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Reducing the Burden on the Dismounted Soldier Capability Vision Task 3 - The 'Energy-Efficient Soldier'

Centre for Defence Enterprise call for proposals & expressions of interest

Release date: 24th March 2009v1.0



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Reducing the Burden on the Dismounted Soldier Capability Vision
The 'Energy Efficient Soldier'

Call for proposals & expressions of interest

Foreword

The 'Energy Efficient Soldier' forms part of the 'Reducing the Burden on the Dismounted Soldier' Capability Vision launched by MOD in 2009. Incorporating the Man-Portable Energy Supply High Innovation Rapid Implementation Demonstrator Programme (MPES HIRID), the Reducing the Burden Capability Vision seeks to reduce the physiological burden on dismounts to a recommended load of no more than 25 kg. The 'Energy Efficient Soldier' will constitute a complete re-think about electronic systems and their associated power supplies which contribute significantly to the weight burden.

On patrol UK soldiers frequently have to carry a huge weight burden caused by body armour, communications and IT, batteries, night vision, food, water, weapons, ammunition and much else in hot, dry and sometimes mountainous conditions. A significant part of the Defence Research Programme is looking at new technology to evolve this capability and improve the survivability and fighting effectiveness of the dismounted soldier. However, in parallel with this work we want to look at a generational leap focussed more on maintaining these levels of fighting effectiveness but with a significant fall in physiological burden. To that end, the 'Energy Efficient Soldier' will seek to achieve rapid pull-through of high risk, high pay-off technologies to a fully integrated soldier-power system demonstration within two years.

This document provides an overview of the functions that might be required from a soldier-power system, the scenarios in which it might be used, and potentially relevant technologies. However, it must be stressed that the scenarios and technologies are provided to stimulate thought and should not be allowed to constrain potential ideas or solutions; nor should they be seen as exhaustive.

Proposals for funding should be submitted using the Centre for Defence Enterprise portal and clearly marked 'Energy Efficient Soldier'. More general expressions of interest in involvement in the 'Energy Efficient Soldier' Programme should be sent to helsley@mail.dstl.gov.uk.



1 Context

- 1.1 The UK Government spends over £30Bn per year on Defence. The MOD invests over half of this budget on equipment, works and miscellaneous stores and services ranging from, for example, tanks, ships and aircraft through to tools, clothing and window cleaning.
- 1.2 The Defence Industrial Strategy¹ describes MOD’s future military capability requirements and the interaction between MOD and the defence supplier base. This strategy stresses the value MOD places on engagement with a wider supplier base, including the academic sector and small companies, to stimulate innovation and exploit technological advance for the benefit of UK defence.
- 1.3 A recent study² found that research and development (R&D) accounted for approximately £2.6Bn of the defence budget. Approximately £2.1Bn of this is part of the equipment and support programme. Approximately £500M is centrally managed as a Science, Innovation and Technology (SIT) programme. Figure 1 illustrates the transition from *ideas* through *growth* to *demonstrators* and on to *application*, and lists initiatives in place to support each stage.

Counter Terrorism			
Competition of Ideas	Enterprise Growth	Rapid Development of Solutions in Operations	Equipment and Support for Operations
Grand Challenge	Defence Technology Centres		
Seed Corn Research	Consortia based Research and Technology	High Risk High Impact Demonstrators	
International Research Collaboration			
Challenge Workshops	Joint Funded Research and Technology	Risk Reduction Demonstrators	
Single Source Research	Single Source Research and Technology		
Advice / Assessments			
<i>Ideas</i>	<i>Growth</i>	<i>Demonstrators</i>	<i>Application</i>

Figure 1: The MOD science & technology delivery model

- 1.4 The Defence Industrial Strategy and MOD Innovation Strategy³ emphasise the need for flexibility, agility and responsiveness in developing new technology and concepts to meet emerging capability needs. The Defence Technology Plan, which was announced in Autumn 2007 and publicly launched in February 2009, identified the concept of capability visions as a mechanism for bringing forward innovation and a revolution in capability.
- 1.5 The concept and underpinning mechanisms behind the capability visions were endorsed by the Defence R&D Board in early 2008, which agreed that up to 10% of the science and technology budget should be allocated to CVs, although in the first tranche MoD will be investing rather less than this. MoD expects to launch around 5 CVs per year, usually with maximum programme lengths of up to 3 years.

¹ Defence White Paper: Defence Industrial Strategy Cm6697, published December 2005

² Maximising Defence Capability Through R&D, published October 2007

³ Ministry of Defence Innovation Strategy, published December 2007

2 Problem Space

- 2.1 UK dismounted soldiers are operating in very difficult environments where they are hindered by the excessive burden of carried loads. Regularly carrying ~45 kg of equipment and supplies on a mission in temperatures exceeding 45°C is unsustainable, reducing the quantity and types of missions that can be carried out.
- 2.2 The load carried reduces the tempo of infantry operations, making it easier for the enemy to plan attacks and cause casualties. Reduced tempo means that dismounts require more protection to counter enemy attacks, which further increases the load burden. For some roles, up to 30% of the overall burden is due to the power sources (batteries) carried to power the electronic equipment that the modern soldier uses.
- 2.3 The 'Energy Efficient Soldier' programme has been developed to address the problem of power source burden by: reducing the mass of the power source carried; increasing the energy density of the power source carried; reducing the power consumption of carried equipment; decreasing the complexity of use of equipment and increasing soldiers' trust in the power source.

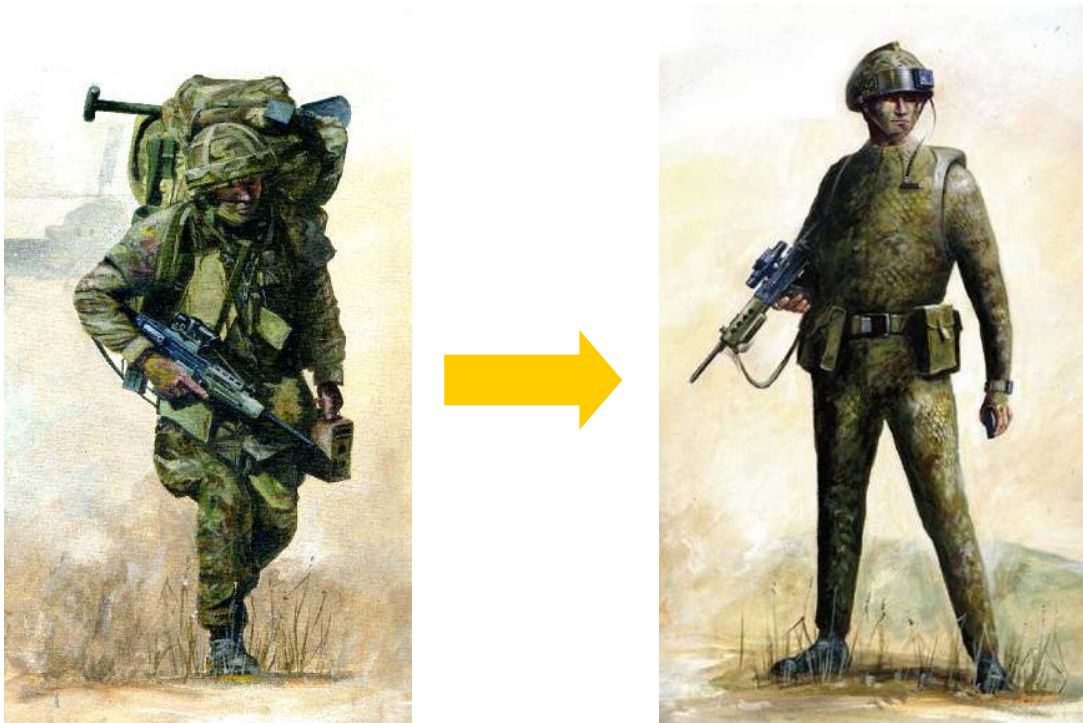


Figure 2 – Capability vision, reduction in dismounted soldier burden

- 2.4 Specific challenges include:
 - identifying and reducing equipment inefficiencies
 - significantly reducing the power source burden below current levels (see Appendix A)
 - identifying suitable solutions for the problem environment
 - affordability
- 2.5 Research has shown that for a rural 48 hour mission the average power source burden is ~ 4kg or 10% on average (see Appendix A), of which 48% is from power sources for survivability equipment, 41% for the tactical communication suite and a further 4% from satellite communications power sources (Appendix B). For different mission types, this average increases significantly from 4 to 10 kg.
- 2.6 Along with the weight burden of the power source the ergonomics of carriage needs to be considered. Big square boxes that are difficult to fit in the Bergen or carry in a pouch are less desirable than ones that are easier to pack. Standardisation would give soldiers another option that they currently lack, although this needs to be balanced against the optimisation of a battery for specific host equipment.

3 Solution Space

- 3.1 The desired outcome of the 'Energy Efficient Soldier' strand of the 'Reducing the Burden on the Dismounted Soldier' Capability Vision is reduction in the weight of electronic systems and power sources by 50%, without loss of functionality or capability. This would have a significant impact on certain specialist roles, such as signallers and those carrying specialist electronic equipment, and would reduce the logistics burden that is generally associated with batteries.
- 3.2 Within a year, the programme plans to demonstrate a systems-engineered power architecture for the soldier and a prototype power source which is half the weight of batteries about to enter service.
- 3.3 By the end of the second year it is intended to demonstrate a fully holistic approach which harnesses 'best of breed' technologies to manage power demand and power delivery. The portable power sources matured in this phase are hoped to be something like 6 to 8 times lighter than current batteries, leading to a highly aspirational stretch target for a system with an effective specific energy of 600-800 Wh/kg.
- 3.4 The solution space in which we aim to achieve these targets will comprise a wide range of power source technologies. These could include:
- Advanced Batteries
 - Fuel cells
 - Hybridisation
 - Micro engines
 - Photovoltaic devices
 - Energy harvesting and scavenging devices

However, this list is not intended to be exhaustive and any technology which can contribute to a reduction in power source weight will be considered.

- 3.5 The other key aspect of the 'Energy Efficient Soldier' is reducing the burden of electronic systems. This may be achieved by utilising some of the following technologies.
- Lightweight electronic systems
 - Advanced display technologies
 - Reduced power consumption electronics
 - Power management techniques and software
 - Optimised system architectures

Again, this list is purely for illustration and should not constrain thinking about potential solutions.

- 3.6 Whilst one of the greatest needs is to reduce the weight of electronic equipment carried by the dismounted soldier, weight is not the only burden and other factors such as the bulk and complexity of any solutions will need to be considered to ensure that they do not add additional physiological or psychological burden to a soldier. Excessive cabling should be avoided, since this has a tendency to snag and break during military operations.
- 3.7 The military environment is a harsh one with equipment being required to operate in a range of extreme conditions. These conditions may include extremes of temperature, humidity, altitude, and dirty and dusty environments. Physical abuse such as shock and vibration loads will also be applied to equipment. Usability and the practicality of carriage will also need to be considered. Modularity may be desirable for larger power sources to enable troops to share the burden of power and to allow both short and long missions to be accommodated. The optimum solution should also have an affordable through life cost.
- 3.8 Whilst military equipment must be robust, there is a balance to be made between selecting an appropriate level of robustness and adding such excessive mass and bulk that a device becomes less effective.
- 3.9 The endurance required from a power source will vary depending upon the missions being performed. Missions can vary from short patrols of a few hours to many days. However, it would be rare to expect most dismounted troops to operate for greater than 48 hours without re-supply.
- 3.10 It is not possible to give power levels for the power source requirements since one of the aims of the 'Energy Efficient Soldier' programme is to reduce the power demands of dismounted electronics. It is

appropriate however to state that electronic equipment on the dismounted soldier requires a range of power levels. Typical power levels include those around 1 W for small electronic devices, tens of watts for communication equipment and up to 100-200 W for more specialist electronic equipment.

- 3.11 The dismounted soldier currently carries batteries ranging from small AA alkaline cells to larger more specialist batteries weighing several kilograms. Both primary (disposable) and secondary (rechargeable) batteries are used. The specific energy of typical power sources carried ranges from around 65 Wh/kg to 200 Wh/kg.
- 3.12 It is important to focus on the power sources and equipment which contribute most to the current power burden. These will be communications systems and their power sources in the range of tens of watts and power sources for specialist electronic equipment in the range 100-200 W. Despite a number of AA batteries being carried, these comprise only a small fraction of the soldier's burden.
- 3.13 At present, equipment is powered by discrete batteries which generally sit within or clip onto the equipment. A systems approach may allow equipment to share power sources, potentially allowing for economies of scale to provide weight reductions. However, any systems approach will need to consider issues such as survivability and redundancy and the practicality of having many pieces of equipment connected together. Optimisation of connectors and cabling in addition to the integration with other non-powered soldier equipment will be essential to produce a practical solution.
- 3.14 Solutions at a range of technology readiness levels (TRLs) will be appropriate. It is initially expected that a range of proof of concept demonstrators at lower TRL will be funded which will then be down-selected to fewer technologies for further development to higher TRL, leading to the final solution which may be a number of promising technologies integrated to form a complete system.

4 Programme plan

- 4.1 Figure 3 provides an outline of the RBDS CV programme plan. The programme commenced mid December 2008 under the HIRID initiative and will progress in several phases.

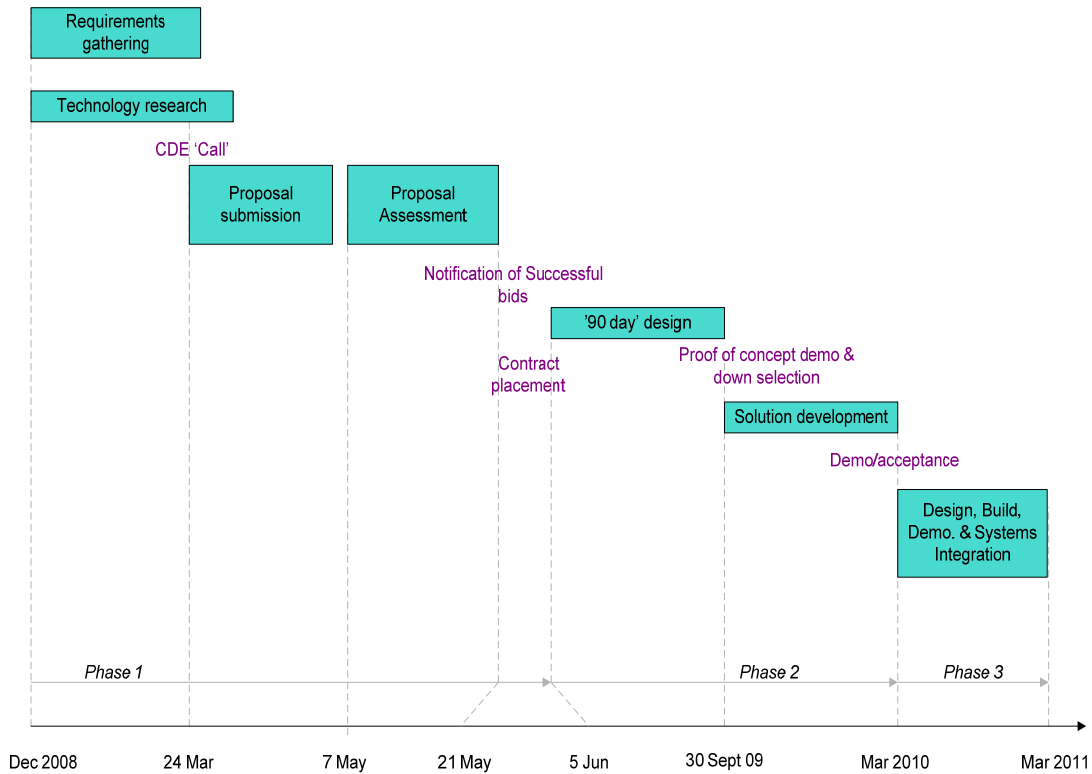


Figure 3: High level RBDS CV programme plan

- 4.2 Phase 1 commenced 12th December 2008 and is planned to end in June 2009. This Phase comprises a number of Work Packages, including:
- Requirements Gathering - a detailed assessment of the equipment carried by Dismounted Close Combat Personnel (DCCP), power demands and operational usage. Key elements of this information are included in the data pack;
 - Market Research – analysis of existing technology and near term future developments.
- 4.3 A cross functional selection team will look at the proposed solutions and commission exploratory work – termed '90 day design' - this is an indicative timeframe that provides a guideline for duration of the exploratory contract.
- 4.4 During Phase 2, the '90 day design' work will be carried out, at the end of which the supplier will provide a technical demonstration with a report and plan that includes their proposal for continued funding. Following a feasibility assessment, continuation contracts will be placed with successful suppliers.
- 4.5 Phase 3 will involve the design, build and, where appropriate, systems integration of the solution, followed by trials.

5 Getting involved

- 5.1 Proposals and expressions of interest in the 'Energy Efficient Soldier' programme are invited from industry and academia.
- 5.2 Proposals for work in the short term should be submitted via the CDE process. Up to £1M (in total) is available for this call. Proposals should be for a maximum duration of three months. Proposals can be for full or partial MOD funding. There is no cap on the value of proposals but it is more likely that a larger number of lower value proposals (£30k – £50k) will be funded than a smaller number of higher value proposals. It is likely that most proposals will be for proof of principle/concept studies. However, proposals for the first stage of a longer project will also be considered, provided that a clear indication of the timeline and scope of the complete project is included. Reports and proposals for further work are to be submitted at the end of the three month working period. The most promising strands of work are likely to be taken forward with follow-on contracts. Further funds are available for these follow-on contracts.
- 5.3 Before submitting a proposal, you should read carefully the guidance on the CDE website. In particular, you should note that the standard terms & conditions of the CDE must be unequivocally accepted in order for a proposal to be considered.
- 5.4 In order to distinguish responses to this call, the title of proposals should start with the words "Energy Efficient Soldier proposal." In addition, proposals should clearly state, in the first section (Innovation Description), estimates of the weights and volumes of their power systems and the timelines they are looking at, or the specific energy of the system over a defined time. Although examples of current equipment and power sources have been given in Sections 2 and 3, these should not be allowed to constrain potential ideas or solutions, nor should they be seen as exhaustive.
- 5.5 It is important for suppliers to understand that the 'Energy Efficient Soldier' programme is focused on looking at *High Risk, Quick Win* solutions, and suppliers are urged to submit their best ideas, regardless of how unusual or outrageous they may at first appear. MoD is seeking disruptive technology that can have a significant impact on operational capability so the desire is for revolution rather than evolution.
- 5.6 The timeline for CDE proposals is as follows:
- 24 Mar CDE seminar: call opens
 - 7 May Call closes
 - 21 May Target for making decisions
 - 5 Jun Target for contract placement
 - Mid Sep Submit reports & proposals for continuing funding
 - End Sep Review contracts & decide which to continue
 - 1 Oct Target for follow-on contract placement
- 5.7 You may submit an expression of interest instead of (or as well as) a CDE proposal. This is not a request for funding. It provides a mechanism by which you can register an interest in future involvement in the Energy Efficient Soldier programme. You can also use it to raise awareness of a system or concept that either exists or is in development and which might form part of the Soldier-Power solution.
- 5.8 Expressions of interest should be sent directly to the 'Energy Efficient Soldier' programme team using the enclosed contact list. Please include the following information:
- enterprise name, point of contact and contact information
 - type & size of enterprise
 - scale of current work for MOD
 - details of any specific research, products or programmes that are relevant to the 'Energy Efficient Soldier' – including why you believe that they are relevant
 - desired future role in the 'Energy Efficient Soldier' programme (system architect, sub-component/technology provider, trial manager, etc)

- 5.9 You should feel free to attach any relevant documents. You may also request a meeting to discuss your interests.
- 5.10 Where possible, expressions of interest should be submitted by 7 May. However, expressions of interest received after this date may still be considered.

6 APPENDICES
6.1 APPENDIX A

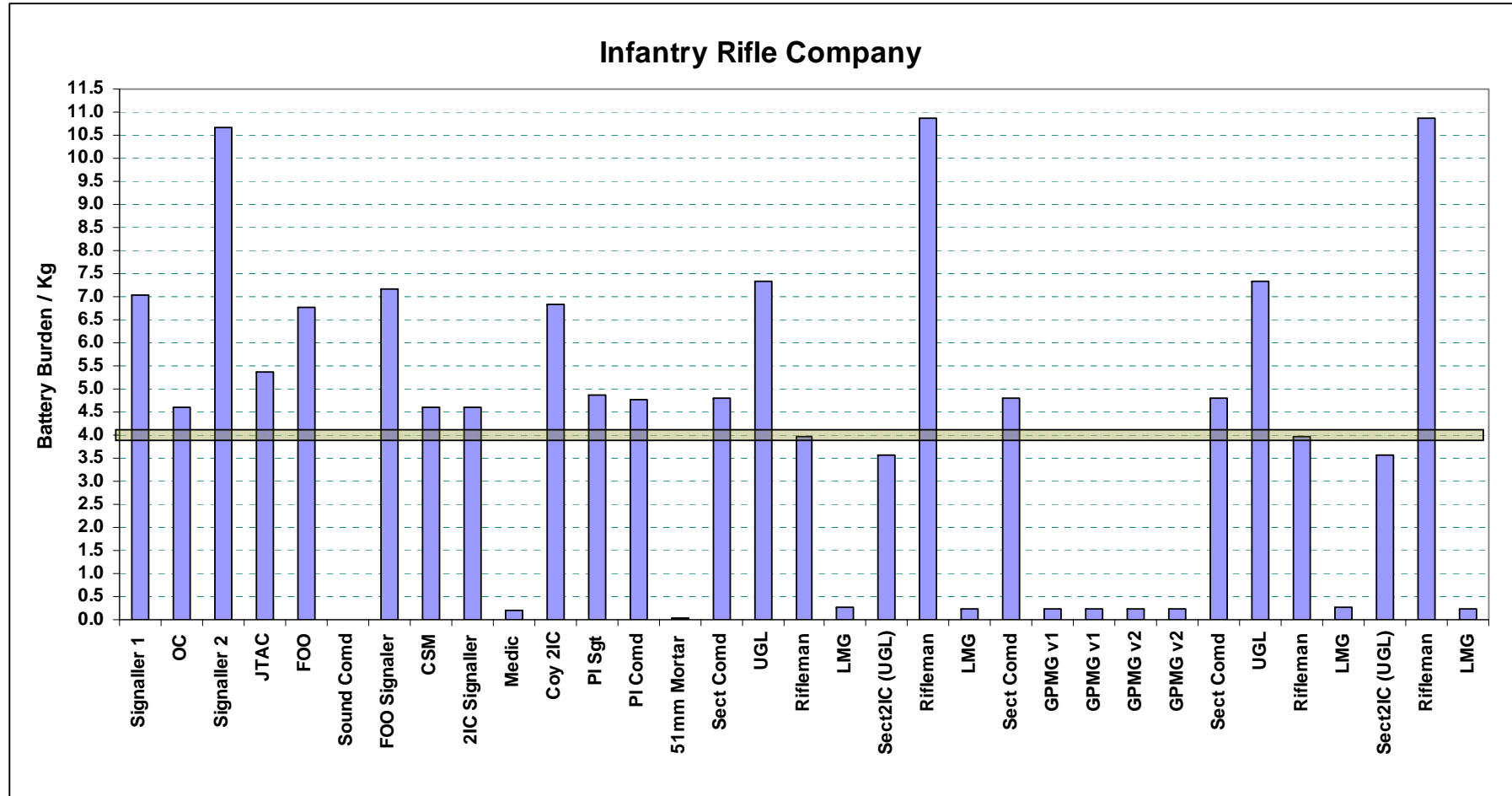


Figure 4 – Battery burden break down by role from a typical 48 hour rural patrol mission. Grey box indicating the average battery burden of ~ 4 kg,

6.2 APPENDIX B

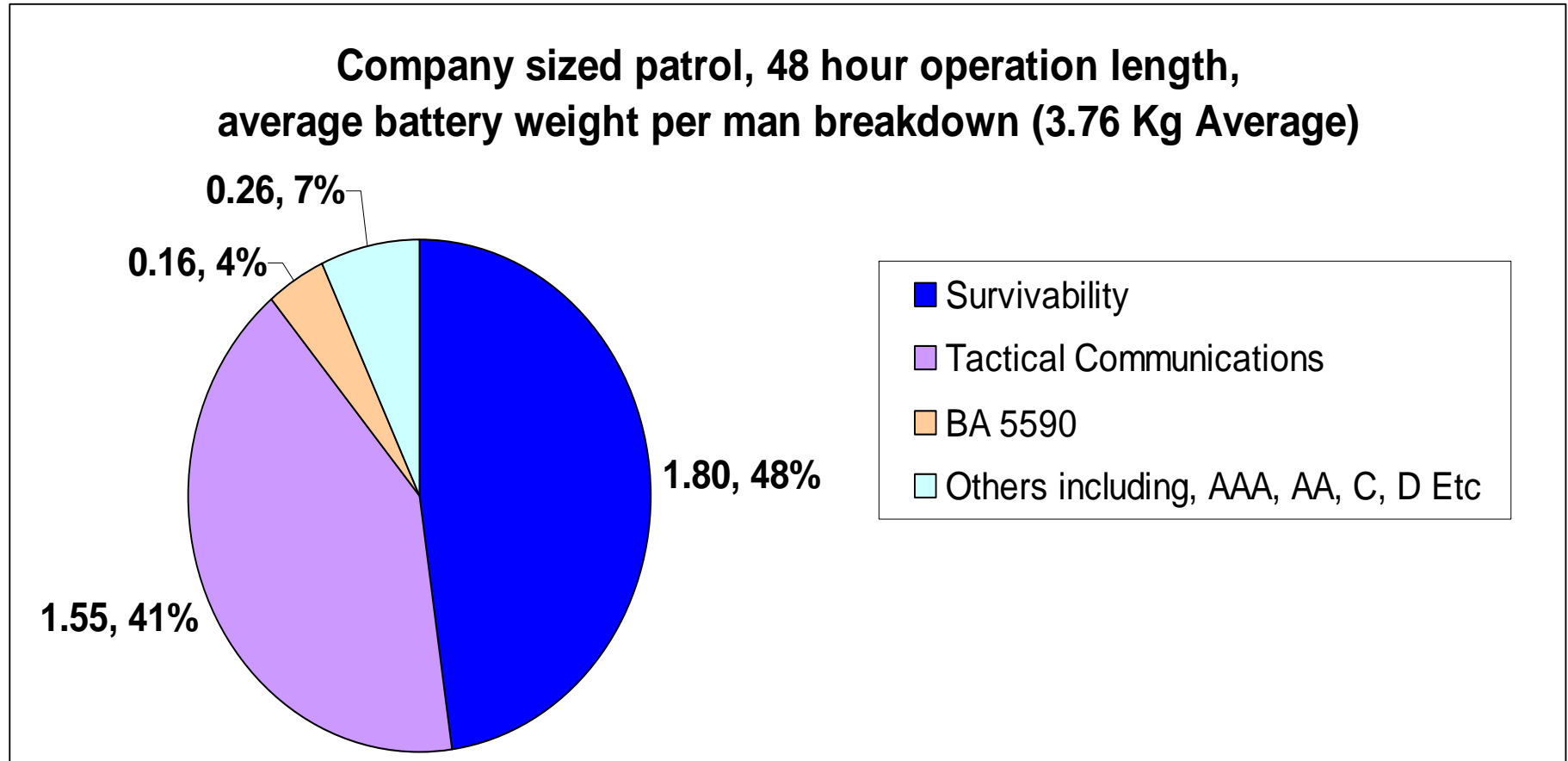


Figure 5 – Average battery burden break down across the whole company (80 – 100 men) on a rural mission.