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## Comparative Assessment of the ADF In-Service Combat Boot with boots used by Allied Forces

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16 March 2008

### Abstract

In order to ascertain the relative performance, the ADF in-service combat boot ("Terra") was compared with other similar combat boots which are commercially available for purchase and used by allied forces US and New Zealand. The boots used in the comparison with the Terra combat boot are made by Crossfire, This comparison was based on a test and evaluation program that included laboratory testing, a fit assessment, and biomechanical and ergonomic trials. Test and analysis results of each combat boot were evaluated against functional characteristic definitions to determine the overall performance of each boot.

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## Executive Summary

1. The ADF in-service combat boot ("Terra") was compared with similar combat boots used by allied forces US and New Zealand

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other boots used in this comparison were

Along with the Terra, the

Crossfire,

This comparative assessment, which was based on a test and evaluation program that included laboratory testing, a fit assessment and biomechanical and ergonomic trials was conducted

during the period

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January 2008 to March 2008.

2. Laboratory testing was conducted at accredited specialist footwear laboratories, LASRA and SATRA located in New Zealand and the United Kingdom respectively. Podiatrists and footwear specialists did the technical evaluation activities. The test and analysis results of each combat boot was evaluated against the definitions for the functional characteristics

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## Section 1

### Introduction

5. Booz Allen Hamilton Pty Ltd (BAH) conducted an independent assessment of the ADF in-service combat boot ("Terra") in 2007. An outcome from this assessment was the need to evaluate the Terra combat boot against similar combat boots in use by allied forces and available for purchase in the market. conducted this combat boot comparative assessment over the period January to March 2008 and the findings along with the results are presented in this report.

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### Background

6. The 'ADF Clothing Review 2006' recommended an independent review of the ADF in-service combat boot. Through a DMOSS tender, BAH was selected to undertake this assessment and the assessment team consisted of subject matter experts including footwear specialists and podiatrists. The BAH independent assessment was undertaken based on the following main elements:

- a. Assessment of boot design, materials and construction,
- b. Laboratory Testing,
- c. Foot measure assessment,
- d. Biomechanical Trials,
- e. On-line user survey,
- f. Written submissions from stakeholders including users and footwear manufacturers, and
- g. On-site fitment survey and ergonomics trial at four ADF locations.

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8. Furthermore, as part of the independent assessment BAH defined “functional characteristics” required for a combat boot to determine if it is fit-for-function. These functional characteristics are separate to the ADF combat boot user requirements and specifications which are used to ensure the combat boot is fit-for-purpose in accordance with the Technical Regulation of Army Materiel Manual (TRAMM).

#### **Purpose and Objective**

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## Section 2

### Assessment Methodology

#### Combat Boot Selection

10. The combat boots for the comparative assessment were selected based on the following criteria:

- a. The boot was a \_\_\_\_\_ combat boot that is designed for a similar role to the Terra combat boot. 540
- b. The boot was available in a brown/tan/khaki colour to meet the requirements of the normal footwear for all Army ranks in combat. Black leather boots are considered to be parade boots and were not included in this assessment; and
- c. The boot was a current in-service \_\_\_\_\_ combat boot used by allied forces; or
- d. The boot was a \_\_\_\_\_ combat boot identified as an alternative to the Terra combat boot by Australian troops; or
- e. The boot was a \_\_\_\_\_ combat boot issued by DMO as an alternative to the Terra combat boot.

11. This selection criterion was considered to be the most suitable for the majority of combat soldiers in the Australian Army. However, it is noted that Special Operations have a requirement to use boots that do not meet this criteria. These boots were not included in this assessment for the following reasons:

- a. The aim of the assessment was not to compare the operation of combat boots against \_\_\_\_\_, tactical and hiking boots. This would have limited gain because the differences between these boot types is already well known; and 540
- b. These boots could not be properly evaluated as part of this assessment which was designed for evaluating \_\_\_\_\_ combat boots. For assessing tactical and hiking boots a different test methodology is required.



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12. Research and investigation was conducted in order to determine the current in-service combat boots used by the allied forces namely, US, UK, Canada and New Zealand. This search revealed a number of combat boots in use by the US Army, US Marines, UK and New Zealand Armies. From these a range of different boot models were selected and short-listed based on those that satisfied the boot selection criteria. Table 1 below shows the boots selected for this assessment.

**Table 1: Combat Boots selected for the comparative assessment.**

Serial	Make	Model	Remarks
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	Crossfire	Peacekeeper Plus	
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### Test and Evaluation Methodology

15. The comparative assessment comprised of qualitative and quantitative assessment activities to enable the evaluation of combat boots against the functional characteristics

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This assessment consisted of laboratory testing, biomechanical and ergonomic trials, and technical evaluation activities conducted by podiatrists and footwear specialists which are explained below. The test program is given in Annex B.

- a. *Assessment of Design, Materials and Construction.* Essential Footwear International (EFI) conducted a qualitative assessment of the design, materials and construction features of each boot. This assessment was conducted to identify any major technical issues with the boots and aid with evaluation of each boot against the functional characteristics. The EFI assessment results are contained at Annex C.
- b. *Fit Assessment.* This quantitative assessment was undertaken by EFI to determine the relative percentage fit that could be achieved by each boot.

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- c. *Laboratory Testing.* This quantitative testing was performed by specialist footwear laboratories, namely the Leather and Shoe Research Association (LASRA) located in New Zealand and SATRA Technology Centre in the United Kingdom. The LASRA testing consisted of a combination of standard and non-standard tests derived from current industry standards for safety and protective footwear. Where applicable, testing was conducted against Australian Standards, followed by approved LASRA test instructions and finally conducting non-standard tests. A range of laboratory tests were



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selected to test all combat boots that included tests as simple as weight measurements and as complex as the latest 'Advanced Moisture Management' (AMM) test conducted by SATRA. The AMM test was conducted to assess aspects of Comfort, Health & Hygiene and Environmental Protection of the boots. Further details on these laboratory tests are included at Annex B. The LASRA test results are contained at Annex D and the SATRA test results at Annex E.

- d. **Biomechanical Testing.** This quantitative testing was conducted by to provide empirical data relating to Comfort and Support characteristics of the combat boots. Measurements of the forefoot and rearfoot loads, peak forefoot pressure, and forefoot flexion of soldiers were recorded for both loaded (with standard issue pack, webbing and helmet) and unloaded conditions. Further instructions on this testing are included at Annex F and the test results are contained at Annex G.
- e. **Ergonomics Assessment.** This qualitative assessment was conducted by to assess aspects of Support, Comfort, Flexibility and Prevention of Injury functional characteristics for each combat boot. As part of the assessment soldiers were put through an exercise routine in order to record user input on aspects such as Fit, Flexibility, Comfort and Cushioning of the boot under loaded and unloaded conditions. Details on this trial program are contained at Annex F and the trial results at Annex G.
- f. **Donning and Doffing Assessment.** This quantitative assessment (see Annex G) was conducted in conjunction with the ergonomics assessment conducted by . This assessment was conducted using the same sample population to assess any difficulties with donning and doffing the boots.
- g. **Evaluation Workshop.** At the end of the test and evaluation phases the participating podiatrists and footwear specialists were invited to an evaluation workshop during which the data was analysed to formulate conclusions about each boot. The evaluation workshop was conducted and the results of the workshop assessment are included at Annex H.

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## Assumptions

16. The following assumptions were made for this comparative assessment:

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## Analyses and Test Summary

17. The test and evaluation program conducted as part of this combat boot comparative assessment consisted of laboratory testing, biomechanical and ergonomic trials, a fit assessment and other technical evaluation activities. Annex B and C detail all test and evaluation activities conducted under this assessment. Laboratory test and evaluation activities were conducted by accredited test agencies in New Zealand and the United Kingdom that specialise in footwear testing. The biomechanical and ergonomic trials, fit



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assessment and other technical evaluation activities were conducted by podiatrists and footwear experts in Australian industry.

18. The assessment was conducted using mostly quantitative data rather than qualitative data and the individual test and evaluation activities that contribute to an adequate assessment of each combat boot against the functional characteristics are mapped in the test criteria matrix at Annex 1.



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## **Section 3**

### **Individual Assessments**

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### Combat Boot 6: Crossfire Peacekeeper Plus Combat Boot (“Crossfire”)

54. Figure 6 depicts the Crossfire Peacekeeper Plus combat boot.

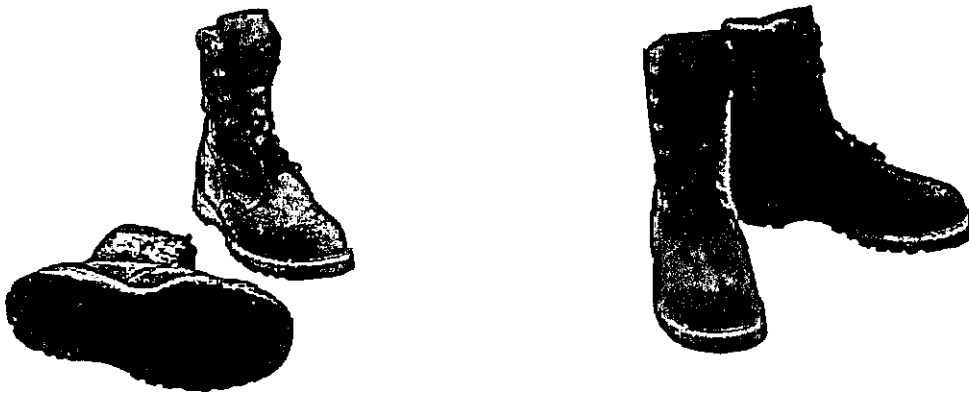


Figure 6: Photographs depicting the Crossfire Peacekeeper Plus combat boot.

55. The main features of the Crossfire combat boot are:
- **Weight** - 966g (Size 9)
  - **Boot Upper** - HT nylon with a 75mm web belt at the ankle, 2.2-2.4mm Suede leather on the heel and vamp.
  - **Insole** – 2.5 mm Fibreboard cemented to insole
  - **Soling** – 3-Layer (3mm Resin rubber, Polyurethane midsole and Vibram<sup>®</sup> Sierra outsole)
  - **Sole Adhesion** – Welted and cemented sole
  - **Shank** – Too short (5cm) poorly positioned fibreglass shank
  - **Internal Lining** – Boot upper is foam backed/wicking lining. Vamp lining is Calico and the heel lining is leather
  - **Footbed** – Removable molded Polyurethane and Sorbothane like pads at joint and toe.
  - **Drain Eyelets** – Nil
  - **Toe Spring** – 18 mm
  - **Heel Camber** – Nil
  - **Heel to Joint Differential** – 13.9mm
  - **Lacing** – Three eyelets at the bottom and four speed hooks at the top with no speed laces.
  - **Size Range (UK)** – 6-11 in half sizes, 12 & 13 (Medium and Wide).



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56. The Crossfire combat boot assessment against the functional characteristics is summarised at Table 7.

**Table 7: Crossfire combat boot assessment against functional characteristics.**

Fit	Cushion	Support	Stability	Traction & Grip	Flexibility	Protection
Average	Average	Average	Average	Average	Average	Average
Environ. Protection	Health & Hygiene	Comfort	Prevention of Injury	Safety	Ease of Donning & Doffing	Durability
Average	Average	Average	Average	Average	Average	Above Average

57. The Crossfire boot was ranked third overall relative to the other boots in the LASRA laboratory testing. It performed best in the cut resistance to ankle test and worst in the slip resistance test.

58. The results from the SATRA AMM test show that the Crossfire boot ranked fifth overall for moisture management.

59. The Crossfire boot was assessed by to perform 'reasonably satisfactory' in both the biomechanical and ergonomics trials.

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60. EFI assessed the Crossfire boot to have a moderate level of fit and a restricted size range.





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## Section 4

### Comparative Assessment

76. In order to analyse the test and evaluation results including finalisation of findings, workshop was held with the participating podiatrists and footwear specialists. The summary of evaluation workshop results for the boots against the functional characteristics is shown in Table 12. As part of this evaluation workshop a three level criteria namely; 'Above Average', 'Average' or 'Below Average' was used to rate the boot performance against each functional characteristic.

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78. The and Crossfire boots were assessed as Average against the majority of functional characteristics and Above Average for one functional characteristic (i.e. for Fit and Crossfire for Durability). Normally Durability is a property best judged by actual utilisation and trials, however, the Crossfire boot was rated Above Average due to its sturdy stitchdown welt construction and reinforcing stitch at the front.

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86. The Crossfire boot has been rated Average against all the functional characteristics except Durability where it is rated at Above Average, which can be attributed to its sturdy stitchdown welt type construction. The boot has a Vibram sole and exhibited good upper-



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outsole adhesion, however, it was one of the heavier boots with equivalent slip resistance, sole penetration, sole abrasion and cut growth resistance properties comparable to other boots with Vibram soles. It has a three layered sole exhibiting good energy absorbency and heat insulation properties. However, the water penetration test showed the Crossfire boot to be amongst the lesser performing boots in that water ingress was recorded at the first 30 minute mark. In contrast, the Crossfire boot was better than the

in the drying time test. The boot upper is HT Nylon with a 75mm web at the ankle for support and the lower part is Suede leather. In comparison with other boots, the Crossfire showed the best cut resistance at the ankle which can be attributed to the HT Nylon web. Overall the Crossfire boot was rated Average,  
against the majority of functional characteristics.

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89. Some of the design features that contribute to the Comfort, Support and Stability aspects of a combat boot are discussed below. The boot heel camber and toe spring aid smooth transition of foot loads from one foot to the other whilst walking, and a good heel to joint height differential provides better foot stability. From the fit assessment it was found that the heel to joint height differential for the boots ranged between 11-21mm where the [redacted] had the lowest, whilst the [redacted] had the highest height differential. Table 10 shows the height differential for all boots in the comparative assessment.

**Table 10: Height Differential of the tested boots.**

Serial	Boot Model	Height Differential (mm)
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	Crossfire Peacekeeper Plus	13.9
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**Note:** Typically for a running shoe a 10mm height differential is considered appropriate.

90. Table 11 shows the toe spring and heel camber for all boots tested. Boots that have a heel camber and high toe spring are considered good for shock absorbency during walking and running.



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**Table 11:** Toe spring and heel camber of the tested boots.

Serial	Boot Models	Heel Camber (mm)	Toe Spring (mm)
	Crossfire Peacekeeper Plus	Nil	18.0

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91. The [redacted] has the lowest toe spring. Therefore whilst walking and when transitioning the weight from one foot to the other, the toe (as opposed to the heel) would initially touch the ground making walking difficult. However, the second peak results from the biomechanical trial (see Annex G) indicates equivalent loading for all the boots suggesting that the tested boots exhibit similar shock absorbency properties when transferring the load between the two feet whilst walking.

92. The test results indicate that the boots are in general similar across the functional characteristics

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## Overall Assessment

93. Each combat boot was evaluated against the functional characteristics and the overall assessment results are summarised in Table 12.

94. The outcomes summary of the comparative assessment are:

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Crossfire provided equivalent or improved performance in all the functional characteristics.

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97. Given that Fit is regarded as the most important characteristic that has a direct influence on a number of other functional characteristics, the results of this comparative assessment has highlighted a need to have a range of boot options available to the Australian soldier. Boot fitment is a function of an individual's foot anatomy and therefore each individual will have a personal preference according to the best Fit achieved with a particular boot type.

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Boot Make	Functional Characteristics											Overall Functional Rating				
	Fit	Cushion	Support	Stability	Traction & Grip	Flexibility	Protection	Environ. Protection	Health & Hygiene	Comfort	Prevention of Injury		Safety	Ease of Donning & Doffing	Durability	

<b>Crossfire</b>	Average	Average	Average	Average	Average	Average	Average	Average	Average	Average	Average	Average	Average	Average	Average	Average
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Table 12: Combat Boot Comparative Assessment Results Summary.

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## Section 5

### Concluding Remarks

100. This comparative assessment evaluated the ADF in-service combat boot against different types of combat boots currently used by allied forces and available for purchase in the market place. The assessment was based on a test and evaluation program that included laboratory testing, biomechanical and ergonomic trials, fit assessment, and evaluation activities. Laboratory testing was conducted at accredited specialist footwear laboratories whilst podiatrists and footwear specialists did the technical evaluation activities. The test and analysis results of each combat boot were evaluated against the definitions for the functional characteristics when determining the Above Average, Average and Below Average ratings.

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101. The test and evaluation results indicate that the boots are in general similar across all the functional characteristics.

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102. From the comparative assessment it is found that,

performance. Crossfire provide equivalent

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### Final Conclusions

105. This comparative assessment has concluded the following:

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improved or equivalent functional performance against all functional characteristics. Crossfire) have

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c.



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## Section 6

### Recommendations

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108. It is recommended that Crossfire combat boots be considered as alternatives noting that introduction into service of these boots be conducted in accordance with the TRAMM.





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## Annexes

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## Annex A: DEFINED TERMS, ACRONYMS AND ABBREVIATIONS

Table 1: Combat boot Functional Characteristics defined by Booz Allen Hamilton Pty Ltd

Serial	Functional Characteristic	Definition
	Fit	<p>The characteristic of <i>fit</i> is the most important considerations of all footwear characteristics. Fit is the ability of the boot to conform to the size, width, shape and proportions of the foot. Fit is directly affected by the last but some other factors include: activity, psychology, style, materials and design. There is no way to measure fit and it has no clearly stated metric. Fit is achieved by trial and error and judged by "the wearer"; the manufacturer uses dimensional substitutes (length, width, etc) to define a consistent size structure.</p> <p><b>Key related characteristics:</b> Comfort, Stability, Support, Flexibility, Safety, Health &amp; Hygiene and Prevention of Injury.</p>
	Cushioning	<p>The characteristic of <i>cushioning</i> is the inherent ability of the combat boot's components to individually, and/or collectively, dissipate the forces the foot and lower limb are exposed to during the stance phase of gait. The most critical time for this quality to be effective is during heel strike and toe-off when the soldier is involved in combat training, route marching etc.</p> <p><b>Key related characteristics:</b> Fit, Stability, Prevention of Injury, Comfort, Support, Flexibility and Health &amp; Hygiene.</p>



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	Support	<p>The characteristic of <i>support</i> is the ability of the combat boot to sustain the anatomical integrity of the foot when exposed to a level of intense activity that would normally not be undertaken unshod. The soldier would in turn feel safe and confident to re-attempt these activities repeatedly without fear of injuring him/herself. Minimising excessive lateral movement at the ankle and/or maintaining the position of the foot's medial arch under load would be examples of this quality.</p> <p><b>Key related characteristics:</b> Fit, Comfort, Prevention of Injury, Safety, Flexibility, Stability and Health &amp; Hygiene.</p>
	Stability	<p>The characteristic of <i>stability</i> refers to the capacity of the soldier to feel he/she has a level of steadiness or permanence whilst using the combat boot when undertaking intensive levels of activity. A feeling of confidence in a combat boot when in contact with the ground is critical for the dismounted soldier as it is an integral part of his/her proprioceptive (sensory) arsenal.</p> <p><b>Key related characteristics:</b> Fit, Comfort, Support and Prevention of Injury.</p>
	Traction & Grip	<p>This characteristic refers to the capacity of the boot to allow the dismounted soldier to minimize slippage and keep his/her feet whilst running, crawling and climbing by imbedding the tread on the outsole into a variety of terrain surfaces. This characteristic could be considered a subset of stability, but for the purposes of this Review was evaluated separately.</p> <p><b>Key related characteristics:</b> Prevention of Injury, Safety, Flexibility, Comfort, Support, Stability, Durability and Health &amp; Hygiene.</p>



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	Flexibility	<p>The characteristic of <i>flexibility</i> refers to allowing the foot to function as close to its normal performance levels even whilst wearing the combat boot. Nowhere is this more important than in the forefoot at the “metatarsal break”. If inadequate amounts of flexibility are available, excessive overload will occur from the plantar to the metatarsal heads of the foot causing pain and, furthermore, dramatically affect propulsion i.e., the ability of the soldier to freely walk, run, dodge and/or jump.</p> <p><b>Key related characteristics:</b> Comfort, Support and Stability.</p>
	Protection	<p>The characteristic of <i>protection</i> is the combat boot’s ability to protect the soldier’s foot from specified man made threats.</p> <p>Whilst no one “safety standard” covers the in-service ADF combat boot, it must be constructed to provide a barrier for the soldier from any number of dangerous activities and circumstances he/she may face in an operational environment. This must be done within reason so as not to detract from the functionality of the boot.</p> <p><b>Key related characteristics:</b> Comfort, Prevention of Injury, Environmental Protection, Health &amp; Hygiene and Safety.</p>



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	<p>Environmental Protection</p>	<p>The characteristic of <i>environmental protection</i> is the combat boot's ability to protect the soldier's foot from climatic and other non-climatic impediments. It is considered to be a fundamental problem if feet cannot be protected from the elements, particularly the ingress of water. Regardless of how the water gets into the boot, via stitching, vent holes or through the foot entry portal – problems will result. A complementary issue is the ability of moisture or sweat being unable to escape from the boot. Other non-climatic impediments such as sand and dirt are also problematic in certain environments.</p> <p>This characteristic could be considered a subset of protection, but for the purposes of this Review was evaluated separately.</p> <p><b>Key related characteristics:</b> Comfort, Prevention of Injury, Protection, Foot Health &amp; Hygiene, Durability and Safety.</p>
	<p>Health &amp; Hygiene</p>	<p>This characteristic refers to the combat boot's ability to allow the soldier to maintain a healthy and fit foot in operational environments. In combination with prevention of injury it encompasses the occupational health aspects of a combat boot.</p> <p>The minimisation of secondary health and hygiene problems on the foot, particularly of the skin, are paramount to a soldier's ability to function in the field. Many of these are related to heat, sweating, water ingress and the organisms that are propagated by these issues such as tinea, maceration of skin and blisters. Cold and chilling disorders are seen less frequently, particularly in hot tropical environment but they are of no less significance.</p> <p><b>Key related characteristics:</b> Environmental Protection and Prevention of Injury.</p>



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	<p>Comfort</p>	<p>Comfort is closely interrelated with Fit and other footwear characteristics. It is a subjective characteristic based on an individual's assessment on how the combat boot 'feels' during use in various environments. Such an assessment can change due to differing environmental factors e.g. a boot may feel 'comfortable' in a relatively benign environment, but becomes 'uncomfortable' in a more physically demanding environment.</p> <p>It is considered to be the most subjective, and arguably, after Fit, the next most important of all characteristics of the combat boot.</p> <p><b>Key related characteristics:</b> Fit, Prevention of Injury, Stability, Support, Cushioning and Protection and Environmental Protection.</p>
	<p>Prevention of Injury</p>	<p>This characteristic refers to the combat boot's ability to prevent injury either from external factors or by the use of the combat boot itself not causing injury either short term or long term to the soldier.</p> <p>To prevent injury is a principal quality of any combat boot.</p> <p><b>Key related characteristics:</b> Support, Stability, Traction &amp; Grip, Protection, Environmental Protection, Health &amp; Hygiene and Comfort.</p>



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	<p>Safety</p>	<p>The characteristic of safety is the combat boot's ability to keep the soldier's foot from harm from specified hazards.</p> <p>Whilst no one "safety standard" covers the ADF military boot, it must be constructed to provide a barrier to the combat soldier from any number of dangerous activities and circumstances he/she may face in a non-operational environment. This must be done within reason so as not to detract from the functionality of the boot.</p> <p>This characteristic could be considered a subset of protection, but for the purposes of this Review was evaluated separately.</p> <p><b>Key related characteristics:</b> Prevention of Injury, Traction &amp; Grip and Protection.</p>
	<p>Ease of Donning &amp; Doffing</p>	<p>This characteristic refers to the ease with which the combat boot can be put on and removed by the soldier. An additional consideration could also be for boot removal following lower limb injury. A complicated process in a situation of providing immediate medical assistance to a foot injury could have deleterious effects on the soldier.</p> <p><b>Key related characteristics:</b> Comfort, Health &amp; Hygiene and Protection.</p>
	<p>Durability</p>	<p>This characteristic refers to the combat boot's ability to undergo reasonable 'wear and tear' by a soldier over a specified period. This could be further described in the following terms:</p> <p>"The combat boot continues to be fit for function under operational conditions for the dismounted soldier (essential X months, desirable XX months) and has a storage shelf life (Y years)."</p> <p><b>Key related characteristics:</b> Comfort, Prevention of Injury, Support, Cushioning, Protection, Safety and Environmental Protection.</p>

Table 2: Definitions/Acronyms/Abbreviations



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Serial	Term	Description
	Anthropometric	Measurements of the body or sections of the body.
	Ball	In the foot, the ball comprises the heads of the five metatarsal bones and the surrounding tissue. On the shoe the ball is the corresponding section of area. Along with the heel, the ball is one of the two primary weight bearing and tread sections of the foot and shoe.
	Biomechanics	The study of the human body and movement in mechanical terms.
	Biomechanical Comfort	Term used to refer to collective biomechanical aspects of the boot such as; cushioning, shock absorbency, support, arch support, motion support, stability and flexibility.
	Dual Density	A shoe component with two different sections having different degrees of resilience or flexibility, such as sole and heel on a unit sole or a midsole and outsole, to meet the functional requirements of the foot.
	Eyelets	A small, flat ring of metal or plastic attached to the upper along the eye stay to provide holes for the laces to pass through.
	Flexion	The bend action of the foot across the ball, or of a shoe or outsole across the ball and vamp. The degree of the flex of the foot or the walking ease of the shoe.
	Fit	The ability of the shoe to conform to the size, width, shape and proportions of the foot. Sizing that allows the proper fit and foot function inside the shoe.
	Footbed	The area and shape of the shoe on which the foot directly rests; the insole and midsole.
	Forefoot	The part of the foot from the ball or metatarsal heads forward.
	Forefoot Flexion	The bending action of the forefoot.
	Heel	The raised component under the rear of the shoe, consisting of any of a wide variety of shapes, heights, styles and materials.





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	Heel Cup (or Counter)	A cupped shaped insert to cradle the foot's heel for motion control or cushioning.
	Hot Spots	A patch of skin on the foot subjected to friction causing discomfort and blisters.
	Insole	A layer of material shaped to the bottom of the last and sandwiched between the outsole (or midsole) and the sole of the foot inside the shoe. It is the shoe's natural anchor to which is attached the upper, Toe box, linings and welting.
	Insole Board	Material for an insole made of cellulose or other fibres imbedded with a matrix that binds the fibres close together. May be infused with antibacterial or antifungal additives. The board combines flexibility with stability.
	Last	Used a noun, the plastic, wood or metal foot-shaped form over which the shoe is made to conform to the prescribed shape and size of the shoe. Used as a verb, it refers to the process of shaping the shoe to the last. The last is the single most important element in the shoe making process.
	Lining	Inside covering of the shoe or boot, may be leather or fabrics incorporating features such as wicking, moisture control, antibacterial, odour control, e.g., vamp lining, and tongue lining.
	Midsole	The layer of soling between outsole and insole. Used to provide a layer of cushioning.
	Mondopoint	A system to designate the size of the last and/or shoe, which include a girth measurement and use a metric system. Designed by SATRA, its objective is to be an international shoe sizing system.
	Podiatry	The branch of medicine dealing with the diagnosis and treatment of foot disorders by surgical, mechanical or other means.
	Shank	The bridge portion of the sole between the heel breast and the ball tread area.



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	Shock absorbency	The natural ability of a body part, such as the foot, to absorb a normal amount of shock as in walking or running; or the use of special shoe components or materials, such as cushioning, to aid in the absorption of step shock.
	Size 270/94 (US 9–UK 8)	Mondopoint size length/width in mm (US–UK equivalent arithmetic sizes)
	Sole	The bottom part of the shoe in contact with the ground.
	Sole Adhesion	The ability of the sole (or midsole) material to adhere to the upper of the shoe.
	Support	1. The foot's natural support system which includes the bones and joints, muscles and tendons, ligaments, arches, and plantar fascia. 2. Any supplementary components or design built into the shoe and offering support to the foot's own support system.
	Toe Box (or Cap, or Toe Puff)	The firm, reinforced toe area of a shoe. Can be made from plastic, leather, fabric, fibreboard metal etc. To provide wear and/or impact protection.
	Tongue	The flap part of the shoe's upper, or a section affixed to the vamp and extending rearward and upward to cover the instep or beyond.
	Tongue Insert	Shape material inserted into the tongue pocket to provide padding to the instep.
	Traction	The pulling or drawing of a load against the ground surface, and the leverage action resulting from the friction between the moving and the stationary part.
	Tread	1. To walk on, or the particular way the weight bearing foot implants itself on the ground to create a tread pattern. 2. On the last, the widest section of the last bottom so that the shoe will "walk" properly. 3. On a shoe, the areas of the sole and heel that are in primarily contact with the ground in walking. Proper tread is important to the floor, last and shoe.



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	Upper	All the parts or sections (vamp, quarters, linings, etc) above the shoe's sole that are stitched or otherwise joined together to become a unit, and then attached to the insole and outsole.
	Water Resistant	A material or product specially treated and designed to resist entry or repel absorption of moisture, but not necessarily waterproof.
	DMOSS	DMO Support Services
	DMO	Defence Materiel Organisation
	ADF	Australian Defence Force



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**Annex G : EVALUATION WORKSHOP SUMMARY**



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**ADF COMBAT BOOT COMPARATIVE ASSESSMENT  
EVALUATION WORKSHOP SUMMARY**

**Introduction**

1. A Evaluation Workshop was conducted for the ADF Combat Boot Comparative Assessment.

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2. The aim of the workshop was to two fold. Firstly, review all test results from the laboratory testing, biomechanical and ergonomics trial and fit assessment activities conducted. Secondly to evaluate how each boot meets the key functional characteristics, namely; fit, cushioning, health & hygiene, support, protection, stability, environmental protection, safety, traction & grip, comfort, flexibility, prevention of injury, ease of donning & doffing, and durability.

**Agenda**

3. The workshop agenda was undertaken in two parts as follows:  
a.  
b.

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**Attendance**

4. The attendees for the workshop comprised  
a.  
b.  
c.  
d.  
e.  
f.  
g.

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h.

5.

**Evaluation Methodology**

6. The evaluation methodology adopted for the workshop was as follows:
- a. **Step 1.** Confirm the evaluation methodology and ratings to be applied  

These ratings represent an Above Average, Average and Below Average relative functional performance of each boot against the specific functional characteristic.
  - b. **Step 2.** Identify the specific functional characteristic against which all boots were to be evaluated e.g. Donning & Doffing.
  - c. **Step 3.** Review and confirm the general understanding of the agreed definition of the functional characteristic, including relevant boot features to be addressed.
  - d. **Step 4.** Identify and review applicable test and trial data to be used (Any inconsistencies or outstanding data was noted).
  - e. **Step 5.** Conduct evaluation of all boots against the functional characteristic making specific observations against individual boots.

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Where appropriate, general comments applicable to all samples under evaluation were noted, and recorded accordingly to avoid repetition.

- f. **Step 6.** Confirm overall rating for each boot by identifying any key discriminator(s) that would allow a boot to be rated higher or lower than the Average rating
- g. **Step 7.** Repeat Steps 2-6 until all functional characteristics have been evaluated.
- h. **Step 8.** Review the consolidated ratings for all boots and undertake any adjustment to a specific rating for a boot based on general consensus.
- i. **Step 9.** Identify the ratio of quantitative and qualitative data used for each of the functional characteristic evaluations.

**Results**

7. Based on the evaluation methodology outlined above the workshop results of each functional characteristic were recorded in a tabulated format. These results are enclosed. A consolidated matrix of the ratings is shown on the next page.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
<b>Boot Type</b>	<b>Fit</b>	<b>Cushion</b>	<b>Support</b>	<b>Stability</b>	<b>Traction and Grip</b>	<b>Flexibility</b>	<b>Protection</b>	<b>Environmental Protection</b>	<b>Health &amp; Hygiene</b>	<b>Comfort</b>	<b>Prevention of Injury</b>	<b>Safety</b>	<b>Donning &amp; Doffing</b>	<b>Durability</b>

Crossfire

<b>Score</b>	
POOR (Below Average)	
OK (Average)	
GOOD (Above Average)	

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**Summary**

8. The evaluation of boot types against the functional characteristics was completed by the workshop attendees and the findings contained in this document.

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9.

**Enclosures:**


1. Functional Characteristic Results ( )



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Enclosure 1

<u>Functional Characteristic – Fit and Size</u>		
Boot Type	Rating	General Observations
Crossfire	7-12 in Half sizes (M&F), 13,14 (M&F)	

SCORE	
POOR	
OK	
GOOD	

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<u>Functional Characteristic – Cushioning</u>		
Boot Type	Rating	General Observations
Crossfire		

Specific Comments

SCORE	
POOR	
OK	
GOOD	



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<u>Functional Characteristic – Stability</u>		
Boot Type	Rating	General Observations
Crossfire	Short shank – poor position	

SCORE	
POOR	
OK	
GOOD	

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<u>Functional Characteristic -- Traction and Grip</u>		
Boot Type	Rating	General Observations
Specific Comments		
Crossfire *		

SCORE	
POOR	
OK	
GOOD	

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<u>Functional Characteristic – Comfort</u>		
Boot Tyne	Rating	General Observations
Crossfire	No air vents	

SCORE	
POOR	
OK	
GOOD	

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<u>Functional Characteristic – Flexibility</u>		
Boot Type	Rating	General Observations
Specific Comments		
Crossfire		

SCORE	
POOR	
OK	
GOOD	





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<u>Functional Characteristic – Health and Hygiene</u>		
Boot Type	Rating	General Observations
		<ol style="list-style-type: none"> <li>Awaiting results from SATRA on advanced moisture management test.</li> <li>Drying test – foot out of shoe, 25°C, 65% humidity.</li> </ol>
Crossfire		Very poor air vents, Slow to dry, Foam back walking

SCORE	
POOR	
OK	
GOOD	

<u>Functional Characteristic – Safety</u>			
Boot Type	Rating	Specific Comments	General Observations
Crossfire			

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SCORE		
POOR		
OK		
GOOD		

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<u>Functional Characteristic – Prevention of Injury</u>		
Boot Type	Rating	General Observations
Specific Comments		
Crossfire		

SCORE	
POOR	
OK	
GOOD	

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<u>Functional Characteristic – Protection</u>		
Boot Type	Rating	General Observations
Specific Comments		
Crossfire	Best on cut resistance	

SCORE	
POOR	
OK	
GOOD	

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<u>Functional Characteristic – Donning And Doffing</u>		
Boot Type	Rating	General Observations
Specific Comments		
Crossfire		Slightly reduced entry into throat of boot – no impact

SCORE	
POOR	
OK	
GOOD	

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<u>Functional Characteristic – Durability</u>		
Boot Type	Rating	General Observations
Specific Comments		
Crossfire	Goodyear welt	

SCORE	
POOR	
OK	
GOOD	