow rapid conversion of the weapon to other variants with different barrel lengths.

e. The Steyr chamber design is also unique in that it is relieved for a short distance near the base of the case in the area where extraction resistance or 'stiction' between case and chamber are greatest. This reduces the high extraction loads which are a feature of the 5.56 mm cartridge case, and is an advantage particularly under adverse conditions. Due to this feature, fired cases from the Steyr have the characteristic of a slight bulge near the base.

f. The Steyr method of cold swaging the barrel has not only permitted them to incorporate the modified chamber design on the mandrel, but also to produce a tapered bore towards the muzzle, having three distinct changes of diameter. This undoubtedly increases the barrel accuracy life dramatically and the manufacturer's claim of 20,000 rounds may well be accurate.

g. The carrier operating rods contain the return springs for the working parts and are pre-lubricated and sealed in position during manufacture. The springs are operated by plunger rods attached to the back of the plastic butt stock. Because this system is self lubricated it was found important not to add any additional lubrication to the weapon, except on the cam lug. Otherwise the rate of fire increases and the performance and stability of the weapon deteriorates and the ejection path becomes erratic. This of course is another reason why it performs so well in sand and dust, which are not picked up by any exposed lubricants.

34. EDE considers that it was these many unique and excellent design features of the Steyr system that were fundamental to its excellent performance during the evaluation trials.

RESULTS

35. A summary of results against the ASR and order of merit is attached at Annex A to this part of the report.

36. Detailed trial results are contained in Parts 2 to 4 inclusive.

37. A brief summary of the important factors arising out of the Engineering Evaluation is as follows:

a. Endurance and Accuracy Trial

Barrel accuracy life of the Colt did not meet the 10,000 rounds criteria of the ASR. The durability requirement was not met by the Colt; the barrel could not be exchanged in the prescribed 30 minutes. The handguard of the Colt was too hot to hold during the endurance cycles resulting in poor stability and accuracy. The Steyr satisfied all these requirements and the stability and accuracy during the endurance firing at 300 metres was markedly superior to the Colt, particularly at automatic fire. The latter feature was particularly evident from video records of the firings.

b. Adverse Conditions Tests

The tests were conducted in accordance with D/14 (Ref D) requirements. The Colt failed the majority of the tests and only passed Tank No 1 of the Mud Test. The Steyr passed all the adverse tests and Tank No 3 of the Mud Test. It performed significantly better than the Colt and due to its plastic components was less affected by corrosion and salt.

c. Grenade Firing

Both weapons fired the bullet trap grenades satisfactorily. The M203 grenade launcher can be satisfactorily used with both weapons, but the Steyr mounting requires use of an alternative heavy barrel.

d. Engineering Comments

(1) The design features incorporated in the Steyr from a point of view of simplicity, durability, handling, stripping and maintenance were considered excellent, and all contributed to the outstanding performance, particularly under adverse conditions.

(2) The design features incorporated in the Colt, whilst eliminating disturbance of the aim during firing by eliminating moving parts, undoubtedly reduced its performance under adverse conditions. It was a reliable weapon up to 6000 rounds. Many of its design features make it a difficult weapon to manufacture and to maintain.

e. General Comment Trial Staff

Without exception, including the soldier firers, all preferred the Steyr in terms of shooting, performance, cleaning, maintenance and handling.

CONCLUSION

38. From the results of the Engineering Evaluation, EDE has no hesitation in stating the Steyr is the significantly better weapon of the IW contenders, in terms of satisfying the engineering aspects of ASR 48.8, and is considered suitable for introduction into service without any modifications.

RECOMMENDATIONS

39. EDE recommends the adoption of the Steyr AUG A1 as most likely to satisfy the requirements of ASR 48.8 from an engineering point of view.

ANNEX A: COMPARISON OF RESULTS - FINAL REPORT.

ANNEX A TO
PART ONE TO
EDE 17/85

ENGINEERING DEVELOPMENT ESTABLISHMENT

ENGINEERING EVALUATION OF INDIVIDUAL WEAPONS

COMPARISON OF RESULTS - FINAL REPORT

SUMMARY OF ABBREVIATIONS

ASR	-	Army Staff Requirement No 48.8
D-14	-	Evaluation Procedures for Future NATO Small Arms Weapons Systems
TD	-	Trials Directive 8/513 from DTRIALS
MRBS	-	Mean Rounds Between Stoppages
FBR	-	Failure of Bolt to Remain at Rear When Magazine Empty
FF	-	Failure to Feed
QSTAG	-	Quadripartite Standardization Treaty Agreement
FJ	-	Failure to Eject
MRBF	-	Mean Rounds Between Failures
LSW	-	Light Support Weapon
IW	-	Individual Weapon
BSO	-	Broad Side On
SLR	-	Self Loading Rifle
AP	-	Armour Piercing
FX	-	Failure to Extract
BFA	-	Blank Firing Attachment
FBC	-	Failure of Bolt to Close
OT	-	Other Type, eg, Light Strike
DF	-	Double Field
BOB	-	Bolt over Base
FML	-	Failure of Magazine to Lock

Serial No (a)	Evaluation Test (b)	Requirement Para No ASR (c)	D-14 (d)	TD (e)	Results STEYR (f)	COLT (g)	Remarks (h)	Order of Merit (i)	(j)
1	Reliability								
a.	MRBS	B17b	2.7	9	Passed 2193	Passed 1858	a. Minimum MRBS in ASR is 1800. Figures quoted in Colums (f) and (g) refer to Weapon Engendered Stoppages only. b. Magazine Stoppages were: (1) STEYR 24 (of which 9 were FBR) (2) COLT 17 (of which 16 were FBR)	STEYR	COLT
b.	Adverse Conditions								
(1)	Drag Sand	B15	2.18.5	12	Passed	Failed	COLT failed with both plastic and metal magazines. Plastic magazines could be removed only with considerable difficulty.	STEYR	
(2)	Mud Test	B15	2.18.6	12	Passed TANKS 1, 2, 3	Passed TANK 1 only	Because it commences with TANK 6, D14 implies TANK 6 should be passed. If it is not passed test commences at TANK 1. The L1A1 only passed TANKS 1 and 2, so STEYR was the best performer.	STEYR	COLT
(3)	Static Sand	B15	2.18.4	12	Passed	Passed	COLT used plastic magazines only. From here onwards as instructed from PDSARP.	EQUAL	
(4)	Dynamic Sand	B15	2.18.4	12	Passed	Passed		EQUAL	
(5)	Water Spray	B15	2.18.2	12	Passed	Failed	COLT FF.	STEYR	
(6)	Freezing - 46°C	B15	2.14.1	12	Passed	Failed	COLT FF; Unrealistic for Australian Conditions but not for QSTAG 360 requirements.	STEYR	
(7)	Hot Dry, 52°C	B15	2.14.2	12	Passed	Failed	COLT FX 26 times also (2) FJ, (1) FF.	STEYR	
(8)	Salt Water/Humid	B15	2.18.3	12	Passed	Failed	COLT Bolt mechanism jammed solid and cannot be stripped.	STEYR	
(9)	Toxicity	B15	2.13.2	12	Passed	Passed	CO - 0.06% by volume.	EQUAL	
c.	MRBF	B17a	2.7	9	Passed (1 in 10234)	Failed (1 in 3075)	Minimum MRBF in ASR is 4500. STEYR had no failures until 8387 rounds, ie in excess of COLT Effective Accuracy Life. Some failures did not cause a stoppage eg broken firing pin.	STEYR	

Serial No (a)	Evaluation Test (b)	Requirement Para No ASR (c)	D-14 (d)	TD (e)	Results STEYR (f)	COLT (g)	Remarks (h)	Order of Merit 1 (i)	2 (j)
2	Performance	Glossary							
a.	Accuracy	5a	2.4	8					
(1)	400 m Effective 0.95 Probability of hit on a Torso Target, 460 mm x 1120 mm	B11			Passed Average weapon rounds of 10,200	Failed	All COLTS failed the ASR hit probability. Two after 5000 rounds, one after 6000.	STEYR	
(2)	600 m Neutralization 0.95 Probability of hitting a target 3 m in diameter with at least one round in four.		2.4	8	Passed	Passed	STEYR accuracy remained consistent with original accuracy figure well inside requirements for neutralization at 600 m. This consistency continued in excess of 10000 rounds, was still satisfactory at end of trial. The COLT also satisfied this requirement. STEYR basic system was entirely satisfactory at 400/600 m but using the optical sight fitted, the degree of aiming off at 600 m is considered impractical. After discussion with DTRIALS EDE used the alternative STEYR x 4 Telescopic Sight with 3-5-7 hundred metre graticules, which proved entirely satisfactory for establishing the STEYR accuracy at 600 m.	STEYR	COLT
b.	Barrel Wear/ Accuracy	B19	2.8	13	Passed >10000 rounds	Failed	The Barrel effective Accuracy Life for the required performance for 10000 rounds is not met by the COLTS.	STEYR	
c.	Weapon Performance								
(1)	Cook-Off Temperature	B12	2.19	9	Cook-off 206 rounds after 26 seconds	Cook-off 175 rounds after 68 seconds	TEST: 90 RPM at 25.4°C STEYR / COLT No 'Cook-off' 202 rounds / 172 rounds 'Cook-off' 206 rounds / 176 rounds	STEYR	COLT
3	Handling	B12	2.2.3	3	Passed	Failed	The handguard temperature on the COLT during both the performance and endurance cycle exceeded 50°C; a temperature at which is not possible for the firer to handle and fire accurately.	STEYR	

Serial No	Evaluation Test	Requirement Para No			Results		Remarks	Order of Merit	
		ASR	D-14	TD	STEYR	COLT		1	2
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
4	Sighting	B13	2.24	10					
a.	Iron Battle Sight	a			Passed	Passed	STEYR: Uses an Optical Sight and includes Night Iron Battle Sights. A Telescopic Sight may be fitted to the COLT but requires zeroing.	EQUAL	
b.	Telescopic Sight	b	2.24	10	Passed	Failed	STEYR: Has interchangeable 'Receiver Integral' with alternative sight mounting and sight which do not need to be rezeroed when exchanged. The COLT requires rezeroing and a coin to carry this out.	STEYR	
c.	Range	c	2.24	10	Passed	Passed	COLT is adjustable for all ranges to 600 m. STEYR has x 1.5 Optical Sight zeroed for 300 m and engages alternative Ranges by an aiming off technique. STEYR supply a 1 x 4 Power Scope with 3-5-7 Hundred Metre Graticule which is more consistent for ranges beyond 400 m than the optical single Graticule solution unless zeroed for longer ranges.	EQUAL	
d.	Zeroing	d	2.2	10	Passed	Passed		EQUAL	
e.	Vision	e	2.24	10	Passed	Passed	COLT foresight too thick, and obliterates target at longer ranges. STEYR permits wide field of view with two eyes.	STEYR	COLT
f.	Low Profile Position	f	2.2	10	Passed	Passed	Both weapons have straight through reaction barrel and actions. This means the line of sight is higher than normal, but acceptable.	EQUAL	
g.	Robustness	g	2.24	10	Passed	Passed	Tested as part of mechanical stresses. During endurance firing, COLT index rearsight screw fell out on several occasions presenting range adjustment.	STEYR	COLT
h.	Low Light	h	2.24	10	Passed	Failed	STEYR has luminous paint source on iron battle sight.	STEYR	
i.	Range Settings	i	2.24	10	Failed	Passed	STEYR has optical sight with 300 m zero with a reticle which permits correct aim adjustment by observation from 100 to 500 m. A 1 x 4 scope with range adjustment is also available for up to 700 m.	COLT	
j.	Need of Special Tools	j	2.24	10	Passed	Passed	No need for Special Tools.	EQUAL	

Serial No	Evaluation Test	Requirement Para No			Results		Remarks	Order of Merit	
		ASR	D-14	TD	STEYR	COLT		1	2
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
k.	Passive Night Sights	k	2.24	10	Passed	Failed	Believe Passive Sight being considered for COLT, but on present information it would require rezeroing. STEYR available with exchange of body housing which does not require rezero.	STEYR	
l.	Iron Sights when Telescopic used	l	2.24	10	Passed	Passed	Available on both weapons.		EQUAL
5	Safety	B14	2.15	11					
a.	Integral Safety	a			Passed	Passed	STEYR includes an additional mechanical safety sear to prevent accidental operation of trigger when cocked, but not on Safe, this is a drop safety device locking the sear.	STEYR	COLT
b.	Operation of Safety Catch	b	2.15	11	Passed	Passed	COLT requires the operator to relocate his hand to operate the safety or change lever. This is accentuated for a left handed firer.	STEYR	COLT
c.	Ejection Pattern	c	2.15	11	Passed	Passed	Both Weapons eject between 90° and forward. COLT ejection pattern is more consistent.	COLT	STEYR
6	Operating Conditions	B15		12					
a.	Climatic Extremes	a	2.12				Adverse conditions (See Serial 1(b)) of this Annex.		
b.	Adverse Conditions	b	2.12						
c.	Mechanical Stresses during Transit	c	2.15				After vibration, jolting and bouncing tests both systems operated without any detrimental effects. No damage to either weapons.		EQUAL
d.	Wear/Corrosion	d			Passed	Failed	COLT failed both Barrel Accuracy Life (Serial 2b) and Salt Water test (Serial 1.b(8)).	STEYR	
e.	Choice of Materials	e					STEYR - Plastic components include trigger and firing mechanism which showed no signs of wear after the endurance test. They behaved well under adverse conditions, in particular salt water and tropical rain. EDE experienced no problems with the strengths of either the plastic furniture or plastic magazines when tested in accordance with D14. COLT plastic handguard traps barrel heat (too hot to hold during endurance cycles, 50°C). Barrels failed durability during endurance test.		EQUAL

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Serial No (a)	Evaluation Test (b)	Requirement Para No ASR (c)	D-14 (d)	TD (e)	Results STEYR (f)	COLT (g)	Remarks (h)	Order of Merit 1 (i)	2 (j)
7	Battlefield Mission	B16	2.7	13	Passed in excess of 10,000 RDS	Passed 5000 rounds	The three COLT weapons failed the 10000 round durability requirement due to barrel wear, and loss of accuracy.	STEYR	COLT
8	Maintainability	B18	2.7	13	Passed	Failed	COLT barrel cannot be replaced in 30 minutes. COLT barrel maximum service life is approximately 5000 rounds.	STEYR	
9	Durability	B19	2.7	13	Passed	Failed	The COLT barrels reach unacceptable accuracy criteria from 5000 rounds when dispersion doubles, and BSO's occur. The barrel cannot be exchanged in the field or within 30 mins. STEYR accuracy/consistency is as good at 10000 rounds as at commencement of trial.	STEYR	
10	Signature	B20	2.12	14	Satisfactory	Satisfactory	The ASR requires that the flash shall not be greater than the SLR. Both COLT and STEYR were greater, the STEYR being the brighter. From a practical point of view both were considered acceptable.	COLT	STEYR
a.	Flash								
b.	Smoke	B20	2.12	14	Passed	Passed	Both weapons were visible but it is a very subjective test to distinguish from the SLR. Neither weapon has an underside flash eliminator slot, this reduces dust being produced by the propellant gases.	EQUAL	
11	Left and Right Handed Firing	B5a 7	2.2.3	1	Passed	Passed	COLT inherent characteristic, by case deflector. R/H ejection only. The deflector is cast in the body and limits the rearward ejection path over an acute angle. No conversion is necessary. STEYR L/H ejection is available by converting to L/H bolt, and closing R/H ejection port. L/H ejection path similar to R/H ejection. It is necessary to strip the weapon and assemble alternative components for conversion. A L/H shooter cannot fire weapon safely unless converted due to the ejection path of the Bull Pup design.	COLT	STEYR

Serial No	Evaluation Test	Requirement Para No			Results		Remarks	Order of Merit	
		ASH	D-14	TD	STEYR	COLT		1	2
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
12	Bayonet Fitting and Firing	B5a 8-9	2.17	2	Passed	Passed	COLT bayonet is fitted with one hand and positively locked into position. The COLT MPI is raised with the bayonet fitted at 100 m and the accuracy performance decreased. STEYR bayonet is fitted easily with one hand, although the catch must be depressed, when it is positively locked into position. Neither the accuracy performance of the STEYR or the MPI is affected with the bayonet fitted.	STEYR	COLT
13	Rate and Mode of Fire	B6	2.2.3	4	Passed	Passed	Both Weapons feature single shot and automatic fire. The COLT 3 round burst limiter is standard on the variants but not on the trial weapons and was considered unsatisfactory as it could not fire a 3 round burst at will.	EQUAL	
14	Ammunition Feed	B7	2.2.3	5	Passed	Passed	COLT Magazines are loaded with a magazine filler from 10 round clip. Magazines are available in 20 and 30 round types, the 30 round being standard issue and compatible with LSW. Metal Magazines proved unsatisfactory and Thermold plastic magazines were used. STEYR Magazines are unable to be loaded from the NATO Standard filler, but a factory packed magazine filler does exist. There is no 20 round magazine; the 30 round magazine being standard and a 40 round magazine is available. The STEYR Magazine is not interchangeable with the M16A1 Magazine.	EQUAL	
15	Ammunition Type	B8	2.2.3	6	Passed	Passed	Both systems are optimized for firing SS109 ammunition with a 1 in 7 twist rifling. They are capable of firing both training and blank M200 ammunition by fitting a BFA. The STEYR requires a modified BFA orifice to fire FN STAR blank which is satisfactory in the COLT.	EQUAL	
16	Grenade Launching	B9	2.25	7	Passed	Passed	Both systems fired both the bullet trap grenades and with the M203 attachments satisfactorily. The recoil with the bullet trap grenades was approximately 50 Joules which is considered very high for shoulder firing. Both systems could be fired with the butt under the armpit or from the waist standing kneeling or lying.	EQUAL	

Serial No (a)	Evaluation Test (b)	Requirement Para No ASR (c)	Requirement Para No D-14 (d)	Requirement Para No TD (e)	Results STEYR (f)	Results COLT (g)	Remarks (h)	Order of Merit 1 (i)	Order of Merit 2 (j)
17	Drop Test	15	2.20.3	12	Passed	Passed	The Magazine catch on in STEYR broke at the lip when the weapon was dropped vertically, muzzle down with a full magazine. The weapon was functioned after the test and was able to be fired by holding the magazine in position. No other damage occurred with either system. The catch is easily replaced.	COLT	STEYR
18	Barrel Obstruction	15	2.15.3	11	Satisfactory	Satisfactory	1. BULLET AT GAS PORT With an obstruction at the gas port, both systems suffered bulged barrels. The weapons were still serviceable after the test and no harm would have been caused to the firer.	EQUAL	
					Satisfactory	Satisfactory	2. WATER OBSTRUCTION (10 ml) With 10 ml of water injected into the barrels, both systems suffered bulged barrels. No other damage was incurred and the weapons were still serviceable. No harm occurred to the firer.	EQUAL	
					Failed	Failed	3. BULLET IN LEAD Both systems were substantially damaged. The damaged areas included the receivers, the magazines and the butt stocks. It is considered that with both weapons, the firer may have been injured.	BOTH FAILED	
19	Bipod	5b (2)	2.17	3	Passed	Passed	Both systems offer a fold-away detachable bipod. The STEYR has an inbuilt wire cutting device.	EQUAL	
20	NBC ASR 54.1	5a (6)					Test performed by MRL, separate report issued.		
21	Sling Points	5b (3)	2.2.3	3	Passed	Passed	Each system has slings available. On both systems, the front sling points are fixed. The rear points are hinged.	EQUAL	
22	Storage, Package and Delivery	21	2.2.1		Passed	Unsatisfactory	The STEYR packaging as received by EDE was far superior to the COLT packaging. The STEYRS were secured in place by individual cradles in a sturdy case. The COLTS arrived in a simple transit box without fittings.	STEYR	COLT

Serial No (a)	Evaluation Test (b)	Requirement Para No ASR (c)	Requirement Para No D-14 (d)	Requirement Para No TD (e)	Results STEYR (f)	Results COLT (g)	Remarks (h)			Order of Merit 1 (i)	Order of Merit 2 (j)
23	Training Aids	24	2.2.3		Passed	Passed	ASR PARA	STEYR	COLT	STEYR	COLT
							a	Yes	Very Limited		
							b	Yes	No		
							c	Yes	No		
							d	No	No		
							e	Yes	Yes		
							f	Yes*	Yes		
							g	No	No		
							* Different STEYR BFA for both M200 and FN STAR blank ammunition.				
24	Cleaning Kit	29	2.2.3		Passed	Passed	Both systems have satisfactory cleaning kits which are located in the butt.			EQUAL	
25	Publications	25			Excellent	Limited	ASR PARA	STEYR	COLT	STEYR	COLT
							25 a	Yes Very detailed	Yes but minimal		
							b	As above	As above		
							c	As above	As above		
26	Priorities	29			See remarks		ASR PARA	STEYR	COLT	STEYR	COLT
							29 a	Pass	Pass		
							b	Pass	Pass		
							c	Pass	Fail		
							d	Pass	Pass		
							e	Pass	Fail		

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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.

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