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UNCONTROLLED EVALUATION OF THE MODULAR FIGHTING RIGS

by:

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Abstract

The Modular Fighting Rig (MFR) extended user evaluation took the form of a series of surveys and focus groups conducted with three task forces. Each task force drew from one of the infantry regiments (PPCLI, R22ER, and RCR) from across Canada, who were the primary target for collection of feedback on the MFRs. A total of three MFRs (800 sets of each) were evaluated in this study, all of which were issued by the Directorate of Land Requirements (DLR) regardless of this study. Once DLR issued the MFRs to the battle group they determined which soldiers would be issued the MFRs. The three MFR design alternatives under evaluation in this study have been labelled Alpha (A), Bravo (B), and Charlie (C). MFR A is a multi-part system that uses interchangeable front and back panels. Three front panels (A1, A2, A3) and two back panels are provided with MFR Alpha. All of the trial vests performed well across the duration of the trial. The majority of the ratings for each criterion for each of the MFRs were acceptable for both the mid-deployment and post-deployment questionnaires. In terms of the mid deployment data collection we received feedback from 265 soldiers for MFR A (33%), 239 soldiers for MFR B (29.9%), and 226 soldiers for MFR C (28.3%). In terms of the post deployment data collection we had responses from 96 soldiers for MFR A (12%) and 140 soldiers for MFR B (17.5%). Across the vast majority of criteria MFR A had higher acceptability ratings compared to MFR B and MFR C. The majority of participants who were given MFR A to use chose to use the MFR A2 front panel for its increased real estate to mount pouches. There were only two instances of ratings that were unacceptable across all of the MFRs and they were both for MFR C (stability while in prone, and ease of donning during the mid-deployment questionnaire). Despite the positive ratings the majority of participants indicated that the MFRs require minor modifications prior to being fielded to entire Canadian Forces. One of the modifications to MFR A2 that most of the participants agreed upon is to make the side attachment system more accessible by either reversing the buckles or by lengthening the webbing strap on the rear buckle. All of the vests in this trial were proved to be an acceptable alternative for the in-service tactical vest during an operational tour.

Résumé

L'évaluation approfondie de la veste de combat modulaire (VCM) par l'utilisateur a pris la forme de sondages et de groupes de discussion menés auprès de trois groupes de travail. Chacun de ces groupes était constitué de soldats provenant d'un des régiments d'infanterie (PPCLI, R22eR et RCR) de partout au Canada. Ces soldats ont été désignés comme étant les participants cibles pour recueillir des commentaires sur les VCM. Au total, trois VCM (800 ensembles de chaque) ont fait l'objet d'une évaluation dans le cadre de la présente étude. La Direction des besoins en ressources terrestres (DBRT) a fourni toutes les vestes sans tenir compte de l'étude. Après avoir remis les VCM au Groupement tactique, la Direction a déterminé quels soldats recevraient les VCM. Les trois options de conception de VCM soumises aux évaluations dans le cadre de la présente étude ont été étiquetées Alpha (A), Bravo (B), and Charlie (C). La VCM A est un système multipièce qui utilise trois panneaux avant (A1, A2, A3) et deux panneaux arrière interchangeables. Toutes les vestes soumises aux essais ont obtenu un bon rendement. Pour chaque VCM, la majorité des notes obtenues pour chacun des critères d'évaluation étaient acceptables pour les questionnaires remis à mi-déploiement et après le déploiement. En ce qui a trait aux données recueillies à mi-déploiement, nous avons reçu les commentaires de 265 soldats pour la VCM A (33 %), de 239 soldats pour la VCM B (29,9 %) et de 226 soldats pour la VCM C (28,3 %). Pour les données recueillies après le déploiement, les réponses obtenues provenaient de 96 soldats pour la VCM A (12 %) et de 140 soldats pour la VCM B (17,5 %). Pour la grande majorité des critères, la VCM A a obtenu un taux d'acceptation plus élevé que la VCM B et la VCM C. La majorité des participants qui ont reçu une VCM A ont préféré la VCM A2 (deux panneaux avant) parce qu'il y a plus d'espace pour fixer une pochette. Pour l'ensemble des VCM, il n'y a qu'à deux reprises où le résultat a été inacceptable. Dans les deux cas, il s'agissait de la VCM C (stabilité en position couchée et facilité à enfiler pour le questionnaire remis à mi-déploiement). Malgré les résultats positifs, la majorité des participants ont indiqué que de légères modifications devraient être apportées aux VCM avant leur mise en service dans l'ensemble des Forces canadiennes. La plupart des participants s'entendent pour dire qu'il faudrait accroître l'accessibilité du système d'attache latéral de la VCM A2 en inversant les boucles ou en allongeant la sangle de la boucle arrière. Toutes les vestes soumises à cet essai se sont avérées une solution acceptable pour remplacer la veste tactique présentement utilisée pendant une affectation opérationnelle.

Executive Summary

Uncontrolled Evaluation of the Modular Fighting Rigs

Chris Ste-Croix, Harry Angel, Brian Mangan, and Cheryl Karthaus, Humansystems® Incorporated; DRDC Toronto No. CR2013-034; Defence R&D Canada – Toronto; January 2013.

Mandate This study was conducted from July 2010 to December 2012 on behalf of DRDC Toronto under PWGSC Contract No.W8486-094085.3072 TOR Task No.094085.3072

Purpose The aim of the survey was to solicit feedback on the MFR systems usability, compatibility with soldier equipment and tasks, impact on operational performance, design features, and functionality. Results will be used to inform and influence the acquisition of a MFR for the Canadian Forces.

Background The Tactical Vest (TV) currently in use by the Canadian Forces (CF) was developed as part of the Clothe the Soldier (CTS) project in June 1995 in order to provide load carriage capabilities for the Army. In 1999, the Statement of Requirements (SOR) was written for the TV and the equipment came into service in early 2002 following a series of controlled user trials and clinical evaluations conducted at Queen's University, Kingston.

The current TV was developed using technology from the 1990s and reflects the operational requirements of that time (efficient logistical resupply, short duration engagements, etc.) The CF is actively engaged in dispersed operations overseas and is in need of a new TV to meet the demands of prolonged operations with minimal logistical resupply.

Recent operational experience has generated many observations concerning the inadequacy of the TV. The complaints have centred on the inability of the infantry soldier to configure pouches and pockets to personalize the load configuration for assigned tasks/roles (e.g. C7 M-203 gunner, C9 gunner, etc.) and on the inability to have immediate access to munitions and ammunition. Consequently, many soldiers currently being deployed to Afghanistan are acquiring non-issued equipment over the service standard. This is potentially dangerous to the soldier as these non-issued vests have not been tested to meet CF standards.

Method The MFR extended user evaluation took the form of a series of surveys and focus groups conducted with three task forces. Each task force drew from one of the infantry regiments (PPCLI, R22ER, and RCR) from across Canada, who were the primary target for collection of feedback on the MFRs. DLR determined that each task force be issued one of the three MFR systems identified by the SME jury.

The means of survey implementation were mainly paper-based. Surveys were completed during deployment (mid-deployment), and following deployment (post-deployment for only MFR A and MFR B). The post deployment survey was accompanied by a focus group session. This created an independent groups, repeated observations experimental design. Note that this was an uncontrolled evaluation taking place during training and operations, and there was little control over the issuing of MFRs, timing of data collection, or use of the MFRs.

Main Results All of the trial vests performed well across the duration of the trial. The majority of the ratings for each criterion for each of the MFRs were acceptable for both the mid-deployment and

post-deployment questionnaires. Across the vast majority of criteria MFR A had higher acceptability ratings compared to MFR B and MFR C. In most cases MFR A these higher acceptability ratings were found to be statistically significant. There were only two instances of ratings that were unacceptable and they were both for MFR C (stability while in prone, and ease of donning on the mid-deployment questionnaire). Despite the positive ratings the majority of participants indicated that all of the MFRs require minor modifications prior to being fielded to entire Canadian Forces.

Participants provided ratings of acceptability on specific features for each of the MFRs. All of the features for MFR A and MFR B were found to be acceptable. The features for MFR A tended to have higher acceptability ratings compared to those for MFR B. There was a slight preference to a side opening vest style compared to a front opening vest style.

Main Conclusions: Overall, all of the vests received acceptable ratings across the vast majority of the criteria that we evaluated. MFR A was the vest that tended to receive the highest ratings across most of the criteria. Despite the positive ratings the majority of participants indicated that all of the MFRs require minor modifications prior to being fielded to entire Canadian Forces. One of the modifications to MFR A2 that most of the participants agreed upon is to make the side attachment system more accessible by either reversing the buckles or by lengthening the webbing strap on the rear buckle. With regards to MFR B, participants indicated that increasing the MOLLE real estate would likely decrease the bulk issue of mounting pouches onto pouches. All of the vests in this trial were proved to be an acceptable alternative for the in-service tactical vest during an operational tour.

Sommaire

Évaluation non contrôlée des vestes de combat modulaires

Chris Ste-Croix, Harry Angel, Brian Mangan, et Cheryl Karthaus, Humansystems® Incorporated; RDDC Toronto No. CR2013-034; R&D pour la défense Canada – Toronto; janvier 2013.

Mandat La présente étude a été menée de juillet 2010 à décembre 2012 au nom de RDDC Toronto dans le cadre du contrat de TPSGC n° : W8486-094085.3072 TOR, tâche n° : 094085.3072

Objet Le sondage visait à recueillir des commentaires sur la facilité d'utilisation du système VCM, la compatibilité avec l'équipement et les tâches du soldat, les répercussions sur le rendement opérationnel, les caractéristiques et la fonctionnalité. Les résultats serviront à informer et à promouvoir l'achat de VCM pour les Forces canadiennes.

Introduction La veste tactique (VT) actuellement utilisée par les Forces canadiennes (FC) a été conçue dans le cadre du projet « Habillez le soldat » en juin 1995 afin d'offrir à l'armée des moyens de transport de charge. En 1999, un énoncé des besoins a été rédigé pour le projet de la VT. Puis, l'équipement est entré en service au début de 2002, à la suite d'une série d'essais contrôlés et d'évaluations cliniques menés auprès d'utilisateurs à l'Université Queen's, Kingston.

La VT actuelle a été conçue en utilisant la technologie des années 1990 et elle reflète les exigences opérationnelles de l'époque (réapprovisionnement logique efficace, engagement de courte durée, etc.). Les FC participent activement aux opérations dispersées à l'étranger et elles ont besoin d'une nouvelle VT pour satisfaire aux demandes d'opérations prolongées avec un réapprovisionnement logique minimal.

Dans le cadre d'une récente expérience opérationnelle, nous avons reçu plusieurs commentaires à l'effet que la VT actuelle était inadéquate. Les plaintes portaient surtout sur l'incapacité pour le soldat d'infanterie de configurer les poches et les pochettes en vue de personnaliser la configuration de chargement requise pour les tâches et les rôles assignés (p. ex. canonnière C7 M-203, canonnière C9, etc.) et sur l'incapacité d'avoir un accès immédiat aux munitions. Par conséquent, plusieurs soldats, présentement déployés en Afghanistan, font l'acquisition d'équipement en faisant fi de la norme de service. Ce geste constitue un danger potentiel pour le soldat compte tenu que ces vestes non prescrites n'ont pas été soumises aux essais et ne satisfont pas aux normes des FC.

Méthode L'évaluation approfondie de la VCM par l'utilisateur a pris la forme de sondages et de groupes de discussion menés auprès de trois groupes de travail. Chacun de ces groupes était constitué de soldats provenant d'un des régiments d'infanterie (PPCLI, R22eR et RCR) de partout au Canada. Ces soldats étaient désignés comme étant les participants cibles pour recueillir des commentaires sur les VCM. La Direction des besoins en ressources terrestres (DBRT) a déterminé que chaque groupe de travail recevrait l'un des trois systèmes VCM identifiés par un juré expert en la matière.

Le sondage s'est effectué principalement à l'aide de questionnaires. Ces derniers ont été remplis à mi-déploiement et après le déploiement (postdéploiement pour la VCM A et la VCM B seulement). Le sondage postdéploiement s'accompagnait de discussions en groupes. Cela a donné lieu à la création de deux groupes indépendants et à des observations répétées sur les conceptions expérimentales. Il est important de se rappeler qu'il s'agissait d'une évaluation non contrôlée menée

pendant la formation et les opérations et que les groupes de travail avaient peu de contrôle sur la livraison des VCM, le temps opportun pour la cueillette des données ou l'utilisation des VCM.

Résultats Toutes les vestes soumises aux essais ont obtenu un bon rendement. Pour chaque VCM, la majorité des notes obtenues pour chaque critère d'évaluation étaient acceptables pour les questionnaires remis à mi-déploiement et à postdéploiement. Pour la grande majorité des critères, la VCM A a obtenu un taux d'acceptation plus élevé que la VCM B et la VCM C. Dans la majorité des cas, ces taux d'acceptation supérieurs avaient une importance du point de vue statistique. Les résultats de l'évaluation ont été inacceptables à deux occasions seulement. Dans les deux cas, il s'agissait de la VCM C (stabilité en position couchée et facilité à enfiler pour le questionnaire remis à mi-déploiement). Malgré les résultats positifs, la majorité des participants ont indiqué que de légères modifications devraient être apportées à toutes les VCM avant leur mise en service dans l'ensemble des Forces canadiennes.

Pour chaque VCM, les participants ont coté diverses caractéristiques. En ce qui a trait à la VCM A et à la VCM B, les participants ont trouvé que toutes les caractéristiques étaient acceptables. Les caractéristiques pour la VCM A avaient tendance à obtenir un meilleur taux d'acceptation par rapport à celles pour la VCM B. On note une légère préférence pour une veste qui s'ouvre sur le côté plutôt qu'à l'avant.

Principales conclusions : Dans l'ensemble, les vestes ont reçu une note acceptable pour la grande majorité des critères évalués. La veste qui a obtenu les meilleurs résultats est la VCM A. Malgré les résultats positifs, la majorité des participants ont indiqué qu'il faudrait apporter de légères modifications aux VCM avant leur mise en service dans l'ensemble des Forces canadiennes. La plupart des participants s'entendent pour dire qu'il faudrait accroître l'accessibilité du système d'attache latéral en inversant les boucles ou en allongeant la sangle de la boucle arrière. En ce qui a trait à la VCM B, les participants indiquent que l'augmentation de l'espace pour l'ELMTC réglerait probablement le problème d'encombrement lié au fait d'installer des pochettes sur des pochettes. Toutes les vestes soumises à cet essai se sont avérées une solution acceptable pour remplacer la veste tactique actuellement utilisée pendant une affectation opérationnelle.

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1. Background

The Tactical Vest (TV) currently in use by the Canadian Forces (CF) was developed as part of the Clothe the Soldier (CTS) project in June 1995 to provide load carriage capabilities for the Army. In 1999, the Statement of Operational Requirements (SOR) was written for the TV and the equipment came into service in early 2002 following a series of controlled user trials and clinical evaluations conducted at Queen's University, Kingston.

The current TV was developed using technology from the 1990s and reflects the technology available and the operational requirements of that time (efficient logistical resupply, short duration engagements, etc.). The CF is actively engaged in dispersed operations overseas and is in need of a new load carriage solution to meet the demands of prolonged operations with minimal logistical resupply. All members of the CF must be able to perform missions and tasks in a variety of aversive environments in order to protect themselves and others during combat operations. As a result, the development of a new load carriage solution is an immediate requirement for the Land Force (LF)

Recent operational experience has generated many observations concerning the inadequacy of the current issue TV. The anecdotal complaints have centred on the inability of the infantry soldier to configure pouches and pockets to personalize the load configuration for assigned tasks/roles (e.g. C7 M-203 gunner, C9 gunner, etc.) and on the inability to have immediate access to munitions and ammunition. Consequently, many soldiers currently being deployed to Afghanistan are acquiring and utilizing commercial systems. This is potentially dangerous to the soldier as these non-issued load carriage systems have not been tested to meet CF standards (e. g. fire retardency, camouflage, infrared).

A focus group workshop with a jury of Subject Matter Experts (SMEs) was held in July 2009 to identify possible solutions for a short term load carriage acquisition and evaluation effort. Thirty-four highly experienced soldiers representing Canadian Army units from across Canada participated. The workshop included sessions to help identify realistic loads to be carried, to identify relative importance between competing requirements, a baseline evaluation of the current issue TV, and systematic evaluation of 12 candidate load carriage systems, establishing load carriage pouch requirements, identifying desirable pouch features, and refining the suite of required pouches. The primary reason cited as to why the current tactical vest should be replaced is that it does not have the capacity to carry the amount of ammunition and items that soldiers typically carry and that it is not fully configurable to accommodate different job requirements and carry different items. The new load carriage system was given the name, Modular Fighting Rig (MFR). Overall ratings of the MFR systems evaluated identified MFR alternatives A, C, and F as the highest potential systems (see Ste-Croix, Morton, and Angel, 2009). During the focus group discussion, more than 80% of SMEs indicated that MFRs A, C, or F should be forwarded for formal army evaluation.

A pilot trial was conducted to perform a preliminary evaluation of the MFRs and develop methods of evaluation for future trials. Fourteen soldiers participated in a balanced, repeated measures evaluation of the MFRs selected by the SME jury. From this study recommendations for pouch placement on each of the new MFRs were developed and methods of MFR evaluation were refined (Ste-Croix, Morton, and Angel, 2010).

The three highest potential MFRs were subsequently procured in quantity and issued to the next three task forces deploying to Afghanistan (timeframe 2010-2011). The Directorate of Land Requirements (DLR) issued these MFRs to fulfil the commander of the LF's promise to equip soldiers deploying to Afghanistan with an alternative load carriage solution to the TV. To capitalize on this opportunity to

learn more about the performance of these MFRs, Defence Research and Development Canada (DRDC) Toronto was asked to collect feedback from these soldiers. This feedback will help to inform future acquisition of a new modular load carriage system for the Canadian Forces (CF) to replace the TV.

1.1 Abbreviations and Definitions

The following abbreviations are used throughout this report.

<u>Abbreviation</u>	<u>Definition</u>
ANOVA	Analysis of Variance
CF	Canadian Forces
COTS	Commercial-Off-the-Shelf
CTS	Clothe the Soldier
DLR	Directorate of Land Requirements
DRDC	Defence Research and Development Canada
FPV	Fragmentation Protection Vest
GPS	Global Positioning System
HF	Human Factors
LF	Land Forces
LMG	Light Machine Gun
MFR	Modular Fighting Rig
MMG	Medium Machine Gun
MOLLE	Modular Lightweight Load-Carrying Equipment
NBC	Nuclear, Biological, Chemical
PALS	Pouch Attachment Ladder System
PPCLI	Princess Patricia's Canadian Light Infantry
PRC	Portable Radio Communications
PRR	Personal Role Radio
R22eR	Royal 22 nd Regiment
RCR	Royal Canadian Regiment
Rds	Rounds
ROM	Range of Motion
SCS	SORD Classic System
SD	Standard Deviation
SME	Subject Matter Experts
SOR	Statement of Operational Requirements
SORD	Special Operations Research and Development
TCCC	Tactical Combat Casualty Care
TV	Tactical Vest

2. Aim

The aim of the survey was to solicit feedback on the MFR systems usability, compatibility with soldier equipment and tasks, impact on operational performance, design features, and functionality. Results will be used to inform and influence the acquisition of a new MFR for the Canadian Forces.



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3. Methods

The MFR extended user evaluation took the form of a series of surveys and focus groups conducted with three task forces. Each task force drew from one of the infantry regiments (PPCLI, R22ER, and RCR) from across Canada, who were the primary target for collection of feedback on the MFRs. DLR determined that each task force be issued one of the three MFR systems identified by the SME jury.

The means of survey implementation were mainly paper-based. Surveys were completed during deployment (mid-deployment), and following deployment (post-deployment for only MFR A and MFR B). The post deployment survey was accompanied by a focus group session. This created an independent groups, repeated observations experimental design. Note that this was an uncontrolled evaluation taking place during training and operations, and there was little control over the issuing of MFRs, timing of data collection, or use of the MFRs.

The mid-deployment extended user evaluation for MFR A, MFR B, and MFR C took the form of a series of surveys and focus groups conducted in Afghanistan by DLR 5 during a Joint Task Force operation. The paper-based surveys and configuration photos were captured after a number of months of MFR use.

The post-deployment extended user evaluation for MFR A and MFR B took the form of a series of surveys and focus groups conducted once the soldiers returned from their deployment.

A total of 800 sets of the MFRs were issued to each of the task forces. MFR A was issued to the 2R22R task force, MFR B was issued to the 1PPCLI task force, and MFR C was issued to the 3RCR task force. Each task force command was responsible for issuing the MFRs internally to their units according to their own set of priorities (i.e. rifle companies first). The MFR systems were subsequently used during pre-deployment training and while deployed.

3.1 Conditions

The three MFR design alternatives under evaluation in this study have been labelled Alpha (A), Bravo (B), and Charlie (C). These alphanumeric labels have been given for consistency with past MFR evaluations and to reduce biases associated with brand names.

3.1.1 MFR A

MFR Alpha was developed by Special Operations Research and Development (SORD) Australia and is a multi-part system that uses interchangeable front and back panels. Three front panels (A1, A2, A3) and two back panels are provided with MFR Alpha.

MFR A1 is the SORD Classic System Vest with a Chest Rig Back Mesh – see Figure 1. MFR A1 is a front opening vest held together with 3 side release buckles, and the system can be adjusted at the shoulders. Pocket Attachment Ladder System (PALS) real estate is provided on the front and back of the system and the PALS webbing is stitched overtop a mesh material.



Figure 1: MFR A1

MFR A2 is the SORD Classic System Chest Rig with their Chest Rig Back – see Figure 2. MFR A2 is a side opening vest, that can also be donned overhead, that encompasses a larger amount of PALS real estate on the front of the vest. It is attached at the waist by a side release buckle on both sides.



Figure 2: MFR A2

MFR A3 is the SORD Classic System DH Chest Rig with the Chest Rig Back Mesh panel – see Figure 3. MFR A3 has a similar waist attachment system as MFR A2 but it lacks the front panel bib that MFR A2 provides, therefore decreasing the amount of PALS real estate on the front.



Figure 3: MFR A3

3.1.2 MFR B

MFR B is a 2-piece Modular Assault Vest designed by Tactical Tailor® – see Figure 4. MFR B is a front opening vest that is attached using two side release buckles and has PALS real estate on the front and back. The PALS real estate on front was increased by the addition of an add-on central adaptor that bridged the gap between the right and left panels – see Figure 4.



Figure 4: MFR B and adaptor

3.1.3 MFR C

MFR C was developed by SORD Australia as their Chest Rig system – see Figure 5. MFR C is a side opening vest with attachments at both sides of the vest with additional PALS webbing on the shoulder straps. MFR C also has a bib that is attached at the shoulders by a D-ring and snap which can be left up to provide additional PALS real estate on the front or it can be folded down into a more traditional chest rig design.



Figure 5: MFR C

3.2 Participants

Two sets of questionnaires were completed during this survey, one during mid-deployment, and one during post-deployment. The following table shows the response rate for each of the surveys – see Table 1.

Table 1: Participant response rates

MFR	Mid Deployment (%)	Post Deployment (%)
MFR A	265 (33%)*	96 (12%)
MFR B	239 (29.9%)*	140 (17.5%)
MFR C	226 (28.3%)*	-

*For MFR A two participants were female, for MFR B, three participants were female, and for MFR C 14 participants were female.

3.2.1 Mid- Deployment

In the mid-deployment survey several anthropometric measures were self-recorded including weight (kg), stature (cm), chest circumference at the level of the thelion (cm), and waist circumference at the level of the omphalion (cm). With respect to participant weight, the average weight for each MFR ranged from 82.2 kg to 86.7 kg which is equal to the 55th – 65th percentile male according the 1997 Canadian Forces anthropometric survey. The minimum weights for each MFR ranged from 1st %ile female to the 5th %ile female with the maximum weights ranging from the 98th %ile male to greater than the 99th %ile male – see Table 2.

In terms of stature the average for each MFR ranged from 177.3cm to 180.3cm which was equal to the 61st %ile male to the 75th %ile male. The minimum and maximum heights of the participants for each MFR ranged from the 5th – 15th %ile female to greater than the 99th %ile male – see Table 2.

For MFR A the participants median chest circumference was equal to the 48th %ile male while the waist circumference was equal to the 25th %ile male. The group of participants that wore MFR B had a chest circumference equal to the 55th %ile male and a waist circumference of the 35th %ile male. In terms of the participants that wore MFR C the average chest circumference was equal to the 40th %ile

male and the waist circumference was equal to the 55th %ile male. For the majority of MFRs the range of participants for the chest and waist circumference varied from less than the 1st%ile female to greater than the 99th %ile male – see Table 2.

The anthropometric data gathered from all the participants of the mid deployment shows that there a large representation of participants with regards to their anthropometry.

Table 2 – Anthropometry of mid-deployment participants compared to CF averages

Anthropometric	MFR A Mean \pm SD (%ile)		MFR B Mean \pm SD (%ile)		MFR C Mean \pm SD (%ile)	
	Min (%ile)	Max (%ile)	Min (%ile)	Max (%ile)	Min (%ile)	Max (%ile)
Weight (kg)	82.2 \pm 10.2 (55 th)		85.6 \pm 11.3 (65 th)		86.7 \pm 13.8 (65 th)	
	47.7 (1 st F)	113.6 (98 th M)	51.8 (5 th F)	118.2 (99 th M)	51.8 (5 th F)	136.4 (>99 th M)
Stature (cm)	177.3 \pm 7.2 (61 st)		180.3 \pm 6.7 (75 th)		179.1 \pm 7.5 (70 th)	
	154.9 (5 th F)	198.1 (>99 th M)	155 (5 th F)	198.1 (>99 th M)	157.5 (15 th F)	205.7 (>99 th M)
Chest Circumference - Thelion (cm)	101.9 \pm 11.9 (48 th)		103.6 \pm 8.4 (55 th)		99.8 \pm 8.6 (40 th)	
	71.1 (<1 st F)	152.4 (>99 th M)	74.9 (<1 st F)	127 (>99 th M)	78.7 (<1 st F)	130.0 (>99 th M)
Waist Circumference - Omphalion (cm)	84.5 \pm 7.3 (25 th)		87.3 \pm 7.9 (35 th)		93.3 \pm 10.5 (55 th)	
	50.8 (<1 st F)	106.7 (90 th M)	68.6 (1 st F)	121.9 (>99 th M)	66.0 (<1 st F)	127.0 (>99 th M)

Of those participants who indicated their rank on the survey form, the ranks ranged from Private to LtCol. For MFR A the majority of participants (n = 108) were at the Private rank (including Troopers and Sappers). The greatest representation from the officer corps was Lieutenants (n = 8). For MFR B and MFR C the majority of participants (n=92 and 68) were at the Corporal level with the highest representation from the officer corps being Captain (n=16 and 26). The breakdown of ranks is presented in Table 3.

Table 3 – Participants by rank

Rank	MFR A (n)	MFR B (n)	MFR C (n)
LT	8	3	4
CAPT	4	16	26
MAJ / LtCdr	2	-	7
LtCol	-	1	4
PTE / Trooper / Sapper	108	57	28
CPL / BDR	90	92	68
MCPL / MBDR	22	32	35
SGT	15	21	27
WO	8	12	17
MWO	-	3	4

The majority of participants indicated what their home unit was and the vast majority of the participants indicated that their home was the primary infantry battalion for the specific battle group. For MFR A the majority of participants who noted their home unit came from the 1st Battalion of the Royal 22^e Regiment (R22ER) (n = 159) while for MFR B the majority of participants (n=218) came from 3rd battalion of Princess Patricia's Canadian Light Infantry (PPCLI) and for MFR C the majority of participants (n=117) came from the 2nd battalion of the Royal Canadian Regiment (RCR) – see Table 4.

Table 4 – MFR A unit distribution of responses

Unit	n
1R22ER	159
3R22ER	39
5RGC	18
5 RALC	12
12RBC	6
2R22ER	5
CIE PARA	5
1CER	4
5 AMB C	4
34 RGC	1
Total	253

Table 5: MFR B unit distribution of responses

Unit	n
3PPCLI	218
LdSH	7
BCR	3
LER	3
1 Fd Ambulance	2
1CER	1
1RCHA	1
C Scot R	1
Rocky Mountain Rangers	1
Total	237

Table 6: MFR C unit distribution of responses

Unit	n
2RCR	117
NCSE	18
Signals	13
CFC	10
CCTM-A	6
Service Battalion	5
RCD	5
1 and 3 RCR	4
1 CDN FD Hospital	3
MTAG	3
2 FD Ambulance	2
Total	186

Participants noted their primary weapon system they used during the first part of their deployment and for each battle group there was a wide selection of weapons indicated as their primary weapon. The most common primary weapon across each battle group was the C7A2. One hundred and five subjects that used MFR A indicated that they primarily used the C7A2, 71 indicated the C8, 48 said they used the C7 with the M203 grenade launcher, and 42 indicated that they were automatic riflemen using the C9. For MFR B, 117 indicated that they primarily used the C7A2, 80 indicated the C8, 25 said they used the C7 with the M203 grenade launcher, and 27 indicated that they were automatic riflemen using the C9. For the MFR C, 143 indicated that they primarily used the C7A2, 63 indicated the C8, 8 said they used the C7 with the M203 grenade launcher, and 13 indicated that they were automatic riflemen using the C9. These results are summarized in Table 7.

Table 7 – Primary weapon used with MFR

Primary Weapon	MFR A (n)	MFR B (n)	MFR C (n)
C7A2	105	117	143
C8	71	80	63
C7/M203	48	25	8
C9	42	27	13
9mm	32	87	76
Other	15	3	1

3.2.2 Post-deployment

For the post-deployment data collection a total of 96 CF soldiers participated in the evaluation of MFR A and a total of 140 CF soldiers participated in the evaluation of MFR B. All of the participants that took part in the post-deployment evaluation for MFR A were from the 1st Battalion R22eR while all of the participants that took part in the post-deployment evaluation for MFR B were from the 3rd Battalion PPCLI.

3.3 Data Collection Tools

The primary data collection tools used in this study were surveys. Factors affecting MFR performance were deconstructed into a series of unique criteria for investigation. Further criteria included unique role, mission, task, and load considerations. Standardized likert-style scales, as shown in Figure 6, were used to quantify soldier assessments.

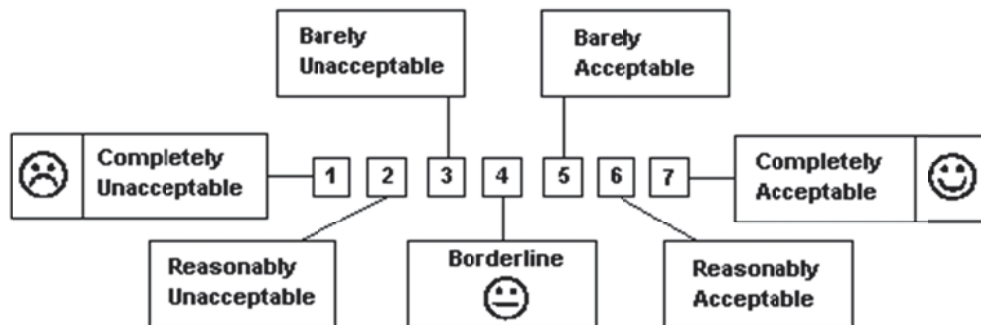


Figure 6: Standard rating scale

3.4 Mid-Deployment Questionnaires

Participants completed a number of questionnaires, under the supervision of DLR 5, that were intended to gather feedback on their perceptions of the MFR designs.

Participants completed a personal information questionnaire that gathered information on the participants' gender, age, unit, personal weapon, job title, anthropometrics, and operational experience – see Annex A.

Participants completed a photo survey questionnaire that prompted them to indicate the weight of their vest (including fighting load). Participants also indicated which configuration of pouches they wore (i.e. rifleman, gunner, commander, etc...) and the size of MFR, if applicable. Participants were asked to indicate the type of missions they took part in, the average duration of the missions, and the

percentage of time the missions were dismounted, mounted, during the day, or at night. Participants then had to opportunity to indicate the items that they carried within their small pack and which pouches they wore on their MFR for a typical mission. Participants also noted which pouches they purchased on their own. Additionally, for MFR A participants indicated which front and back panels they used most often – see Annex B.

The last questionnaire participants completed assessed the MFR over a range of issues (e.g. stability, modularity, fit, compatibility, capacity, comfort, and durability). Participants rated the acceptability of the MFRs across all of the criteria using the seven-point scale of acceptance (e.g. ease of use, stability, mobility, etc...) – see Annex C.

3.5 Post-Deployment Survey and Focus Group

Participants completed a number of questionnaires that were intended to gather feedback on their perceptions of the MFR designs after they have a full operational tour of using the MFR. One of the questionnaires that participants completed assessed the MFR over a range of issues (e.g. stability, modularity, fit, compatibility, capacity, comfort, and durability). Participants rated the acceptability of the MFRs across all of the criteria using the standard seven-point scale of acceptance. This questionnaire was identical to the one completed by the participants during mid-deployment and therefore ratings can be compared from mid to post-deployment – see Annex D.

A series of MFR specific feature questionnaires were also used to collect participant ratings on the major design attributes of each MFR. The standard seven-point scale of acceptability was used to collect all ratings. Space was provided on each questionnaire for written comments, in either official language, on each MFR system – see Annex E.

Participants also took part in a guided focus group discussion. All participants were equipped with an audience response “clicker” device from Turning Technologies which is a dynamic data response system (TurningPoint, 2009). The clicker device allowed for each participant to provide a response to the directed focus group questions. Answers were tallied instantaneously for immediate debriefing and discussion. Once researchers and participants reviewed the results of the questions, focus group discussions ensued.

3.6 Data Analysis

All of the data gathered from the mid-deployment and post-deployment questionnaires were entered in an Excel database and then imported into the Statistica 11.0 software package from StatSoft Inc. The quantitative (subjective) results of the mid-deployment data were analysed using parametric Analysis of Variance (ANOVA) and appropriate post hoc tests, while data from the post-deployment questionnaires were analysed using an independent groups t-test. Not every item from the questionnaires was included into the statistical analyses. Only the overall results from each block of criteria (i.e. Overall Fit and Adjustability, Overall Stability, etc...) were included. Statistically significant differences were identified at $p < 0.05$.



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4. Results

4.1 Mid-Deployment Acceptability Questionnaire

During the MFR mid-deployment evaluation period, the participants completed a series of questionnaires under supervision. The mid-deployment questionnaire was paper-based and examined each MFR using a number of evaluation criteria. Questions were grouped into logical categories and were answered using the 7-point acceptance scale ranging from '1' (completely unacceptable) to '7' (completely acceptable). A value of '4' denoted a 'borderline' answer, neither unacceptable nor acceptable.

The ratings given by the participants were analysed using descriptive statistics and all results are presented as mean with one standard deviation (sd). Presented in the following sections are the results obtained from the mid-deployment questionnaire.

A total of 730 personnel completed the mid-deployment questionnaire. Presented in Figure 7 are the summary results for the overall ratings in each assessment category. Across the majority of the categories MFR A had the highest acceptability ratings, except for comfort not loaded where MFR B had a slightly higher rating. MFR C had the lowest ratings across all the categories when compared against the other MFRs. However, all of the average ratings across the overall categories were rated as acceptable with the majority of the ratings between 'barely acceptable' and 'completely acceptable'.

For MFR A material properties was rated the most acceptable at 6.4 (± 0.8) while fit and adjustability, stability, and bulk were rated the least acceptable at 5.9 (± 1.1 , 1.0, and 1.1, respectively). The lowest rated acceptability scores were 5.9, which indicate that participants viewed those categories as still being 'reasonably acceptable'.

For MFR B, comfort not loaded was rated the most acceptable at 6.3 (± 0.9) followed by modularity and configurability, and mobility and ROM with ratings of 6.0 (± 1.0). The least acceptable criterion for MFR B was bulk with a rating of 5.4 (± 1.2).

For MFR C, comfort not loaded was rated the most acceptable at 5.9 (± 0.9) followed by material properties with a rating of 5.7 (± 0.9). The least acceptable criteria were bulk, and comfort fully loaded with rating of 5.0 and 5.1 respectively (± 1.3 and ± 1.3).

In terms of overall rating, MFR A had the highest rating with a value of 6.3 (± 0.8) followed by MFR B with a rating of 5.8 (± 0.9), and then followed by MFR C with a rating of 5.0 (± 1.4). Although MFR C was rated with the lowest overall acceptability it was still rated as being acceptable.

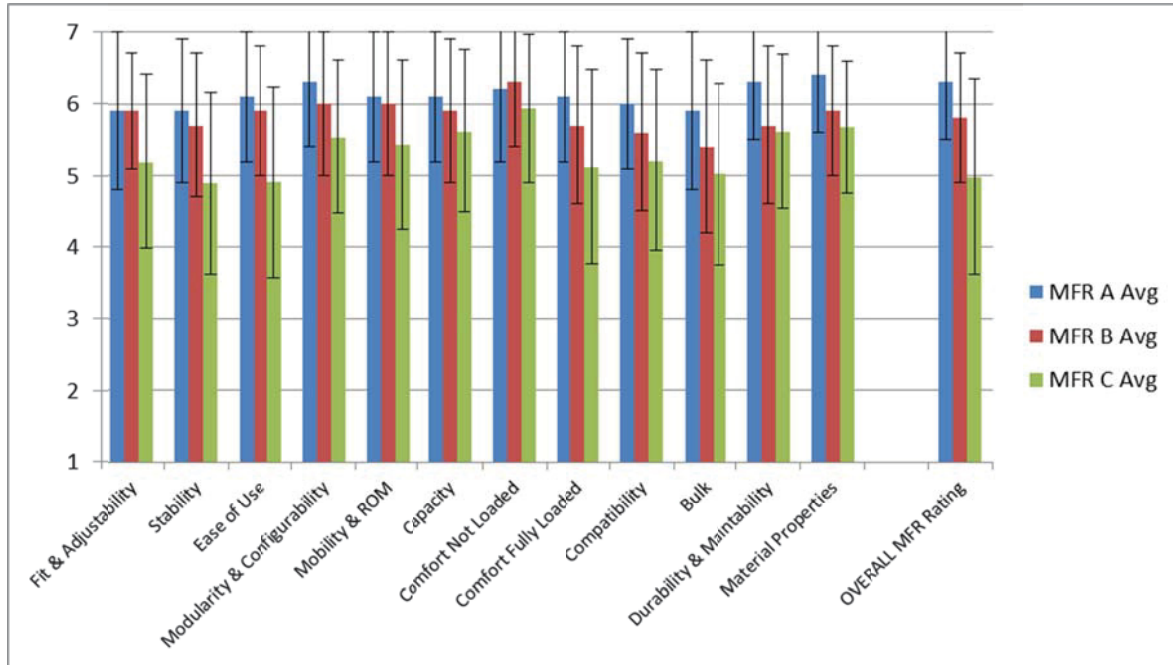


Figure 7: Overall mid-deployment acceptability of the MFR

4.1.1 Fit and Adjustability

Participants rated the acceptability of the fit and adjustability of the MFRs across five factors – see Table 8. The MFRs were acceptable across all the criteria. For MFR A the fit over the Fragmentation Protection Vest (FPV) was rated most acceptable at 6.0 ± 1.2 . The ease of adjustment was rated least acceptable at 5.2 ± 1.6 ; this corresponds to a ‘barely acceptable’ level of acceptability. Participants rated the overall fit and adjustability of MFR A at 5.9 ± 1.1 . For MFR B, the range of adjustability was rated the most acceptable with a rating of 6.0 ± 1.1 . The ease of adjustment and fit with combat uniform only were rated the lowest with ratings between ‘barely acceptable’ and ‘reasonably acceptable’. Participants rated the overall fit and adjustability of MFR B as just below ‘reasonably acceptable’ (5.9 ± 0.8). With respect to MFR C the highest rated criterion was the adjustment retention with a rating of 5.6 ± 1.3 and the lowest rated criterion was the ease of adjustment with a rating that was just above ‘borderline’ (4.2 ± 1.7). Participants rated the overall fit and adjustability of MFR C as just above ‘barely acceptable’ (5.2 ± 1.2).

Table 8 – Mid-deployment fit and adjustability acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD	MFR C Mean \pm SD
Fit with combat uniform only	5.8 \pm 1.1	5.8 \pm 1.3	5.4 \pm 1.6	5.8 \pm 1.3	5.5 \pm 1.4	5.1 \pm 1.4
Fit over Fragmentation Protection Vest (FPV)	6.2 \pm 1.2	5.9 \pm 1.2	5.9 \pm 1.4	6.0 \pm 1.2	5.9 \pm 1.2	5.3 \pm 1.4
Ease of adjustment	5.9 \pm 1.2	5.1 \pm 1.6	5.2 \pm 1.8	5.2 \pm 1.6	5.5 \pm 1.3	4.2 \pm 1.7
Range of adjustability	6.1 \pm 1.2	5.8 \pm 1.1	5.4 \pm 1.7	5.8 \pm 1.3	6.0 \pm 1.1	5.2 \pm 1.4
Adjustment retention	6.1 \pm 1.3	5.9 \pm 1.1	5.8 \pm 1.5	5.9 \pm 1.2	5.7 \pm 1.2	5.6 \pm 1.3
Overall Fit & Adjustability	6.2 \pm 0.9	5.9 \pm 1.1	5.7 \pm 1.3	5.9 \pm 1.1	5.9 \pm 0.8	5.2 \pm 1.2

MFR A had the highest acceptability ratings across the majority of criteria when compared to MFR B and MFR C. Ease of adjustment and range of adjustability were the only criteria which another MFR (MFR B) had a higher acceptability than MFR A. Overall, each MFR had average acceptability ratings that were above ‘borderline’ for all the criteria. A one-way ANOVA was conducted on the ratings for overall fit and adjustability and significant differences were found ($F=8.2391$, $p\text{-value}<0.0001$). MFR C had a significant lower overall rating when compared to MFR A ($p\text{-value}<0.0001$) and MFR B ($p\text{-value}<0.0001$).

All MFRs were found to be acceptable for fit and adjustability but MFR A and MFR B were found to be slightly more acceptable than MFR C.

4.1.2 Stability

Stability was rated by participants across eight factors – see Table 9. Each MFR received acceptability ratings that were above ‘borderline’, except for MFR C for one factor (stability of the MFR while in the prone). Stability of MFR A was rated most acceptable in terms of its integration with the FPV (6.2 \pm 0.9) and least acceptable in terms of while in the prone (4.8 \pm 1.7). Stability for MFR A while in the prone was rated slightly less acceptable than ‘barely acceptable’. Overall stability of MFR A was rated at 5.9 \pm 1.0 and was considered ‘reasonably acceptable’.

With respect to MFR B, the most acceptable stability criterion was stability with FPV (5.8 \pm 1.0) and the least acceptable criteria was stability while prone (4.7 \pm 1.6). Overall stability of MFR B was rated at 5.7 \pm 1.0 which is between ‘barely acceptable’ and ‘reasonably acceptable’.

In terms of MFR C, the most acceptable stability criterion was stability with the FPV (5.2 \pm 1.4) and the least acceptable criteria was stability while prone (3.9 \pm 1.7) which is slightly below ‘borderline’. Overall stability of MFR C was rated at 4.9 \pm 1.3 which is just below ‘barely acceptable’.

Table 9 - Mid-deployment stability acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD	MFR C Mean \pm SD
Stability with combat uniform	5.9 \pm 1.1	5.8 \pm 1.2	5.3 \pm 1.7	5.7 \pm 1.3	5.4 \pm 1.3	4.8 \pm 1.4
Stability With FPV	6.1 \pm 1.0	6.2 \pm 0.9	6.1 \pm 1.0	6.2 \pm 0.9	5.8 \pm 1.0	5.2 \pm 1.4
Stability while running	6.1 \pm 1.0	5.8 \pm 1.1	5.8 \pm 1.3	5.8 \pm 1.1	5.4 \pm 1.2	4.5 \pm 1.5
Stability while crouching	6.0 \pm 1.1	5.6 \pm 1.3	6.0 \pm 1.2	5.7 \pm 1.3	5.6 \pm 1.1	4.8 \pm 1.3
Stability while sitting	6.2 \pm 0.7	5.9 \pm 1.0	6.1 \pm 1.3	6.0 \pm 1.1	5.7 \pm 1.0	5.1 \pm 1.3
Stability while kneeling	6.2 \pm 1.1	5.9 \pm 1.1	6.3 \pm 0.9	6.0 \pm 1.1	5.7 \pm 1.0	5.0 \pm 1.3
Stability while prone	5.5 \pm 1.3	4.6 \pm 1.7	5.1 \pm 1.7	4.8 \pm 1.7	4.7 \pm 1.6	3.9 \pm 1.7
Stability with full combat load	6.1 \pm 0.9	5.9 \pm 1.1	6.2 \pm 0.9	5.9 \pm 1.0	5.7 \pm 1.0	5.0 \pm 1.3
Overall Stability	6.2 \pm 0.8	5.8 \pm 1.0	6.0 \pm 1.2	5.9 \pm 1.0	5.7 \pm 1.0	4.9 \pm 1.3

A one-way ANOVA was conducted on the ratings for overall stability and significant differences were found ($F=8.2391$, $p\text{-value}<0.0001$). MFR C had a significant lower overall rating when compared to MFR A ($p\text{-value}<0.0001$) and MFR B ($p\text{-value}<0.0001$).

MFR A had the highest acceptability ratings across all of the criteria when compared to MFR B and MFR C.

4.1.3 Ease of Use

Ease of use was rated in terms of donning, doffing, configuration, medical access, and pouch access. Across all of the criteria each MFR received average acceptability ratings that were above 'borderline' except for MFR C and the ease of donning – see Table 10. MFR A was rated most acceptable in terms of its medical access (6.3 ± 0.8) and least acceptable with respect to its ease of donning (4.9 ± 1.7); the ease of use ratings for MFR A ranged from 'barely acceptable' to 'reasonably acceptable'. The overall acceptability for ease of use for MFR A was rated at 6.1 ± 0.9 .

MFR B was rated most acceptable in terms of ease of medical access (5.8 ± 1.2) and least acceptable with respect to its ease of donning (5.6 ± 1.3); the ease of use ratings for MFR B ranged from 'barely acceptable' to 'reasonably acceptable'. The overall acceptability for ease of use for MFR B was rated at 5.9 ± 0.9 .

With respect to MFR C, it was rated most acceptable in terms of its medical access (5.6 ± 1.3) and least acceptable with respect to its ease of donning (3.3 ± 1.7) which is below 'borderline'; the ease of use ratings for MFR A ranged from 'barely unacceptable' to 'reasonably acceptable'. The overall acceptability for ease of use for MFR A was rated at 4.9 ± 1.3 .

Table 10 – Mid-deployment ease of use acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD	MFR C Mean \pm SD
Ease of donning	5.7 \pm 1.6	4.9 \pm 1.7	4.4 \pm 1.9	4.9 \pm 1.7	5.6 \pm 1.3	3.3 \pm 1.7
Ease of doffing	5.8 \pm 1.3	5.4 \pm 1.4	5.2 \pm 1.4	5.4 \pm 1.4	5.7 \pm 1.1	4.7 \pm 1.5
Ease of configuration	6.1 \pm 0.8	6.2 \pm 1.0	6.1 \pm 1.1	6.2 \pm 1.0	5.7 \pm 1.1	5.2 \pm 1.4
Ease of medical access	6.4 \pm 0.8	6.3 \pm 0.8	6.3 \pm 0.9	6.3 \pm 0.8	5.8 \pm 1.2	5.6 \pm 1.3
Ease of pouch content access and replacement	6.5 \pm 0.6	6.1 \pm 1.0	6.1 \pm 1.3	6.2 \pm 1.0	5.7 \pm 1.0	5.4 \pm 1.3
Overall Ease of Use	6.3 \pm 0.7	6.2 \pm 0.8	5.8 \pm 1.4	6.1 \pm 0.9	5.9 \pm 0.9	4.9 \pm 1.3

MFR A had the highest acceptability ratings across the majority of criteria when compared to MFR B and MFR C. Ease of donning and ease of doffing were the only criteria which another MFR (MFR B) had a higher acceptability than MFR A. A one-way ANOVA was conducted on the ratings for overall ease of use and significant differences were found ($F=8.2391$, $p\text{-value}<0.0001$). MFR C had a significant lower overall ease of use rating when compared to MFR A ($p\text{-value}<0.0001$) and MFR B ($p\text{-value}<0.0001$).

While all MFRs were rated as being acceptable for ease of use, MFR A and MFR B were rated by the participants as having more acceptable ease of use.

4.1.4 Modularity and Configurability

The modularity and configurability of the MFRs were rated across four factors. Each MFR was rated as being better than ‘barely acceptable’ across all criteria – see Table 11. Configuring MFR A by mission, according to role, and by load were all rated at 6.2 (± 0.9 , 0.9, and 1.0, respectively). The ease of modifying to suit person preference/handedness was rated at 6.4 ± 0.8 . The overall acceptability of MFR A’s modularity and configurability was rated at 6.3 ± 0.9 .

Ease of modifying to suit personal preference / handedness was the highest rated criterion for MFR B with a rating that 6.1 ± 1.0 while ease of configuring by mission had the lowest rating for MFR B at 5.7 ± 1.2 . The overall acceptability of MFR B’s modularity and configurability was rated at 6.0 ± 1.0 . For MFR B all of the criteria for modularity and configurability had ratings that were either just below ‘reasonably acceptable’ or just above ‘reasonably acceptable’.

For MFR C the highest rated criterion for modularity and configurability was ease of modifying to suit personal preference / handedness with a rating of 5.7 ± 1.2 . The least acceptable criterion for MFR C was ease of configuring by mission which had a rating of 5.2 ± 1.3 . All of the ratings for modularity and configurability for MFR C were between ‘barely acceptable’ and ‘reasonably acceptable’.

Table 11 – Mid-deployment modularity and configurability acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD	MFR C Mean \pm SD
Ease of configuring by mission	6.4 \pm 0.8	6.2 \pm 0.9	6.2 \pm 1.1	6.2 \pm 0.9	5.7 \pm 1.2	5.2 \pm 1.3
Ease of configuring according to role	6.4 \pm 0.8	6.2 \pm 0.9	6.2 \pm 1.1	6.2 \pm 0.9	5.8 \pm 1.1	5.5 \pm 1.2
Ease of configuring by load	6.2 \pm 0.8	6.1 \pm 1.0	6.3 \pm 1.1	6.2 \pm 1.0	5.8 \pm 1.1	5.3 \pm 1.2
Ease of modifying to suit personal preference / handedness	6.4 \pm 0.8	6.3 \pm 0.8	6.5 \pm 0.8	6.4 \pm 0.8	6.1 \pm 1.0	5.7 \pm 1.2
Overall Modularity & Configurability	6.4 \pm 0.8	6.3 \pm 0.8	6.1 \pm 1.3	6.3 \pm 0.9	6.0 \pm 1.0	5.5 \pm 1.1

A one-way ANOVA was conducted on the ratings for overall modularity and configurability and significant differences were found ($F=8.2391$, $p\text{-value}<0.0001$). MFR C had a significant lower overall modularity rating when compared to MFR A ($p\text{-value}<0.0001$) and MFR B ($p\text{-value}=0.0022$). MFR B also had a significant lower overall modularity rating when compared to MFR A ($p\text{-value} = 0.0208$).

While all MFRs were acceptable for modularity and configurability MFRs A and B were rated by the participants as being more modular and configurable than MFR C.

4.1.5 Mobility and Range of Motion

Participants rated the acceptability of the MFRs across five factors relating to mobility and range of motion. Participants tended to rate the mobility and range of motion of MFR A as being ‘reasonably acceptable’ – see Table 12. Overhead arm motion was rated least acceptable at 5.9 ± 1.0 while head motion was rated most acceptable at 6.3 ± 0.8 ; this represents a maximum range of 0.4 acceptability points across all criteria. Overall, mobility and range of motion for MFR A was rated at 6.1 ± 0.9 .

Participants rated the mobility and range of motion of MFR B as being just below ‘reasonably acceptable’ or just above ‘reasonably acceptable’. Trunk motion was rated least acceptable at 5.7 ± 1.1 while head motion was rated most acceptable at 6.2 ± 0.9 . Overall, mobility and range of motion for MFR B was rated at 6.0 ± 1.0 .

Participants rated the mobility and range of motion of MFR C as being between ‘barely acceptable’ and ‘reasonably acceptable’. Ability to perform combat movements was rated least acceptable at 5.0 ± 1.3 while head motion was rated most acceptable at 5.8 ± 1.1 . Overall, mobility and range of motion for MFR C was rated at 5.4 ± 1.2 .

Table 12 – Mid-deployment mobility and range of motion acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD	MFR C Mean \pm SD
Ability to perform combat movements	6.0 \pm 0.8	6.0 \pm 0.9	6.4 \pm 0.9	6.1 \pm 0.9	5.8 \pm 1.0	5.0 \pm 1.3
Arm motion overhead	6.0 \pm 1.0	5.9 \pm 1.0	6.3 \pm 1.1	5.9 \pm 1.0	5.8 \pm 1.1	5.5 \pm 1.3
Arm motion in front	6.4 \pm 0.7	6.1 \pm 0.9	6.4 \pm 0.9	6.2 \pm 0.9	6.0 \pm 1.0	5.5 \pm 1.2
Trunk motion	6.1 \pm 0.9	6.1 \pm 0.9	6.2 \pm 1.1	6.1 \pm 0.9	5.7 \pm 1.1	5.4 \pm 1.2
Head motion	6.5 \pm 0.7	6.3 \pm 0.8	6.5 \pm 0.9	6.3 \pm 0.8	6.2 \pm 0.9	5.8 \pm 1.1
Overall Mobility & ROM	6.2 \pm 0.8	6.1 \pm 0.8	6.2 \pm 1.3	6.1 \pm 0.9	6.0 \pm 1.0	5.4 \pm 1.2

A one-way ANOVA was conducted on the ratings for overall mobility and range of motion and significant differences were found ($F=8.2391$, $p\text{-value}<0.0001$). MFR C had a significant lower overall rating when compared to MFR A ($p\text{-value}<0.0001$) and MFR B ($p\text{-value}=0.0015$).

MFR A had the highest acceptability ratings across all of the criteria when compared to MFR B and MFR C.

4.1.6 Capacity

The capacities of the MFRs were rated in terms of its ability to carry the designated combat load and overall capacity. With respect to MFR A both criterion were rated ‘reasonably acceptable’ at 6.2 ± 0.9 (capacity to carry the designated load) and 6.1 ± 0.9 (overall) – see Table 13. The rating for the capacity to carry the designated combat load for MFR B was 6.0 ± 0.9 and for MFR C it was 5.6 ± 1.1 . The overall rating for capacity for MFR B was 5.9 ± 1.0 and for MFR C it was 5.6 ± 1.1 . In terms of capacity all the MFRs had mean acceptability ratings that were above ‘barely acceptable’ across all the criteria.

Table 13 – Mid-deployment capacity acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD	MFR C Mean \pm SD
Capacity to carry your designated combat load (by configuration)	6.3 \pm 0.8	6.3 \pm 0.8	6.1 \pm 1.1	6.2 \pm 0.9	6.0 \pm 0.9	5.6 \pm 1.1
Overall Capacity	6.3 \pm 0.8	6.1 \pm 0.9	6.1 \pm 1.0	6.1 \pm 0.9	5.9 \pm 1.0	5.6 \pm 1.1

A one-way ANOVA was conducted on the ratings for overall capacity and significant differences were found ($F=8.2391$, $p\text{-value}<0.0001$). MFR A had a significant higher overall rating when compared to MFR B ($p\text{-value}=0.0357$) and MFR C ($p\text{-value}=0.0006$).

4.1.7 Comfort

Participants rated the MFRs comfort across six different criteria. The mean acceptance ratings for the MFRs across all the criteria were between ‘barely acceptable’ and slightly above ‘reasonably acceptable’ – see Table 14. The ratings for MFR A were generally ‘reasonably acceptable’; however, heat retention and pressure points were rated the least acceptable for MFR A at 5.6 ± 1.3 and 5.7 ± 1.3 ,

respectively. Overall comfort while unloaded for MFR A was rated most acceptable at 6.2 ± 1.0 . Overall comfort while fully loaded for MFR A was rated at 6.1 ± 0.9 .

The ratings for MFR B were generally between ‘barely acceptable’ and ‘reasonably acceptable’; however, pressure points was rated least acceptable for MFR B at 5.4 ± 1.4 . Load distribution and chaffing for MFR B were rated most acceptable at 5.7 ± 1.1 and 5.7 ± 1.3 . Overall comfort while fully loaded for MFR B was rated at 5.7 ± 1.1 .

The ratings for MFR C were all between ‘barely acceptable’ and ‘reasonably acceptable’. Overall comfort while not loaded for MFR C was rated most acceptable at 5.9 ± 1.0 . Overall comfort while fully loaded for MFR C was rated at 5.1 ± 1.3 .

Table 14 – Mid-deployment comfort acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD	MFR C Mean \pm SD
Load distribution	6.2 ± 0.9	5.9 ± 1.2	6.2 ± 0.9	6.0 ± 1.1	5.7 ± 1.1	5.1 ± 1.5
Chaffing	6.1 ± 0.7	6.0 ± 1.1	6.0 ± 1.4	6.0 ± 1.1	5.7 ± 1.3	5.4 ± 1.5
Pressure points	5.8 ± 1.2	5.7 ± 1.2	5.5 ± 1.7	5.7 ± 1.3	5.4 ± 1.4	5.1 ± 1.6
Thermal (heat retention)	6.0 ± 1.0	5.6 ± 1.2	5.9 ± 1.4	5.6 ± 1.3	5.6 ± 1.5	5.0 ± 1.6
Overall Comfort Not Loaded	6.3 ± 0.9	6.2 ± 1.0	6.2 ± 1.1	6.2 ± 1.0	6.3 ± 0.9	5.9 ± 1.0
Overall Comfort Fully Loaded	6.1 ± 0.9	6.1 ± 0.9	5.9 ± 1.3	6.1 ± 0.9	5.7 ± 1.1	5.1 ± 1.3

MFR A had the highest acceptability ratings across the majority of criteria when compared to MFR B and MFR C. A one-way ANOVA was conducted on the ratings for overall comfort and significant differences were found ($F=8.2391$, $p\text{-value}<0.0001$). MFR C had a significant lower overall rating when compared to MFR A ($p\text{-value}<0.0001$) and MFR B ($p\text{-value}=0.0024$). MFR B also had a significantly lower overall rating when compared to MFR A ($p\text{-value}=0.0399$).

While all of the MFRs were rated as acceptable in terms of comfort, MZFRs A and B were rated slightly more comfortable than MFR C.

4.1.8 Compatibility

Compatibility of the MFRs with nine pieces of personal gear was evaluated by the participants – see Table 15. Compatibility of MFR A with gloves was rated most acceptable at 6.4 ± 0.9 . Compatibility of MFR A with both the cold weather gear and with vehicles was rated the least acceptable at $5.2 (\pm 1.4$ and 1.6 , respectively). Compatibility of MFR A with personal weapons was rated at 6.2 ± 1.0 . Overall compatibility of MFR A was rated at 6.0 ± 0.9 .

Compatibility of MFR B with the helmet and gloves were rated most acceptable at 6.1 ± 0.9 . Compatibility of MFR B with the rucksack was rated the least acceptable with a rating of 4.4 ± 1.8 while compatibility of MFR B with personal weapons was rated at 5.6 ± 1.2 . Overall compatibility of MFR B was rated at 5.4 ± 1.3 .

Compatibility of MFR C with gloves and the helmet was rated most acceptable with a rating of 5.7 ± 1.2 . Compatibility of MFR C with vehicles was rated the least acceptable with a rating of 4.3 ± 1.8 . Compatibility of MFR C with personal weapons was rated at 5.4 ± 1.3 . Overall compatibility of MFR C was rated at 5.2 ± 1.3 .

Table 15 – Mid-deployment compatibility acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD	MFR C Mean \pm SD
Compatibility with Personal weapon	6.2 \pm 1.0	6.2 \pm 1.0	6.3 \pm 0.9	6.2 \pm 1.0	5.9 \pm 1.0	5.4 \pm 1.3
Compatibility with weapon slings	5.8 \pm 1.2	5.5 \pm 1.4	5.9 \pm 1.3	5.6 \pm 1.3	5.6 \pm 1.2	4.8 \pm 1.6
Compatibility with helmet	6.1 \pm 1.3	6.2 \pm 1.0	6.4 \pm 0.9	6.2 \pm 1.0	6.1 \pm 0.9	5.7 \pm 1.2
Compatibility with fragmentation vest	6.1 \pm 1.4	5.9 \pm 1.3	6.0 \pm 1.5	6.0 \pm 1.3	5.6 \pm 1.5	4.8 \pm 1.8
Compatibility with small pack	5.8 \pm 1.5	5.7 \pm 1.4	5.6 \pm 1.5	5.7 \pm 1.4	4.8 \pm 1.7	4.6 \pm 1.6
Compatibility with rucksack	5.4 \pm 1.4	5.4 \pm 1.3	5.7 \pm 1.3	5.5 \pm 1.3	4.4 \pm 1.8	4.6 \pm 1.6
Compatibility with gloves	6.5 \pm 0.9	6.4 \pm 0.9	6.5 \pm 0.8	6.4 \pm 0.9	6.1 \pm 0.9	5.7 \pm 1.2
Compatibility with cold weather gear (jacket,	4.9 \pm 1.4	5.2 \pm 1.3	5.5 \pm 1.7	5.2 \pm 1.4	5.1 \pm 1.5	4.7 \pm 1.4
Compatibility with vehicles (LAV III, Nyala, etc.)	5.6 \pm 1.2	5.1 \pm 1.7	5.5 \pm 1.6	5.2 \pm 1.6	4.6 \pm 1.6	4.3 \pm 1.8
Overall Compatibility	6.0 \pm 0.8	6.0 \pm 0.9	6.2 \pm 1.0	6.0 \pm 0.9	5.6 \pm 1.1	5.2 \pm 1.3

A one-way ANOVA was conducted on the ratings for overall compatibility and significant differences were found ($F=8.2391$, $p\text{-value}<0.0001$). MFR C had a significant lower overall rating when compared to MFR A ($p\text{-value}<0.0001$) and MFR B ($p\text{-value}=0.0029$). MFR B also had a significantly lower overall rating when compared to MFR A ($p\text{-value}=0.0041$).

MFR A had the highest acceptability ratings across all of the criteria when compared to MFR B and MFR C.

4.1.9 Bulk

Subjective measures of bulk were captured for each MFR according to four criteria – see Table 16. The bulk of MFR A was rated slightly below ‘reasonably acceptable’ across all evaluation criteria with only 0.1 of an acceptance separating all the ratings. The depth of MFR A when loaded and the encumbrance of MFR A at the chest when loaded were both rated the least acceptable aspects of bulk at 5.8 ± 1.2 . The width of MFR A when loaded was rated 5.9 ± 1.0 . Overall, the bulk of MFR A was rated 5.9 ± 1.1 . In terms of the three variants of MFR A there was very little difference in bulk subjective ratings between each of the variants.

With regards to the bulk of MFR B all of its bulk ratings were higher than ‘barely acceptable’ with the highest rated criteria for MFR B being the encumbrance at the chest when loaded with a rating of 5.6 ± 1.2 .

MFR C had slightly lower bulk ratings compared to MFR A and MFR B but were still acceptable with most of the ratings being ‘barely acceptable’.

Table 16 – Mid-deployment bulk acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD	MFR C Mean \pm SD
Width of the MFR when loaded	6.0 \pm 0.9	5.9 \pm 1.1	6.1 \pm 1.1	5.9 \pm 1.0	5.2 \pm 1.3	5.0 \pm 1.3
Depth of the MFR when loaded	6.0 \pm 0.8	5.8 \pm 1.2	6.0 \pm 1.2	5.8 \pm 1.2	5.3 \pm 1.2	4.9 \pm 1.4
Encumbrance at the chest when loaded	5.9 \pm 0.9	5.7 \pm 1.1	5.9 \pm 1.4	5.8 \pm 1.2	5.6 \pm 1.2	5.0 \pm 1.3
Overall Bulk	6.0 \pm 1.0	5.9 \pm 1.2	5.9 \pm 1.2	5.9 \pm 1.1	5.4 \pm 1.2	5.0 \pm 1.3

A one-way ANOVA was conducted on the ratings for overall bulk differences were found ($F=8.2391$, $p\text{-value}<0.0001$). MFR C had a significant lower overall rating when compared to MFR A ($p\text{-value}<0.0001$) and MFR B ($p\text{-value}=0.0428$). MFR B also had a significantly lower overall rating when compared to MFR A ($p\text{-value}=0.0028$).

Overall, all MFRs were found to be acceptable in terms of bulk.

4.1.10 Durability and Maintainability

Participants rated the durability of three common features of the MFRs and the ability to maintain the operational effectiveness of the MFR if a feature fails – see Table 17. The durability of MFR A was rated more acceptable than ‘reasonably acceptable’ across hardware, straps, and material (6.2 \pm 1.0, 6.4 \pm 0.8, and 6.3 \pm 0.8, respectively). Replace and repairing items were less acceptable to participants at 6.0 \pm 1.0 and 5.6 \pm 1.2, respectively. Overall, the durability and maintainability of MFR A was rated 6.3 \pm 0.8.

With respect to MFR B all of the ratings were higher than ‘barely acceptable’. The ease of repairing items was less acceptable than the other items but was still found to be acceptable with a rating of ‘barely acceptable’ (5.0 \pm 1.6). Overall, the durability and maintainability of MFR B was rated 5.7 \pm 1.1.

MFR C had ratings that were between ‘barely acceptable’ and ‘reasonably acceptable’. The ratings for ease of replacing and repairing items for MFR C were lower than MFR A but still acceptable. Overall, the durability and maintainability of MFR C was rated 5.6 \pm 1.1.

Table 17 – Mid-deployment durability and maintainability acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD	MFR C Mean \pm SD
Durability of hardware (buckles, snaps, zippers, etc.)	6.4 \pm 0.7	6.2 \pm 0.9	5.7 \pm 1.6	6.2 \pm 1.0	5.6 \pm 1.3	5.6 \pm 1.3
Durability of straps	6.5 \pm 0.6	6.4 \pm 0.9	6.4 \pm 0.9	6.4 \pm 0.8	5.9 \pm 1.1	5.8 \pm 1.1
Durability of material, MOLLE loops, velcro, shockcord, etc.	6.5 \pm 0.7	6.3 \pm 0.8	6.2 \pm 1.0	6.3 \pm 0.8	5.6 \pm 1.4	5.8 \pm 1.0
Ease of replacing items	6.1 \pm 1.0	6.0 \pm 1.0	6.2 \pm 0.9	6.0 \pm 1.0	5.2 \pm 1.6	5.1 \pm 1.4
Ease of repairing items	5.7 \pm 1.5	5.6 \pm 1.2	5.6 \pm 1.3	5.6 \pm 1.2	5.0 \pm 1.6	5.0 \pm 1.3
Overall Durability & Maintainability	6.1 \pm 0.8	6.3 \pm 0.8	6.2 \pm 0.9	6.3 \pm 0.8	5.7 \pm 1.1	5.6 \pm 1.1

A one-way ANOVA was conducted on the ratings for overall durability and maintainability and significant differences were found ($F=8.2391$, $p\text{-value}<0.0001$). MFR A had a significant higher overall rating when compared to MFR B ($p\text{-value}<0.0001$) and MFR C ($p\text{-value}=0.0024$).

All MFRs were found to be acceptable across all criteria. This is an important result as this was longitudinal study over a number of months.

4.1.11 Material Properties

Participants rated the material properties of the MFR for noise signature, camouflage, and weight – see Table 18. The material properties of MFR A were generally rated as more acceptable than ‘reasonably acceptable’. Noise signature aspects of MFR A were rated least acceptable to participants at 6.1 ± 1.0 while the empty weight of MFR A was rated most acceptable at 6.4 ± 0.9 . Further, the camouflage of MFR A was rated at 6.2 ± 1.0 . Overall, the material properties of MFR A were rated at 6.4 ± 0.8 .

Ratings on material properties for MFR B were slightly lower than MFR A but were still acceptable with all ratings being more acceptable than ‘barely acceptable’. The highest rated material properties criterion for MFR B was the weight (empty) with a rating of 6.2 ± 1.0 . The lowest rated criteria for MFR B were the noise signature and camouflage with ratings of 5.4 ± 1.3 and 5.4 ± 1.2 .

Ratings on material properties for MFR C were slightly lower than MFR B, except for weight (empty) which had a rating of ‘reasonably acceptable’, but were still acceptable with ratings being more acceptable than ‘barely acceptable’. The highest rated material properties criterion for MFR C was the weight (empty) with a rating of 6.0 ± 1.0 . The lowest rated criterion for MFR C was the camouflage with a rating of 5.2 ± 1.2 .

Table 18 – Mid-deployment material properties acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD	MFR C Mean \pm SD
Noise signature (closures, rubbing, etc.)	6.1 ± 0.9	6.1 ± 1.0	6.3 ± 0.9	6.1 ± 1.0	5.4 ± 1.3	5.3 ± 1.4
Camouflage	6.3 ± 0.9	6.2 ± 1.0	5.9 ± 1.2	6.2 ± 1.0	5.4 ± 1.2	5.2 ± 1.2
Weight (empty)	6.3 ± 1.1	6.3 ± 0.9	6.5 ± 0.8	6.4 ± 0.9	6.2 ± 1.0	6.0 ± 1.0
Overall Material Properties	6.5 ± 0.8	6.4 ± 0.8	6.5 ± 0.8	6.4 ± 0.8	5.9 ± 0.9	5.7 ± 0.9

Overall, the MFR which had the highest overall rating for material properties was MFR A with a rating of 6.4 ± 0.8 , followed by MFR B with a rating of 5.9 ± 0.9 , and finally MFR C with a rating of 5.7 ± 0.9 . A one-way ANOVA was conducted on the ratings for overall material properties and significant differences were found ($F=8.2391$, $p\text{-value}<0.0001$). MFR A had a significant higher overall rating when compared to MFR B ($p\text{-value}<0.0001$) and MFR C ($p\text{-value}<0.0001$).

4.1.12 Overall

Overall, participants rated MFR A as being better than ‘reasonably acceptable’ at 6.3 ± 0.8 . Participants rated MFR B overall as being below ‘reasonably acceptable’ at 5.8 ± 0.9 . Participants rated MFR C overall being ‘barely acceptable’ at 5.0 ± 1.4 – see Figure 8.

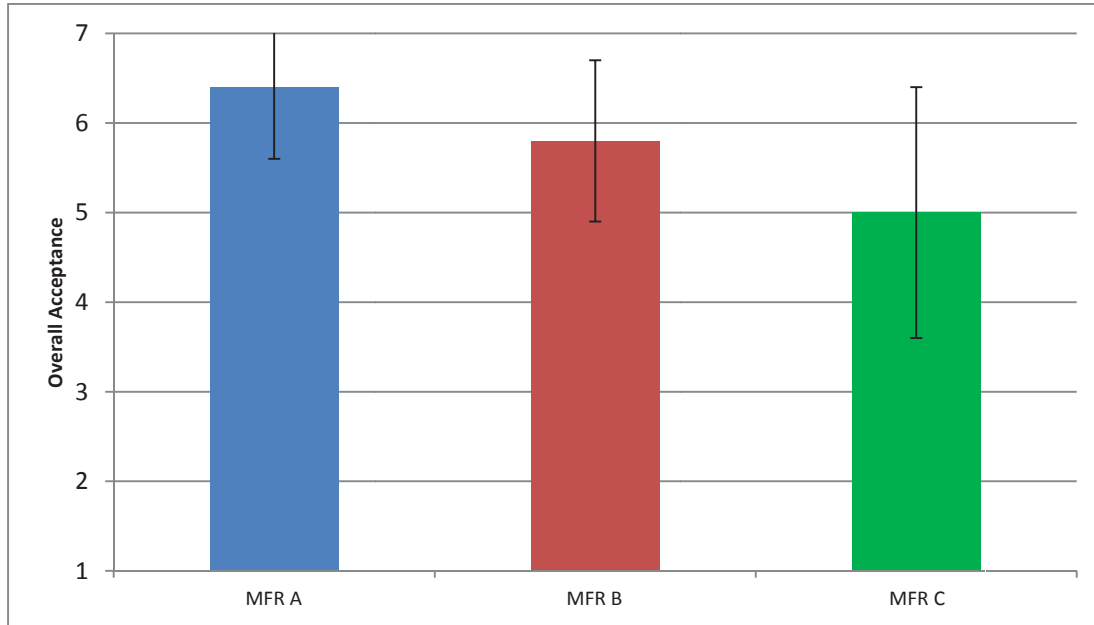


Figure 8: Mid-deployment overall ratings

A one-way ANOVA was conducted on the overall ratings and significant differences were found ($F=8.2391$, $p\text{-value}<0.0001$). MFR A had a significant higher overall rating when compared to MFR B ($p\text{-value}=0.0016$) and MFR C ($p\text{-value}<0.0001$). MFR B also had significantly higher overall rating when compared to MFR C ($p\text{-value}<0.0001$).

While all of the MFRs were rated by the participants as being acceptable, MFRs A and B were rated as being more acceptable than MFR C.

4.2 Mid-Deployment MFR Configuration

In an effort to understand how participants utilized the MFRs as a component of their load bearing equipment, participants were asked to indicate the configuration of MFR typically used on missions, to list all of the contents they carried in their small pack, and identify all of the pouches that were worn by the user. Simultaneously, DLR 5 survey monitors took photos of the participants load configurations.

4.2.1 MFR A Configuration

Approximately six-percent of respondents (6.2%) indicated that their MFR A was a size small, 71.8% indicated that their MFR A was a size medium, and the remaining 22.0% noted that their MFR A was a size large.

Of the 260 respondents who indicated their front MFR A configurations, 74.6% ($n = 194$) said that they used the A2 front, 10.8% ($n = 28$) said that they used the A1 front, while the remaining 14.6% indicated that they used the A3 front. With regard to the back configurations used, 78.0% ($n = 203$) said that they used the SCS chest rig back (4 PALS wide) and the remaining 22.0% ($n = 57$) indicated they used the SCS vest back (6 PALS wide).

Participants noted their pouch configuration; as the pouches were modular, soldiers could configure them in several different ways and, as such, thirty-three soldiers provided more than one answer to this question, suggesting that they changed the configuration of their pouches to meet specific

operational demands. The configuration of the majority (43.7%) of the participants was the ‘rifleman’ configuration. Approximately twenty-two percent of respondents (22.2%) indicated that they used the ‘commander’ configuration; 15.7% said they used the ‘C9’ configuration; 14.2% said they used the ‘M203’ configuration, while 3.8% of the participants said they used the ‘7.62mm marksman’ configuration. One participant (0.4%) noted that they used the ‘confined space’ configuration. It should be noted that the configuration chosen is influenced by the job title of the soldier. The weight of the fully loaded MFR was also weighed. The average weight of MFR A was 10.7 kg (sd=2.8) with a max weight carried by a soldier being 22.2 kg.

The number of pouches worn with MFR A varied. Performing an additional mode analysis indicated that 81.5% of soldiers used three 90 round Velcro pouches, 82% of soldiers used a CFA medic pouch, and 79% of participants used a PRR pouch. These results are summarized in Table 19. The mode represents the amount of the specific pouch most frequently worn; the n represents the total number of participants that wore that specific pouch; and percentage is the percentage of total participants surveyed (265 total participants).

Additional pouches purchased by participants included a Tactical Combat Casualty Care (TCCC) pouch, a pouch dedicated to Night Vision Goggle (NVG) stowage, and a Personal Role Radio (PRR) pouch.

Table 19 – Pouches worn by participants on MFR A

Pouch	Mode	n	%
CFA Medic Pouch	1	217	81.9
90 rd. Velcro	3	216	81.5
PRR Pouch	1	210	79.2
Utility Large (Fastex)	1	188	70.9
Utility Hydration Cover	1	165	62.3
Accessories (Small)	1	162	61.1
F1 x 2 Vertical	1	131	49.4
Multi Tool	1	118	44.5
SMK/NVD	1	116	43.8
F1 x 1	1	91	34.3
Dump	1	89	33.6
D/A 30 rd. Single	1	81	30.6
Etrex GPS Pouch	1	71	26.8
60 rd. Fastex	1	64	24.2
200 rd. C9	2	45	17
Admin Panel	1	45	17
Harris Radio	1	45	17
Pistol Holder	1	19	7.2
D/A USP SF x 2	1	16	6
40mm x 4 Horizontal	1	11	4.2
100 rd. C9	1	9	3.4
40mm x 1	2	8	3
40mm x 4 Vertical	1	8	3
40mm x 2 Horizontal	1	7	2.6
MOLLE Belt	1	3	1.1
S & T Leg Panel	1	2	0.8
SR25 x 2	1	2	0.8

Participants were also asked the type of missions they performed while wearing the MFR. Fifty-seven percent of respondents indicated that their primary mission was patrolling, 30% indicated that their mission was more combat oriented, 9% noted that they performed GT (Tactical Group)-type missions, and 3% said they primarily performed reconnaissance missions. On average, 74% of missions were conducted dismounted and 26% were conducted mounted from vehicles. Eighty-five per cent of missions were conducted during the day while 15% were night time operations.

In addition to weighing MFR A, DLR also weighed the small pack of the soldiers. The average loaded weight of the small pack was recorded at 11.8 kg (25.9 lbs.). Participants were given the opportunity to describe the items carried in their small packs; a frequency analysis was conducted to identify the mode of the most commonly carried gear. Therefore, in a representative small pack, water and extra rations were the most commonly listed items noted by participants. Other items contained within a representative pack were determined to be: a M72 LAW, PCM batteries, socks, t-shirts, gloves, toques, glow sticks, a camera, a Tactical Combat Casualty Care (TCCC) kit, C4 explosives, C4 detonators, crimpers, ballistic glasses, a head lamp, an ablation kit, a flash light, a roll of duct tape, a small mirror, and speed cuffs. Ninety per cent of respondents indicated that this was a typical load for their missions; however, 82% of respondents noted that they changed their load based on the mission requirements.

4.2.2 MFR B Configuration

Of the 239 participants (that completed the mid-deployment questionnaire) noted their pouch configuration; seventeen soldiers provided more than one answer to this question, suggesting that they changed the configuration of their pouches to meet specific operational demands. The configuration preferred by the majority (65.8%) of the participants was the 'rifleman' configuration. Approximately ten percent of respondents (10.3%) indicated that they used the 'commander' configuration; 8.2% said they used the 'C9' configuration; 8.6% said they used the 'M203' configuration, while no participants indicated they used the '7.62mm marksman' configuration. Two participants (0.8%) noted that they used the 'confined space' configuration. Every participant that took part in the survey portion of the mid deployment survey had their loaded tactical vest weighed. The average weight of the vest was 9.10 kg (sd=2.11, min= 4.36, max=16.91). Participants were also asked whether they carried a bayonet. Over 76% of the participants did not carry a bayonet. Of the 56 participants that did carry a bayonet almost 77% of them carried it on their side as opposed to only 5% of them that carried it on the front of their MFR.

Performing an additional mode analysis on the MFR B pouches worn by the soldiers indicates that the most common pouch worn by participants was the individual trauma pouch (78.2%) followed by the 5.56 triple mag panel (75.3%) and the roll-up dump pouch (68.6%). Additionally, the following pouches were worn by more than half of the participants: modular Nalgene (62.3%), tourniquet (57.7%), grenade (56.1%), larger utility (55.2%), and the small radio pouch (54.8%). These results are summarized in Table 20. The mode represents the amount of the specific pouch most frequently worn; the n represents the total number of participants that wore that specific pouch; and percentage is the percentage of total participants surveyed (239 total participants). Additional pouches purchased by participants included a 9mm mag pouches, pistol holder, additional mag pouches, MBITR pouch, TCCC pouch, and additional bibs for the MFR.

Table 20: Pouches worn by participants on MFR B

Pouch	Mode	n	%
Individual Trauma	1	187	78.2
5.56 Triple Mag Panel	2	180	75.3
Roll Up Dump	1	164	68.6
Modular Nalgene	1	149	62.3
Tourniquet	1	138	57.7
Grenade	2	134	56.1
Large Utility	1	132	55.2
Small Radio (PRR)	1	131	54.8
5.56 Single Mag	2	109	45.6
Universal Modular Double Magazine	1	105	43.9
Universal Modular Single Magazine	1	94	39.3
Flashbang / SMK	1	89	37.2
Multi-Tool	1	84	35.1
Canteen Utility	1	73	30.5
Modular Hydration Carrier	1	70	29.3
Strobe / Compass	1	62	25.9
Double Pistol Mag	1	28	11.7
200 Rd.	2	24	10
Radio Pouch AN/PRC 152 Harris Radio	1	17	7.1
40mm M203 Belt	1	11	4.6
Modular Pistol Holster	1	10	4.2
40mm 4rd M203 Panel	2	4	1.7
7.62 Single Mag	1	1	0.4
7.62 Double Mag	-	-	-
Confined Space Rig	-	-	-

The majority of the participants (42.3%) indicated that their primary role on this deployment was training, advising, or mentoring. A remaining 10% of the participants indicated that they performed quick reaction force missions or were part of convoy operations. The remaining participants indicated their primary roles were other staff positions, gate guard, force protection, or recce patrols. Participants also indicated that almost 80% (79.2%) of their missions were conducted during the day with the remaining missions conducted at night. The average duration of the missions indicated were 5.7 hours (sd=5.79, min=2 hours, max=72 hours).

With regard to the small pack carried by soldiers, 80 small packs were weighed with the average loaded weight was recorded at 7.76 kg. Participants were given the opportunity to describe the items carried in their small packs. The most common items carried in the small packs were water, rations, socks, toques, gloves, glow sticks, camera, TCCC, flash lights, PCM batteries, and t-shirts. In addition to the common items listed for the small pack other common items carried in the small pack included; extra ammo, blanket, helmet, MNVG, rain gear, puffy jacket, shaving kit, sleeping bag, extra batteries, spare barrel, maps, thermal clothing, and field message pads. Almost 83% of respondents indicated that this was a typical load for their missions; however, 68% of respondents noted that they changed their load based on the mission requirements.

4.2.3 MFR C Configuration

For MFR C, of the 219 participants (that completed the mid-deployment questionnaire) that noted their pouch configuration; thirteen soldiers provided more than one answer to this question, suggesting a small number of participants changed their configuration of their pouches to meet specific operational demands. The configuration preferred by the majority (70.8%) of the participants was the ‘rifleman’ configuration. Over nineteen percent of respondents (19.6%) indicated that they used the ‘commander’ configuration; 5.4% said they used the ‘C9’ configuration; 2.3% said they used the ‘M203’ configuration, while only two participants indicated they used the ‘7.62mm marksman’ configuration. Another two participants (0.9%) noted that they used the ‘confined space’ configuration. Every participant that took part in the survey portion of the mid deployment survey had their loaded tactical vest weighed. The average weight of the vest was 10.80 kg (sd=2.35, min= 4.77, max=17.64). Participants were also asked whether they carried a bayonet. Over 60% of the participants did not carry a bayonet. Of the 84 participants that did carry a bayonet almost 65% of them carried it on their side as opposed to 32% of them that carried it on the front of their MFR.

Performing an additional mode analysis on the MFR C pouches worn by the soldiers indicates that the most common pouch worn by participants was the CFA medic pouch (94.2%) followed by the 90 rd Velcro (92.9%) and the utility hydration cover (67.7%). Additionally, the following pouches were worn by more than half of the participants: small accessories (64.2%), large utility (60.2%), and the PRR pouch (59.7%). These results are summarized in Table 21. The mode represents the amount of the specific pouch most frequently worn; the n represents the total number of participants that wore that specific pouch; and percentage is the percentage of total participants surveyed (226 total participants). Additional pouches purchased by participants included a double 9mm mag pouches, pistol pouches, CTOMS med pouch, admin pouch, open top 5.56mm mag pouches, MBITR pouch, and pistol holster.

Table 21: Pouches worn by participants with MFR C

Pouch	Mode	n	%
CFA Medic Pouch	1	213	94.2
90 rd. Velcro	3	210	92.9
Utility Hydration Cover	1	153	67.7
Accessories (Small)	1	145	64.2
Utility Large (Fastex)	1	136	60.2
PRR Pouch	1	135	59.7
Dump	1	106	46.9
Multi Tool	1	101	44.7
D/A 30 rd. Single	1	98	43.4
F1 Vertical Grenade	1	94	41.6
SMK/NVD	1	65	28.8
Etrex GPS Pouch	1	54	23.9
60 rd. Fastex	1	34	15.0
D/A USP SF x 2	1	21	9.3
200 rd. C9	2	14	6.2
Harris Radio	1	10	4.4
Pistol Holder	1	8	3.5
40mm x 4 Horizontal	2	4	1.8

Almost 36% of the participants indicated that their primary role on this deployment was training, advising, or mentoring. Another 25% of the participants indicated that they performed quick reaction force missions or were part of convoy operations. The remaining participants indicated their primary roles were logistics, mechanic, road moving, force protection, or other dismounted operations. Participants also indicated that almost 80% (78.9%) of their missions were conducted during the day with the remaining missions conducted at night. The average duration of the missions indicated were 4.8 hours (sd=3.5, min=<1 hours, max=24 hours).

With regard to the small pack carried by soldiers, due to the time available with the participants no small packs were weighed. Only a small number of participants (33) had the opportunity to describe the items carried in their small packs. The results suggest that the small packs weights would resemble the weights carried with the other MFRs. The most common items carried in the small packs were water, rations, socks, toques, gloves, glow sticks, camera, TCCC, flash lights, PCM batteries, and t-shirts. In addition to the common items listed for the small pack other common items carried in the small pack included; blanket, shoes, boots, shower kit, surgical gloves, soft shell jacket, maps, and extra ammo. Over 90% of respondents indicated that this was a typical load for their missions; with only 35% of participants indicating that they changed their load.

4.3 Post Deployment MFR Configuration

The participants from 1R22eR were asked which front and back panel they wore during most of their deployment. The majority of the participants (69%) indicated that they wore MFR A2 as their primary front panel and of the remaining participants 21% wore MFR A1 and 10% wore MFR A3. It should be noted that some participants indicated that the only reason why they wore MFR A3 was because they were initially not issued the MFR so they borrowed from a soldier who had and was not using it. Additionally, 54 percent of participants indicated that they wore the narrower back panel (4 PALS wide) with the remaining participants using the wider back panel (6 PALS wide).

Participants noted their pouch configuration. For MFR A the configuration preferred by the majority (41.8%) of the participants was the 'rifleman' configuration. Approximately twenty-five percent of respondents (25.5%) indicated that they used the 'M203' configuration; 16.4% said they used the 'Commander' configuration; 13.6% said they used the 'C9' configuration, while 2.7% of the participants said they used the '7.62mm marksman' configuration.

For MFR B the configuration preferred by the majority (72.3%) of the participants was the 'rifleman' configuration. Approximately ten percent of respondents (9.49%) indicated that they used the 'M203' configuration and another 9.49% indicated they used the 'C9' configuration; 6.6% said they used the 'Commander' configuration; while 2.2% of the participants said they used the 'confined space rig' configuration.

Participants were also to estimate the time they spent wearing the MFR. For the MFR A, the average time that the MFR was used was almost ten months (9.9 months, sd=1.8 months); for MFR B, the average time that the MFR was used was seven months (sd=2.5 months). The MFRs thus received a thorough testing.

4.4 Post Deployment Acceptability Questionnaire

During the post-deployment evaluation period, participants completed a series of questionnaires in a facilitated session. The post-deployment questionnaire was paper-based and examined each MFR using a number of evaluation criteria similar to that of the mid-deployment questionnaire. Unfortunately, by the time of this report only MFR A and MFR B were assessed.

Basic descriptive statistics were applied to the ratings given by the participants; all results are presented as mean with one standard deviation (sd).

Similar to the mid-deployment questionnaire each logical category, of the post-deployment questionnaire consisted of several sub-questions including an overall rating for that section. Presented in Figure 9 are the summary results for the overall ratings in each category. Across all of the categories MFR A had the highest acceptability ratings. However, all of the average ratings across the overall categories were rated as acceptable. All of the ratings for MFR A were between ‘reasonably acceptable’ and ‘completely acceptable’; while the majority of the ratings for MFR B were between ‘barely acceptable’ and ‘reasonably acceptable’.

For MFR A material properties were rated the most acceptable at 6.7 (± 0.6) while bulk was rated the least acceptable at 6.1 (± 0.9). For MFR B, mobility was rated the most acceptable at 6.0 (± 0.7) and the least acceptable criterion for MFR B was bulk with a rating of 5.4 (± 1.0).

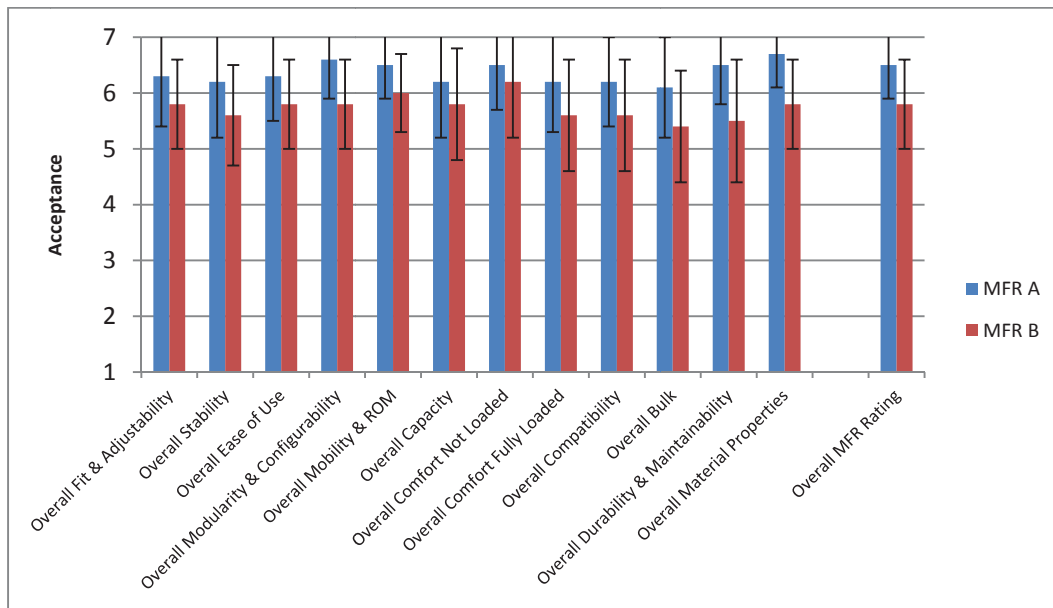


Figure 9: Overall post-deployment acceptability of the MFR

In terms of overall rating, MFR A had the highest rating with a value of 6.5 (± 0.6) while MFR B had a rating of 5.8 (± 0.8).

An independent samples t-test was conducted to compare all the overall ratings of MFR A to MFR B. In each case it was found that MFR A had a significantly higher overall rating when compared to MFR B. The p-values for each of the overall criteria will be displayed in their representative tables.

4.4.1 Fit and Adjustability

Participants rated the acceptability of the fit and adjustability of the MFRs across various criteria – see Table 22. Across all of the criteria each MFR had average acceptability ratings that were above ‘borderline’. For MFR A the fit over the Fragmentation Protection Vest (FPV) and the fit with the combat uniform only were rated most acceptable at 6.2 ± 1.2 and 6.2 ± 1.1 , respectively. The ease of adjustment was rated least acceptable at 5.5 ± 1.5 ; this corresponds to a ‘barely acceptable’ level of acceptability. Participants rated the overall fit and adjustability of MFR A at 6.3 ± 0.9 .

For MFR B, the fit over the fragmentation vest was rated the most acceptable with a rating of 6.0 ± 0.9 . Similar to MFR A, the ease of adjustment was the lowest rated criterion with a rating of 5.4 ± 1.1 . Participants rated the overall fit and adjustability of MFR B as between ‘barely acceptable’ and ‘reasonably acceptable’ (5.8 ± 0.8).

Table 22: Post deployment fit and adjustability acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD
Fit with combat uniform only	6.3 ± 0.8	6.2 ± 1.0	5.4 ± 1.6	6.2 ± 1.0	5.7 ± 1.2
Fit over Fragmentation Protection Vest (FPV)	6.3 ± 0.9	6.2 ± 1.1	5.9 ± 1.6	6.2 ± 1.1	6.0 ± 0.9
Ease of adjustment	5.9 ± 1.2	5.4 ± 1.6	5.7 ± 1.6	5.5 ± 1.5	5.4 ± 1.1
Range of adjustability	6.3 ± 1.0	6.0 ± 1.2	5.9 ± 1.7	6.0 ± 1.2	5.9 ± 0.8
Adjustment retention	6.2 ± 0.9	5.9 ± 1.3	5.3 ± 1.8	5.9 ± 1.3	5.7 ± 1.0
Overall Fit & Adjustability (p-value=0.0007)	6.4 ± 0.8	6.1 ± 0.9	6.7 ± 0.5	6.3 ± 0.9	5.8 ± 0.8

4.4.2 Stability

Stability was rated by participants across various positions and loads – see Table 23. Across all of the criteria each MFR had average acceptability ratings that were above ‘borderline’. MFR A had the highest acceptability ratings across all of the criteria. Stability of MFR A was rated most acceptable in terms of its integration with the FPV (6.24 ± 0.8) and least acceptable in terms of stability while in the prone (5.1 ± 1.6). Stability while in the prone was rated slightly above ‘barely acceptable’. Overall stability of MFR A was rated at 6.2 ± 1.0 and was considered ‘reasonably acceptable’.

With respect to MFR B, the most acceptable stability criterion was stability with the FPV (5.8 ± 1.0) and the least acceptable criteria was stability while in the prone (4.8 ± 1.3). All of the criteria for MFR B had ratings between ‘barely acceptable’ and ‘reasonably acceptable’. Overall stability of MFR B was rated at 5.6 ± 0.9 which is between ‘barely acceptable’ and ‘reasonably acceptable’.

Table 23: Post deployment stability acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD
Stability with combat uniform	5.9 ± 1.3	6.2 ± 1.0	6.0 ± 1.2	6.1 ± 1.1	5.3 ± 1.3
Stability With FPV	6.4 ± 0.9	6.4 ± 0.8	6.4 ± 0.5	6.4 ± 0.8	5.8 ± 1.0
Stability while running	5.9 ± 1.2	6.1 ± 0.9	6.0 ± 0.9	6.0 ± 1.0	5.3 ± 1.2
Stability while crouching	6.0 ± 1.1	6.0 ± 1.1	6.2 ± 0.7	6.0 ± 1.0	5.6 ± 1.0
Stability while sitting	6.2 ± 1.1	6.3 ± 0.7	6.2 ± 0.7	6.3 ± 0.8	5.6 ± 0.9
Stability while kneeling	6.2 ± 0.8	6.3 ± 0.7	6.2 ± 0.4	6.3 ± 0.7	5.6 ± 0.9
Stability while prone	5.0 ± 1.8	5.1 ± 1.6	5.3 ± 1.4	5.1 ± 1.6	4.8 ± 1.3
Stability with full combat load	6.0 ± 0.9	6.3 ± 1.0	6.0 ± 1.0	6.2 ± 1.0	5.7 ± 1.0
Overall Stability (p-value=0.0000)	6.2 ± 1.4	6.2 ± 0.9	6.5 ± 0.5	6.2 ± 1.0	5.6 ± 0.9

4.4.3 Ease of Use

Ease of use was rated in terms of donning, doffing, configuration, and access – see Table 24. Each MFR had average acceptability ratings that were above ‘borderline’ across all of the criteria. MFR A was rated most acceptable in terms of its medical access, configuration, and ease of pouch content accessibility and replacement (6.4 ± 0.8 , 6.4 ± 0.7 , and 6.4 ± 0.7 , respectively) and least acceptable with respect to its ease of donning (5.3 ± 1.6); the ease of use ratings for MFR A ranged from ‘barely acceptable’ to ‘completely acceptable’. The overall acceptability for ease of use for MFR A was rated at 6.3 ± 0.8 .

MFR B was rated most acceptable in terms of ease of donning and ease of doffing (5.9 ± 0.9 and 5.9 ± 0.8) and least acceptable with respect to its ease of pouch content access and replacement (5.6 ± 1.0); the ease of use ratings for MFR B ranged from ‘barely acceptable’ to ‘reasonably acceptable’. The overall acceptability for ease of use for MFR B was rated at 5.8 ± 0.8 .

MFR A had the highest acceptability ratings across the majority of criteria when compared to MFR B. Ease of donning and ease of doffing were the only criteria which another MFR B had a higher acceptability rating than MFR A.

Table 24: Post deployment ease of use acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD
Ease of donning	5.4 ± 1.7	5.2 ± 1.7	5.9 ± 1.0	5.3 ± 1.6	5.9 ± 0.9
Ease of doffing	5.8 ± 1.1	5.7 ± 1.4	5.9 ± 1.1	5.8 ± 1.3	5.9 ± 0.8
Ease of configuration	6.4 ± 0.9	6.5 ± 0.7	6.3 ± 0.7	6.4 ± 0.7	5.8 ± 1.0
Ease of medical access	6.4 ± 0.9	6.4 ± 0.8	6.4 ± 0.5	6.4 ± 0.8	5.8 ± 1.0
Ease of pouch content access and replacement	6.6 ± 0.6	6.4 ± 0.7	6.1 ± 0.9	6.4 ± 0.7	5.6 ± 1.0
Overall Ease of Use (p-value=0.0000)	6.6 ± 0.7	6.2 ± 0.8	6.5 ± 0.8	6.3 ± 0.8	5.8 ± 0.8

4.4.4 Modularity and Configurability

The modularity and configurability of the MFRs were rated across a number of criteria - Table 25. Each MFR was rated as being better than ‘barely acceptable’ across all criteria. MFR A had the highest acceptability ratings across all of the criteria. Ease of modifying to suit personal preference/handedness had the highest rating for MFR A (6.7 ± 0.6); while the ease of configuring by load had the lowest rating (6.4 ± 0.8). All of the ratings for MFR A were between ‘reasonably acceptable’ and ‘completely acceptable’. The overall acceptability of MFR A’s modularity and configurability was rated at 6.6 ± 0.7 .

Ease of modifying to suit personal preference/handedness was the highest rated criterion for MFR B with a rating that 6.0 ± 0.9 while ease of configuring by mission had the lowest rating for MFR B at 5.5 ± 1.1 . The overall acceptability of MFR B’s modularity and configurability was rated at 5.8 ± 0.8 . For MFR B most of the criteria for modularity and configurability had a rating that was between ‘barely acceptable’ and ‘reasonably acceptable’.

Table 25: Post deployment modularity and configurability acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD
Ease of configuring by mission	6.8 \pm 0.5	6.4 \pm 0.7	6.4 \pm 0.7	6.5 \pm 0.7	5.5 \pm 1.1
Ease of configuring according to role	6.7 \pm 0.6	6.6 \pm 0.7	6.4 \pm 0.7	6.6 \pm 0.7	5.7 \pm 1.0
Ease of configuring by load	6.6 \pm 0.8	6.4 \pm 0.8	6.1 \pm 0.8	6.4 \pm 0.8	5.6 \pm 0.9
Ease of modifying to suit personal preference / handedness	6.9 \pm 0.3	6.6 \pm 0.7	6.6 \pm 0.5	6.7 \pm 0.6	6.0 \pm 0.9
Overall Modularity & Configurability (p-value=0.0000)	6.8 \pm 0.4	6.5 \pm 0.8	6.7 \pm 0.5	6.6 \pm 0.7	5.8 \pm 0.8

4.4.5 Mobility and Range of Motion

Participants rated the acceptability of the MFRs across a number of criteria relating to mobility and range of motion – see Table 26. MFR A had the highest acceptability ratings across all of the criteria. Participants rated the mobility and range of motion of MFR A across all criteria between ‘reasonably acceptable’ and ‘completely acceptable’. Overhead arm motion was rated least acceptable at 6.2 \pm 0.9 while head motion was rated most acceptable at 6.5 \pm 0.7; this represents a maximum range of 0.3 acceptability points across all criteria. Overall, mobility and range of motion for MFR A was rated at 6.5 \pm 0.6.

Participants rated the mobility and range of motion of MFR B as being close to ‘reasonably acceptable’. Trunk motion was rated least acceptable at 5.7 \pm 1.0 while head motion was rated most acceptable at 6.2 \pm 0.7. Overall, mobility and range of motion for MFR B was rated at 6.0 \pm 0.7.

Table 26: Post deployment mobility and range of motion acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD
Ability to perform combat movements	6.4 \pm 0.8	6.4 \pm 0.8	6.3 \pm 0.7	6.4 \pm 0.8	5.8 \pm 0.8
Arm motion overhead	6.4 \pm 0.7	6.2 \pm 0.9	6.2 \pm 1.0	6.2 \pm 0.9	6.0 \pm 0.8
Arm motion in front	6.2 \pm 1.1	6.4 \pm 0.7	6.4 \pm 0.5	6.4 \pm 0.8	6.1 \pm 0.8
Trunk motion	6.2 \pm 1.1	6.4 \pm 0.7	6.3 \pm 0.7	6.4 \pm 0.8	5.7 \pm 1.0
Head motion	6.4 \pm 0.9	6.5 \pm 0.7	6.4 \pm 0.5	6.5 \pm 0.7	6.2 \pm 0.7
Overall Mobility & ROM (p-value=0.0000)	6.6 \pm 0.6	6.5 \pm 0.6	6.5 \pm 0.8	6.5 \pm 0.6	6.0 \pm 0.7

4.4.6 Capacity

The capacities of the MFRs were rated in terms of its ability to carry the designated combat load and overall capacity – see Table 27. With respect to MFR A both criterion were rated ‘reasonably acceptable’ at 6.5 \pm 0.7 (capacity to carry the designated load) and 6.2 \pm 1.0 (overall). The rating for the capacity to carry the designated combat load for MFR B was 5.8 \pm 1.0 and the overall rating for capacity for MFR B was 5.8 \pm 1.0. Across all criteria both MFR A and MFR B had mean acceptability ratings that were above ‘barely acceptable’.

Table 27: Post deployment capacity acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD
Capacity to carry your designated combat	6.6 \pm 0.5	6.5 \pm 0.8	6.3 \pm 0.5	6.5 \pm 0.7	5.8 \pm 1.0
Overall Capacity (p-value=0.0101)	6.4 \pm 0.8	6.2 \pm 1.0	5.6 \pm 1.3	6.2 \pm 1.0	5.8 \pm 1.0

4.4.7 Comfort

Participants rated the MFRs comfort across a number of different criteria – see Table 28. The mean acceptance ratings for the MFRs across all the criteria were between ‘barely acceptable’ and ‘completely acceptable’. MFR A had the highest acceptability ratings across all of the criteria, except for thermal comfort where it had the same rating as MFR B.

The ratings for MFR A were generally ‘reasonably acceptable’; however, pressure points was rated the least acceptable for MFR A at 5.6 \pm 1.5. Overall comfort while unloaded for MFR A was rated most acceptable at 6.5 \pm 0.8. Overall comfort while fully loaded for MFR A was rated at 6.2 \pm 0.9.

The ratings for MFR B were generally between ‘barely acceptable’ and ‘reasonably acceptable’. Pressure points was rated least acceptable for MFR B at 5.4 \pm 1.4. Overall comfort while unloaded for MFR B was rated most acceptable at 6.2 \pm 1.0. Overall comfort while fully loaded for MFR B was rated at 5.6 \pm 1.0.

Table 28: Post deployment comfort acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD
Load distribution	6.1 \pm 0.9	5.9 \pm 1.3	5.8 \pm 1.0	5.9 \pm 1.2	5.6 \pm 1.1
Chaffing	6.2 \pm 0.9	5.8 \pm 1.1	5.3 \pm 1.2	5.9 \pm 1.1	5.7 \pm 1.2
Pressure points	5.4 \pm 1.6	5.7 \pm 1.5	5.6 \pm 1.4	5.6 \pm 1.5	5.4 \pm 1.4
Thermal (heat retention)	5.9 \pm 1.0	5.7 \pm 1.2	5.9 \pm 1.0	5.8 \pm 1.1	5.8 \pm 1.2
Overall Comfort Not Loaded	6.4 \pm 0.7	6.6 \pm 0.9	6.8 \pm 0.4	6.5 \pm 0.8	6.2 \pm 1.0
Overall Comfort Fully Loaded (p-value=0.0001)	6.3 \pm 0.8	6.2 \pm 0.9	6.3 \pm 0.8	6.2 \pm 0.9	5.6 \pm 1.0

4.4.8 Compatibility

Compatibility of the MFRs with various pieces of personal gear was evaluated by the participants – see Table 29. Compatibility of MFR A with gloves was rated most acceptable at 6.5 \pm 0.6 while the compatibility with the cold weather gear was rated the least acceptable at 5.5 \pm 1.5. Therefore, the difference between the least acceptable criteria and the most acceptable criteria was one acceptance point. Compatibility of MFR A with personal weapons was rated at 6.4 \pm 0.8. Overall compatibility of MFR A was rated at 6.2 \pm 0.8.

Compatibility of MFR B with the helmet was rated most acceptable at 6.1 \pm 0.8 and the compatibility with the rucksack was rated the least acceptable with a rating of 4.6 \pm 1.7. Compatibility of MFR B with personal weapons was rated at 6.0 \pm 0.8. Overall compatibility of MFR B was rated at 5.6 \pm 1.0.

MFR A had the highest acceptability ratings across the majority of criteria when compared to MFR B. Compatibility with the cold weather gear was the only criteria MFR B had a higher acceptability than MFR A.

Table 29: Post deployment compatibility acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD
Compatibility with Personal weapon	6.3 \pm 0.7	6.4 \pm 0.8	6.3 \pm 0.5	6.4 \pm 0.8	6.0 \pm 0.8
Compatibility with weapon slings	5.8 \pm 1.4	6.2 \pm 0.9	6.0 \pm 0.7	6.1 \pm 1.0	5.8 \pm 1.0
Compatibility with helmet	6.1 \pm 1.3	6.4 \pm 0.8	6.2 \pm 0.4	6.3 \pm 0.9	6.1 \pm 0.8
Compatibility with fragmentation vest	6.1 \pm 1.4	6.3 \pm 0.9	5.7 \pm 1.1	6.2 \pm 1.1	5.8 \pm 1.2
Compatibility with small pack	5.9 \pm 1.2	6.1 \pm 1.1	5.7 \pm 1.2	6.0 \pm 1.1	5.1 \pm 1.4
Compatibility with rucksack	5.9 \pm 0.9	5.8 \pm 1.3	5.8 \pm 1.6	5.8 \pm 1.2	4.6 \pm 1.7
Compatibility with gloves	6.5 \pm 0.7	6.5 \pm 0.7	6.5 \pm 0.5	6.5 \pm 0.6	6.0 \pm 0.9
Compatibility with cold weather gear (jacket,	5.8 \pm 1.6	5.5 \pm 1.5	5.0 \pm 1.2	5.5 \pm 1.5	5.6 \pm 1.2
Compatibility with vehicles (LAV III, Nyala,	6.1 \pm 1.5	5.8 \pm 1.2	5.9 \pm 1.1	5.9 \pm 1.3	4.8 \pm 1.6
Overall Compatibility (p-value=0.0000)	6.5 \pm 0.6	6.0 \pm 0.8	6.3 \pm 0.8	6.2 \pm 0.8	5.6 \pm 1.0

4.4.9 Bulk

Subjective measures of bulk were captured for each MFR – see Table 30. MFR A had the highest acceptability ratings across all of the bulk criteria when compared to MFR B. The bulk of MFR A was rated at approximately ‘reasonably acceptable’ across all evaluation criteria. The encumbrance of MFR A at the chest when loaded was rated the least acceptable aspect of bulk at 5.7 \pm 1.2. The width of MFR A when loaded was rated 6.1 \pm 1.0. Overall, the bulk of MFR A was rated 6.1 \pm 0.9. In terms of the three variants of MFR A there was very little difference in bulk subjective ratings between each of the variants.

With regards to the bulk of MFR B all of its bulk ratings were higher than ‘barely acceptable’ with the highest rated criteria for MFR B being the encumbrance of MFR A at the chest when loaded with a rating of 5.6 \pm 1.0. Overall, the bulk of MFR B was rated 5.4 \pm 1.0.

Table 30: Post deployment bulk acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD
Width of the MFR when loaded	6.1 \pm 1.2	6.0 \pm 1.0	6.0 \pm 1.0	6.1 \pm 1.0	5.1 \pm 1.3
Depth of the MFR when loaded	6.2 \pm 0.9	5.9 \pm 1.2	6.0 \pm 1.0	6.0 \pm 1.1	5.4 \pm 1.1
Encumbrance at the chest when loaded	5.7 \pm 0.8	5.7 \pm 1.3	5.9 \pm 0.9	5.7 \pm 1.2	5.6 \pm 1.0
Overall Bulk (p-value=0.0000)	6.0 \pm 0.9	6.1 \pm 0.9	6.3 \pm 0.8	6.1 \pm 0.9	5.4 \pm 1.0

4.4.10 Durability and Maintainability

Participants rated the durability of specific features of the MFRs and the ability to maintain the operational effectiveness of the MFR if a feature fails – see Table 31. The durability of MFR A was rated more acceptable than ‘reasonably acceptable’ across hardware, straps, ease of replacing items and material (6.2 ± 1.1 , 6.4 ± 0.9 , 6.2 ± 1.2 and 6.3 ± 1.1 , respectively). Repairing items was slightly less acceptable to participants with a rating that was just below ‘reasonably acceptable’. Overall, the durability and maintainability of MFR A was rated 6.5 ± 0.7 .

With respect to MFR B the ratings for the durability of the hardware, material, and the ease of replacing items were between ‘barely acceptable’ and ‘reasonably acceptable’. The durability of the straps had a rating that was just at ‘reasonably acceptable’. The ease of repairing items was slightly less acceptable than the other items but were still found to be acceptable with a rating that was just below ‘barely acceptable’. Overall, the durability and maintainability of MFR B was rated 5.5 ± 1.1 .

Table 31: Post deployment durability and maintainability acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD
Durability of hardware (buckles, snaps, zippers, etc.)	6.4 ± 1.3	6.2 ± 1.1	6.1 ± 0.9	6.2 ± 1.1	5.7 ± 1.2
Durability of straps	6.6 ± 0.9	6.4 ± 0.8	6.1 ± 1.1	6.4 ± 0.9	6.0 ± 0.9
Durability of material, MOLLE loops, velcro, shockcord,	6.3 ± 0.9	6.3 ± 1.2	6.3 ± 0.5	6.3 ± 1.1	5.8 ± 1.0
Ease of replacing items	6.4 ± 0.8	6.2 ± 1.4	6.0 ± 1.0	6.2 ± 1.2	5.3 ± 1.4
Ease of repairing items	6.1 ± 0.9	5.9 ± 1.4	5.8 ± 1.2	5.9 ± 1.3	4.9 ± 1.4
Overall Durability & Maintainability (p-value=0.0000)	6.6 ± 0.6	6.4 ± 0.8	6.3 ± 0.8	6.5 ± 0.7	5.5 ± 1.1

4.4.11 Material Properties

Participants rated the material properties of the MFR for noise signature, camouflage, and weight – see Table 32. The material properties of MFR A were generally rated at more acceptable than ‘reasonably acceptable’. Noise signature aspects of MFR A were rated least acceptable to participants at 6.3 ± 0.8 while the empty weight of MFR A was rated most acceptable at 6.6 ± 0.5 . Further, the camouflage of MFR A was rated at 6.4 ± 0.7 . Overall material properties of MFR A was rated at 6.7 ± 0.6 .

Ratings on material properties for MFR B were slightly lower than MFR A but were still acceptable with all ratings being more acceptable than ‘barely acceptable’. The highest rated material properties criterion for MFR B was the weight (empty) with a rating of 6.2 ± 0.9 . The lowest rated criteria for MFR B were the noise signature and the camouflage with ratings of 5.5 ± 1.1 . Overall material properties of MFR B was rated at 5.8 ± 0.8 .

Table 32: Post deployment material properties acceptability ratings

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD	MFR B Mean \pm SD
Noise signature (closures, rubbing, etc.)	6.4 \pm 0.7	6.3 \pm 0.8	6.3 \pm 0.5	6.3 \pm 0.8	5.5 \pm 1.1
Camouflage	6.5 \pm 0.7	6.4 \pm 0.6	5.9 \pm 1.1	6.4 \pm 0.7	5.5 \pm 1.1
Weight (empty)	6.5 \pm 0.6	6.7 \pm 0.4	6.3 \pm 0.5	6.6 \pm 0.5	6.2 \pm 0.9
Overall Material Properties (p-value=0.0000)	6.7 \pm 0.5	6.7 \pm 0.6	6.5 \pm 0.5	6.7 \pm 0.6	5.8 \pm 0.8

4.4.12 Overall Rating

Overall, participants rated MFR A as being better than ‘reasonably acceptable’ at 6.5 \pm 0.6. Participants rated MFR B almost ‘reasonably acceptable’ with an overall rating of 5.8 \pm 0.8. MFR A was found to have a significantly higher overall rating than MFR B (p-value=0.0000).

4.4.13 Vest Features

Each participant of the post-deployment focus groups completed a features questionnaire for the MFR they wore. The results of the features questionnaire are detailed in the following sections.

4.4.13.1 MFR A1

The results from the features questionnaire of MFR A1 are shown in Figure 10. All of the features of MFR A1 had mean acceptance ratings that were acceptable with the majority of the ratings being between ‘barely acceptable’ and ‘reasonably acceptable’. The highest rated feature for MFR A1 was the plastic loops. Participants indicated that this a good feature to have for the purpose of attaching items to. Also, the webbing loops feature had a rating that was almost ‘reasonably acceptable’ and participants again indicated that they are a good feature to attach items to. The three lowest features of MFR A1 were the side release buckles, padding, and the shoulder attachment / adjustment feature.

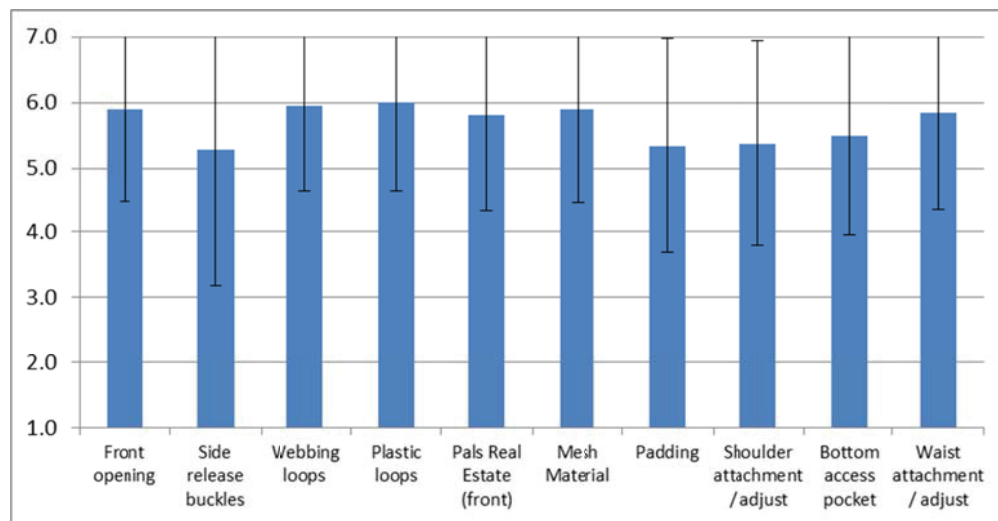


Figure 10: MFR A1 features acceptability ratings

4.4.13.2 MFR A2

The results from the features questionnaire of MFR A2 are shown in Figure 11. All of the features of MFR A2 had mean acceptance ratings that were acceptable with the majority of the ratings being between ‘reasonably acceptable’ and ‘completely acceptable’. The highest rated feature for MFR A2 was the PALS real estate on the front. MFR A2 provided these participants with the most room to mount pouches. Participants indicated that this a good feature to have as it allowed to configure the vest for any role. The next highest rated features for MFR A2 were the side opening/overhead feature and the internal mesh pocket. The three lowest features of MFR A2 were the waist attachment/adjustment, shoulder strap padding, and the shoulder attachment / adjustment feature.

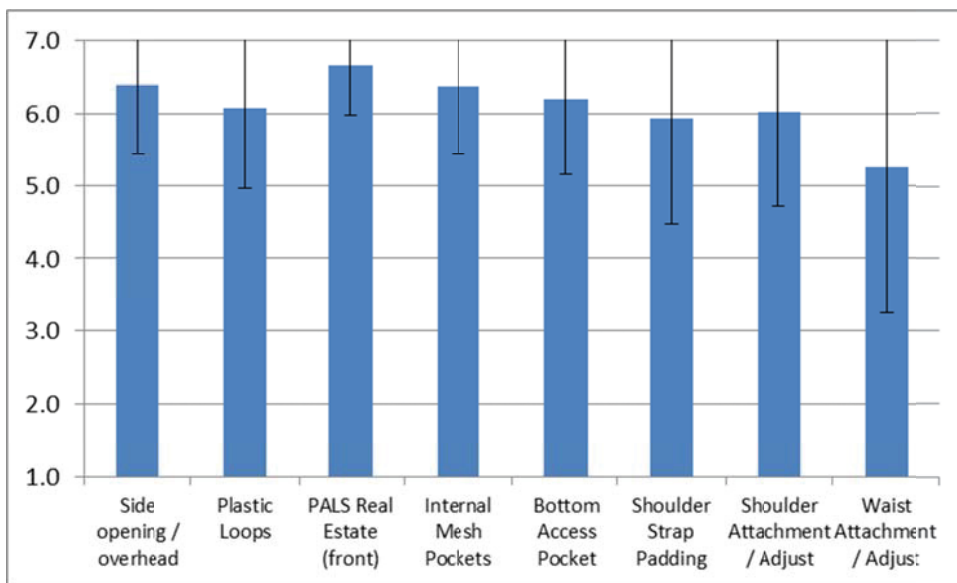


Figure 11: MFR A2 features acceptability ratings

4.4.13.3 MFR A3

The results from the features questionnaire of MFR A3 are shown in Figure 12. All of the features of MFR A3 had mean acceptance ratings that were acceptable with ratings between ‘reasonably acceptable’ and ‘completely acceptable’. The highest rated feature for MFR A3 was the side opening/overhead feature, followed by PALS on the shoulder straps. The lowest rated feature of MFR A3 was the padding but it was still found to be above ‘reasonably acceptable’.

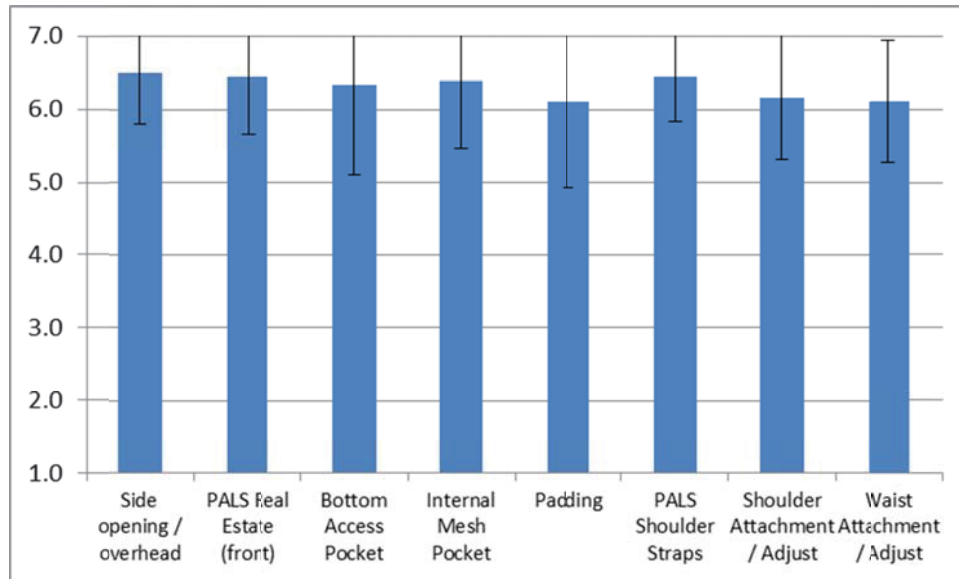


Figure 12: MFR A3 features acceptability ratings

4.4.13.4 MFR B

The results from the features questionnaire of MFR B are shown in Figure 13. All of the features of MFR B had mean acceptance ratings that were acceptable, with the vast majority of the features being rated between ‘barely acceptable’ and ‘reasonably acceptable’. The only feature that had a rating that was below ‘barely acceptable’ was the internal pocket. The highest rated feature for MFR B was the waist attachment system followed by the PALS real estate on the front.

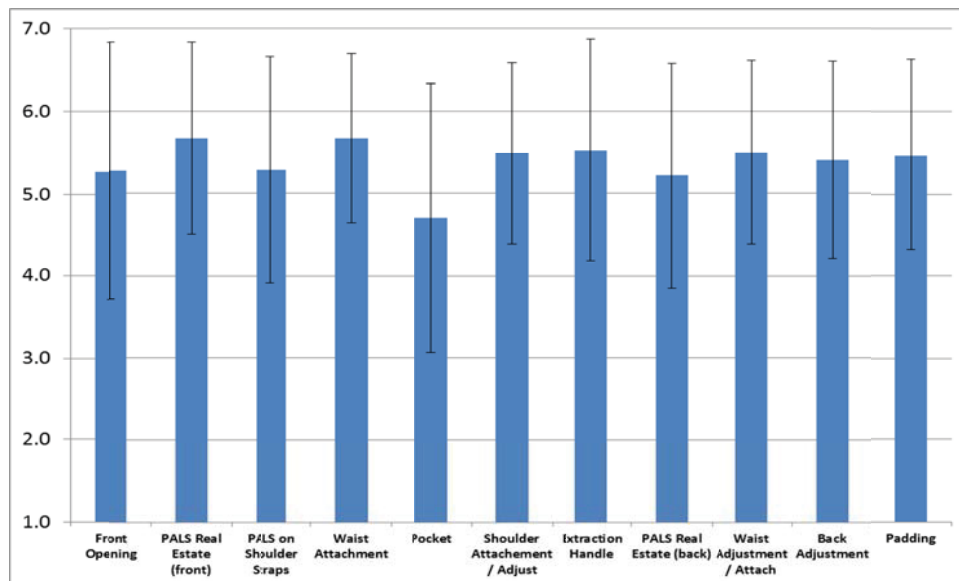


Figure 13: MFR B features acceptability ratings

4.4.14 Mid-Deployment and Post-Deployment Ratings Differences

One of the advantages of collecting data during the middle of the deployment and after the soldiers returned from their full deployment is that we are able to capture the performance of the trial MFRs longitudinally. As deployments often span a number of months and seasons we can analyse whether this had an impact on the ratings of the MFRs across all the criteria. In the following table we present the questionnaire results for both the mid-deployment and post-deployment questionnaires along with the difference between the two questionnaires – see Table 33. Major differences between the mid-deployment and post-deployment data are identified any time that a difference in the ratings was greater than one acceptance point or when the ratings changed their polarity (i.e. acceptable in the mid-deployment to unacceptable to the post-deployment).

The difference in the ratings between mid-deployment and post-deployment for MFR A were very small. There was only one instance where the difference was greater than half an acceptance point and that was for compatibility with vehicles. In all other cases the differences were half an acceptance point or less. In the vast majority of instances the ratings taken from the post-deployment questionnaire were slightly higher than the ratings taken from the mid-deployment questionnaire. There were only four instances where the post-deployment questionnaire had a rating that was less than the mid-deployment rating and for each of these instances the difference was only 0.1 of an acceptance point. Averaging the change in acceptance ratings from the mid-deployment questionnaire to the post-deployment questionnaire resulted in a value of 0.23 (sd=0.14) indicating a small change in the ratings between both questionnaires.

The variance in ratings between the mid-deployment questionnaire and the post-deployment questionnaire was much greater for MFR B when compared to MFR A. There were a total of five instances where the difference between mid-deployment and post-deployment ratings were greater than one acceptance point (fit over fragmentation vest, ease of pouch content and access and replacement, compatibility with rucksack, durability of straps, and thermal (heat retention)). In four out of the five cases the ratings in the post-deployment survey were higher than in the mid-deployment survey (only compatibility with rucksack was lower in the post-deployment questionnaire). Similar to MFR A the vast majority of ratings for MFR B from the post-deployment questionnaire were higher than that of the mid-deployment questionnaire. There were fourteen more cases where the post-deployment questionnaire had rating that was less than the mid-deployment questionnaire for MFR B compared to MFR A. The criterion that had the largest drop in acceptance from mid-deployment to post-deployment was the compatibility with the rucksack which had a difference of one acceptance point. In no instance did the polarity of any of the criteria change between the mid-deployment questionnaire and the post-deployment questionnaire. Averaging the change in acceptance ratings from the mid-deployment questionnaire to the post-deployment questionnaire resulted in a value of 0.20 (sd=0.52) indicating a small change in the ratings between both questionnaires but with a larger standard deviation which indicates a wider range of differences between both questionnaires.

Overall, the differences in ratings between the mid-deployment and post-deployment questionnaires were relatively small and in most cases less than one acceptance point. There were no instances in which a criterion changed its acceptance polarity between the mid-deployment and the post-deployment indicating strong consistency in ratings between the two questionnaires.

Table 33: Differences in ratings between mid-deployment and post-deployment questionnaires

Criteria	MFR A Mid Mean \pm SD	MFR A Post Mean \pm SD	MFR A Diff	MFR B Mid Mean \pm SD	MFR B Post Mean \pm SD	MFR B Diff
Fit with combat uniform only	5.8 \pm 1.3	6.2 \pm 1.0	0.4	5.1 \pm 1.5	5.7 \pm 1.2	0.6
Fit over Fragmentation Protection Vest (FPV)	6.0 \pm 1.2	6.2 \pm 1.1	0.2	4.6 \pm 1.6	6.0 \pm 0.9	1.4
Ease of adjustment	5.2 \pm 1.6	5.5 \pm 1.5	0.3	5.6 \pm 1.1	5.4 \pm 1.1	-0.2
Range of adjustability	5.8 \pm 1.3	6.0 \pm 1.2	0.2	5.2 \pm 1.3	5.9 \pm 0.8	0.7
Adjustment retention	5.9 \pm 1.2	5.9 \pm 1.3	0	5.3 \pm 1.2	5.7 \pm 1.0	0.4
Overall Fit & Adjustability	5.9 \pm 1.1	6.3 \pm 0.9	0.4	5.6 \pm 1.2	5.8 \pm 0.8	0.2
Stability with combat uniform	5.7 \pm 1.3	6.1 \pm 1.1	0.4	5.4 \pm 1.2	5.3 \pm 1.3	-0.1
Stability With FPV	6.2 \pm 0.9	6.4 \pm 0.8	0.2	5.6 \pm 1.3	5.8 \pm 1.0	0.2
Stability while running	5.8 \pm 1.1	6.0 \pm 1.0	0.2	5.9 \pm 1.1	5.3 \pm 1.2	-0.6
Stability while crouching	5.7 \pm 1.3	6.0 \pm 1.0	0.3	5.6 \pm 1.4	5.6 \pm 1.0	0
Stability while sitting	6.0 \pm 1.1	6.3 \pm 0.8	0.3	5.2 \pm 1.6	5.6 \pm 0.9	0.4
Stability while kneeling	6.0 \pm 1.1	6.3 \pm 0.7	0.3	5.0 \pm 1.6	5.6 \pm 0.9	0.6
Stability while prone	4.8 \pm 1.7	5.1 \pm 1.6	0.3	5.7 \pm 1.1	4.8 \pm 1.3	-0.9
Stability with full combat load	5.9 \pm 1.0	6.2 \pm 1.0	0.3	5.4 \pm 1.3	5.7 \pm 1.0	0.3
Overall Stability	5.9 \pm 1.0	6.2 \pm 1.0	0.3	5.4 \pm 1.2	5.6 \pm 0.9	0.2
Ease of donning	4.9 \pm 1.7	5.3 \pm 1.6	0.4	6.2 \pm 1.0	5.9 \pm 0.9	-0.3
Ease of doffing	5.4 \pm 1.4	5.8 \pm 1.3	0.4	5.9 \pm 0.9	5.9 \pm 0.8	0
Ease of configuration	6.2 \pm 1.0	6.4 \pm 0.7	0.2	5.8 \pm 0.9	5.8 \pm 1.0	0
Ease of medical access	6.3 \pm 0.8	6.4 \pm 0.8	0.1	5.1 \pm 1.5	5.8 \pm 1.0	0.7
Ease of pouch content access and replacement	6.2 \pm 1.0	6.4 \pm 0.7	0.2	4.6 \pm 1.6	5.6 \pm 1.0	1
Overall Ease of Use	6.1 \pm 0.9	6.3 \pm 0.8	0.2	5.6 \pm 1.1	5.8 \pm 0.8	0.2
Ease of configuring by mission	6.2 \pm 0.9	6.5 \pm 0.7	0.3	5.2 \pm 1.3	5.5 \pm 1.1	0.3
Ease of configuring according to role	6.2 \pm 0.9	6.6 \pm 0.7	0.4	5.3 \pm 1.2	5.7 \pm 1.0	0.4
Ease of configuring by load	6.2 \pm 1.0	6.4 \pm 0.8	0.2	5.6 \pm 1.2	5.6 \pm 0.9	0
Ease of modifying to suit personal preference / handedness	6.4 \pm 0.8	6.7 \pm 0.6	0.3	5.4 \pm 1.2	6.0 \pm 0.9	0.6
Overall Modularity & Configurability	6.3 \pm 0.9	6.6 \pm 0.7	0.3	5.6 \pm 1.3	5.8 \pm 0.8	0.2
Ability to perform combat movements	6.1 \pm 0.9	6.4 \pm 0.8	0.3	5.9 \pm 1.1	5.8 \pm 0.8	-0.1
Arm motion overhead	5.9 \pm 1.0	6.2 \pm 0.9	0.3	5.6 \pm 1.4	6.0 \pm 0.8	0.4
Arm motion in front	6.2 \pm 0.9	6.4 \pm 0.8	0.2	5.2 \pm 1.6	6.1 \pm 0.8	0.9
Trunk motion	6.1 \pm 0.9	6.4 \pm 0.8	0.3	5.0 \pm 1.6	5.7 \pm 1.0	0.7
Head motion	6.3 \pm 0.8	6.5 \pm 0.7	0.2	5.7 \pm 1.1	6.2 \pm 0.7	0.5
Overall Mobility & ROM	6.1 \pm 0.9	6.5 \pm 0.6	0.4	5.4 \pm 1.3	6.0 \pm 0.7	0.6
Capacity to carry your designated combat load (by configuration)	6.2 \pm 0.9	6.5 \pm 0.7	0.3	5.4 \pm 1.2	5.8 \pm 1.0	0.4

Criteria	MFR A Mid Mean \pm SD	MFR A Post Mean \pm SD	MFR A Diff	MFR B Mid Mean \pm SD	MFR B Post Mean \pm SD	MFR B Diff
Overall Capacity	6.1 \pm 0.9	6.2 \pm 1.0	0.1	6.2 \pm 1.0	5.8 \pm 1.0	-0.4
Load distribution	6.0 \pm 1.1	5.9 \pm 1.2	-0.1	5.9 \pm 0.9	5.6 \pm 1.1	-0.3
Chaffing	6.0 \pm 1.1	5.9 \pm 1.1	-0.1	5.8 \pm 0.9	5.7 \pm 1.2	-0.1
Pressure points	5.7 \pm 1.3	5.6 \pm 1.5	-0.1	5.1 \pm 1.5	5.4 \pm 1.4	0.3
Thermal (heat retention)	5.6 \pm 1.3	5.8 \pm 1.1	0.2	4.6 \pm 1.6	5.8 \pm 1.2	1.2
Overall Comfort Not Loaded	6.2 \pm 1.0	6.5 \pm 0.8	0.3	5.6 \pm 1.1	6.2 \pm 1.0	0.6
Overall Comfort Fully Loaded	6.1 \pm 0.9	6.2 \pm 0.9	0.1	5.2 \pm 1.3	5.6 \pm 1.0	0.4
Compatibility with Personal weapon	6.2 \pm 1.0	6.4 \pm 0.8	0.2	5.3 \pm 1.2	6.0 \pm 0.8	0.7
Compatibility with weapon slings	5.6 \pm 1.3	6.1 \pm 1.0	0.5	5.6 \pm 1.2	5.8 \pm 1.0	0.2
Compatibility with helmet	6.2 \pm 1.0	6.3 \pm 0.9	0.1	5.4 \pm 1.2	6.1 \pm 0.8	0.7
Compatibility with fragmentation vest	6.0 \pm 1.3	6.2 \pm 1.1	0.2	5.6 \pm 1.3	5.8 \pm 1.2	0.2
Compatibility with small pack	5.7 \pm 1.4	6.0 \pm 1.1	0.3	5.9 \pm 1.1	5.1 \pm 1.4	-0.8
Compatibility with rucksack	5.5 \pm 1.3	5.8 \pm 1.2	0.3	5.6 \pm 1.4	4.6 \pm 1.7	-1
Compatibility with gloves	6.4 \pm 0.9	6.5 \pm 0.6	0.1	5.2 \pm 1.6	6.0 \pm 0.9	0.8
Compatibility with cold weather gear (jacket, parka, etc.)	5.2 \pm 1.4	5.5 \pm 1.5	0.3	5.0 \pm 1.6	5.6 \pm 1.2	0.6
Compatibility with vehicles (LAV III, Nyala, etc.)	5.2 \pm 1.6	5.9 \pm 1.3	0.7	5.7 \pm 1.1	4.8 \pm 1.6	-0.9
Overall Compatibility	6.0 \pm 0.9	6.2 \pm 0.8	0.2	5.4 \pm 1.3	5.6 \pm 1.0	0.2
Width of the MFR when loaded	5.9 \pm 1.0	6.1 \pm 1.0	0.2	5.4 \pm 1.2	5.1 \pm 1.3	-0.3
Depth of the MFR when loaded	5.8 \pm 1.2	6.0 \pm 1.1	0.2	6.2 \pm 1.0	5.4 \pm 1.1	-0.8
Encumbrance at the chest when loaded	5.8 \pm 1.2	5.7 \pm 1.2	-0.1	5.9 \pm 0.9	5.6 \pm 1.0	-0.3
Overall Bulk	5.9 \pm 1.1	6.1 \pm 0.9	0.2	5.8 \pm 0.9	5.4 \pm 1.0	-0.4
Durability of hardware (buckles, snaps, zippers, etc.)	6.2 \pm 1.0	6.2 \pm 1.1	0	5.1 \pm 1.5	5.7 \pm 1.2	0.6
Durability of straps	6.4 \pm 0.8	6.4 \pm 0.9	0	4.6 \pm 1.6	6.0 \pm 0.9	1.4
Durability of material, MOLLE loops, velcro, shockcord, etc.	6.3 \pm 0.8	6.3 \pm 1.1	0	5.6 \pm 1.1	5.8 \pm 1.0	0.2
Ease of replacing items	6.0 \pm 1.0	6.2 \pm 1.2	0.2	5.2 \pm 1.3	5.3 \pm 1.4	0.1
Ease of repairing items	5.6 \pm 1.2	5.9 \pm 1.3	0.3	5.3 \pm 1.2	4.9 \pm 1.4	-0.4
Overall Durability & Maintainability	6.3 \pm 0.8	6.5 \pm 0.7	0.2	5.6 \pm 1.2	5.5 \pm 1.1	-0.1
Noise signature (closures, rubbing, etc.)	6.1 \pm 1.0	6.3 \pm 0.8	0.2	5.4 \pm 1.2	5.5 \pm 1.1	0.1
Camouflage	6.2 \pm 1.0	6.4 \pm 0.7	0.2	5.6 \pm 1.3	5.5 \pm 1.1	-0.1
Weight (empty)	6.4 \pm 0.9	6.6 \pm 0.5	0.2	5.9 \pm 1.1	6.2 \pm 0.9	0.3
Overall Material Properties	6.4 \pm 0.8	6.7 \pm 0.6	0.3	5.6 \pm 1.4	5.8 \pm 0.8	0.2
Overall	6.3 \pm 0.8	6.5 \pm 0.6	0.2	5.2 \pm 1.6	5.8 \pm 0.8	0.6

4.4.15 Focus Group

4.4.15.1 MFR A

A total of 95 participants took part in the post deployment focus group on the MFR A system. Twenty-four percent of the participants indicated that their primary role was a rifleman while another 24% indicated that they were M203 gunners. Sixteen percent indicated their primary role was a commander and 15% indicated that they were C9 gunners. There were only three participants that indicated that they were a 7.62mm designated marksman. Participants of the focus group had to indicate which one of the three front vest panels they used mostly. For the most part, MFR A was issued as a system to each soldier but there were some soldiers that were just given front vest panels from other soldiers that were not using them. The majority of the soldiers and participants in this focus group did have the choice as to which front panel they used. Approximately 79% of the participants wore A2 as their primary front panel while 14% wore A3 and the remaining participants wore A1. Participants preferred the A2 front panel because it allowed them to carry the most loads. One negative of carrying the heavy loads was that many participants indicated that the loads caused the vest to ride forward and pulled down. Participants also indicated which back panel they used most. The majority of the participants used the back panel with six rows of MOLLE (76%). Participants indicated that the extra rows of MOLLE provided more stability to the vest system, allowed for room for mounting of pouches, and allowed participants to wear the back fragmentation plate within the back panel; which counter balanced the load on the front of the MFR.

Using the TurningPoint system the participants rated MFR A across a number of criteria using the 7-point scale of acceptance – see Table 34. The answers provided by the participants guided the focus group discussions. Each of the components of the MFR A system had ratings for the vast majority of criteria that were between ‘reasonably acceptable’ and ‘completely acceptable’. The criteria that had the highest ratings across all three variants of MFR A were for overall comfort (not loaded), overall durability and maintainability, overall material properties, and overall modularity and configurability. With respect to the material properties many participants indicated that the material dried very quickly when it was exposed to water/rain. In terms of comfort a number of participants from each focus group indicated that they had pressure points at the shoulder area and that there should be more padding integrated into the shoulder area. All three variants of MFR A had similar ratings across all the criteria, which is not surprising since most of the participants had the freedom to select the variant that most suited their needs. MFR A2 had the highest average overall rating followed by MFR A3, and then MFR A1.

The one criterion where the average overall rating was below ‘reasonably acceptable’ was for ease and overall adjustability for MFR A2 and MFR A3. Participants indicated that this was rated slightly lower than the other criteria because it was slightly difficult to don the MFR because of the orientation of the side buckles on the side. Participants indicated that if the buckles were reversed it would make it easier to put on. Participants indicated that reversing the buckles would change the pull of adjustment making it rear pull. Participants preferred a forward pull so another option was to lengthen the webbing on the rear buckle to make it more easily accessible.

Participants were asked which opening style they preferred, either front opening or side opening. Over 85% of the participants indicated that they would prefer a side opening vest similar to that of MFR A2 and A3. Participants preferred the increase in real estate of MFR A2 compared to the real estate of MFR A1 where some space is lost due to the opening. Participants were asked if they ever had to encounter a situation where they had to emergency doff their vest. Very few people encountered such situations. Some participants indicated that they would enjoy a quick release to the vest but if they ever had to emergency doff their vest they would just cut it off.

Table 34: Overall ratings for MFR A

Criteria	MFR A1 Mean \pm SD	MFR A2 Mean \pm SD	MFR A3 Mean \pm SD	MFR A Mean \pm SD
Overall Adjustability	6.6 \pm 0.5	5.7 \pm 1.7	5.7 \pm 2.2	5.7 \pm 1.7
Overall Stability	6.3 \pm 0.5	6.1 \pm 1.3	6.2 \pm 0.7	6.1 \pm 1.2
Overall Ease of Use	6.4 \pm 0.5	6.3 \pm 1.0	6.5 \pm 0.5	6.3 \pm 0.9
Overall Modularity and Configurability	6.7 \pm 0.5	6.7 \pm 0.8	6.5 \pm 0.9	6.6 \pm 0.8
Overall Mobility and Range of Motion	6.3 \pm 1.0	6.4 \pm 0.9	6.2 \pm 0.7	6.4 \pm 0.9
Overall Capacity	6.4 \pm 0.5	6.5 \pm 1.0	6.3 \pm 0.9	6.5 \pm 0.9
Overall Comfort (Not Loaded)	6.9 \pm 0.4	6.8 \pm 0.8	6.9 \pm 0.3	6.8 \pm 0.7
Overall Comfort (Loaded)	6.3 \pm 0.5	6.1 \pm 1.1	6.1 \pm 0.8	6.1 \pm 1.0
Overall Compatibility	6.1 \pm 0.7	6.4 \pm 0.8	6.4 \pm 0.7	6.4 \pm 0.8
Overall Bulk	6.4 \pm 0.5	6.2 \pm 0.9	6.2 \pm 0.8	6.2 \pm 0.9
Overall Durability and Maintainability	6.7 \pm 0.5	6.6 \pm 0.8	6.8 \pm 0.4	6.6 \pm 0.7
Overall Material Properties	6.6 \pm 0.5	6.7 \pm 0.4	6.8 \pm 0.4	6.7 \pm 0.4
Overall MFR Rating	6.4 \pm 0.5	6.7 \pm 0.5	6.6 \pm 0.5	6.6 \pm 0.5

The last question posed to the participants was whether or not MFR A, as a system, was ready to be fielded as the new tactical vest for the CF. Only 35% of the participants indicated that it is ready to be fielded as is while the remaining participants (65%) indicated that it would be ready to be fielded after minor modifications. The most common modifications suggested by the participants was to lengthen the rear waist attachment strap or to make the waist attachment assembly more easily accessible, add the webbing loops from the front panel of MFR A1 onto the front of MFR A2, and to improve the extraction handle of the back panels so that a participants whole hand can fit underneath it while wearing combat gloves. No participants indicated that it is not ready to be fielded and no major modifications are needed.

4.4.15.2 MFR B

A total of 137 participants took part in the post deployment focus group on the MFR B system. Seventy-two percent of the participants indicated that their primary role was a rifleman while another nine percent indicated that they were C9 gunners. Nine percent also indicated their primary role was a M203 gunner and seven percent indicated that they were commanders. There were only three participants that indicated that they used the confined space rig

Using the TurningPoint system the participants rated MFR B across a number of criteria using the 7-point scale of acceptance – see Table 35. The answers provided by the participants guided the focus group discussions. Each of the components of the MFR B system had mean ratings for the vast majority of criteria that were between ‘barely acceptable’ and ‘reasonably acceptable’. The criteria that had the highest rating was for overall mobility and range of motion with a rating that was just above ‘reasonable acceptable’. The criteria that had the lowest mean rating was for bulk which had a rating that was just above ‘barely acceptable’. During the focus group discussion participants indicated that the primary reason that bulk was an issue for MFR B was that due to the smaller amount of MOLLE real estate. Participants were required to carry their typical assault load but were forced to stack pouches on pouches. Participants indicated this is ok with dismounted ops but it is not suitable for mounted ops due to getting into and out of vehicles and hatches. MFR B did come with a

centre adapter that covered the front closure buckles and provided some more real estate to the participants to mount pouches. Approximately 66% of the participants did use the centre adapter to create more available space to mount pouches. However, many of participants indicated that when they did mount a pouch on the centre adaptor the Velcro on the centre adapter tended to wear out quickly. Participants were also asked what the most common pouch they mounted on the centre adaptor and the most frequent response was a 5.56mm magazine pouch. Participants indicated that the weight of the magazine may have been too much to be supported by the Velcro. If the centre adapter is a feature that is maintained in future MFR designs it should be improved to support a heavier load.

During the focus group discussion participants identified compatibility issues of MFR B with the in-service rucksack. Most participants wore their PRR on the MOLLE on the shoulder straps of the MFR. Due to its location participants were unable to place the shoulder straps of the rucksack in the proper location. Many participants also had issues with putting on the waist belt of the rucksack while wearing the MFR. The MFR is designed to carry loads lower down on the torso which is at the location of where the waist belt of the rucksack was designed to be fastened. Participants that did in fact secure their waist belt of the rucksack did have to move the MFR higher up on their torso to accommodate it.

In terms of ease of use participants did indicate that MFR B is generally easy to use. However, one issue that was brought up a number of times was the length of the adjustment straps. Participants mentioned that the straps are too long and can get in the way. Participants suggested a better retention system of the excess straps is required. Many participants cut the straps to a desired length and then taped up the excess strap. Even though many participants indicated that the adjustment straps were too long they felt that the length should be maintained to accommodate larger soldiers.

Participants were asked which opening style they preferred, either front opening or side opening. Over 85% of the participants indicated that they would prefer a front opening vest which is directly opposite to the focus group members from MFR A. Participants preferred the ease of donning and doffing of front opening vest. Many of the participants of the focus group indicated that they saw soldiers wearing MFR C in theatre and did not like how it took more than one participant to don the system. Participants were asked whether there was a requirement to increase the amount of MOLLE real estate on the front of MFR B. Approximately 72% of the participants indicated that it was necessary to increase the amount of MOLLE real estate on the front with the most common places being an extra row of MOLLE at the top of the MFR and two usable columns of MOLLE of the shoulder straps, further down on the straps closer to the front panel.

Table 35: Overall ratings for MFR B

Criteria	MFR B Mean \pm SD
Overall Adjustability	5.7 \pm 1.1
Overall Stability	5.6 \pm 1.1
Overall Ease of Use	5.9 \pm 0.7
Overall Modularity and Configurability	5.9 \pm 0.8
Overall Mobility and Range of Motion	6.1 \pm 0.7
Overall Capacity	5.8 \pm 0.9
Overall Comfort	5.8 \pm 0.9
Overall Compatibility	5.4 \pm 1.0
Overall Bulk	5.1 \pm 1.0
Overall Durability and Maintainability	5.9 \pm 0.8
Overall Material Properties	5.9 \pm 0.7
Overall MFR Rating	5.9 \pm 0.8

The last question posed to the participants was whether or not MFR B, was ready to be fielded as the new tactical vest for the CF. Only 24% of the participants indicated that it is ready to be fielded as is while the remaining participants (76%) indicated that it would be ready to be fielded after some modifications (90% with minor modifications, 10% with major modifications). Only two participants indicated that it is not suitable for use but during the focus group discussion neither of them indicated why it was not suitable for use. During the focus group discussion participants were asked which modifications they would make to make MFR B more suitable for use. The majority suggested that more MOLLE needs to be added to the front or more capacity to carry items such as a map. Several options were presented as to how to accomplish this including, adding an extra row of MOLLE on the top of the front panel or the addition of a bib (approx. 3 rows high). Participants also indicated that the MOLLE on the shoulder straps was too high up and not usable. If they mounted their PRR on the shoulder straps it would get in the way of the shoulder straps of their ruck sack or assault pack. Therefore, moving the MOLLE on the shoulder straps further down would improve the compatibility of the MFR with the pack. Other modifications to the MFR that were suggested included a more robust front closure system, increase the number of columns of MOLLE on the sides, a reinforced extraction handle, and an improvement to the adjustability of the shoulder straps and waist adjustment. A few participants did indicate that they would like more rows of MOLLE on the back panel of the MFR. This would allow participants to mount items such as their camelback or MBITR. Loading items on the back may pose some compatibility issues with the rucksack or assault pack but may balance out the weight of the load carried on the front of the MFR. Many participants also indicated that they cannot adjust the MFR while it is being worn which was indicated as an important feature for them. A couple participants indicated that in addition to the MFR modifications they would also like to have a field repairable kit to be issued with it, as well as, a carrier for the bayonet.

In addition to the focus group questions regarding the MFR, participants were asked whether or not they would prefer to keep their in-service canteens or prefer to use an alternative water carrier such as a Nalgene bottle. Almost all of the participants indicated that they would prefer the Nalgene and mentioned that the Nalgene is what they currently use. Participants preferred the Nalgene type water carrier instead if the current canteens due to the increased ease of cleaning and the ease of filling it up with water bottles which are common place in theatre. Participants also mentioned that Nalgenes are also more durable than the in-service canteens.

5. Discussion

The aim of this project was to solicit feedback on the various MFR systems usability, compatibility with soldier equipment and tasks, impact on operational performance, design features, and functionality. To accomplish this goal, three potential MFR replacements (MFR A, B, and C) were handed out to three battle groups (800 systems per battle group) to use during their pre-deployment work up training and during their deployment. Results from this data collection effort will be used to inform and influence the acquisition of a new MFR for the Canadian Forces.

In order to illicit feedback data was captured from a number of soldiers who wore the MFRs during the middle of their deployment and at the end of their deployment. The larger the number of soldiers that are able to provide feedback on the MFR would increase the chances of the project selecting certain features that are desirable amongst a large portion of the CF. During mid-deployment data was collected from a total of 730 soldiers (265 for MFR A, 239 for MFR B, and 226 for MFR C) while data was collected from 236 soldiers once they returned from deployment (96 for MFR A, and 140 for MFR B). Not only was valuable data collected from a high number of soldiers who wore the MFRs for an extended period of time, these soldiers were from a number of units and a number of roles. For instance, for the mid-deployment data collection effort soldiers from 10 different units were surveyed that spanned 12 different ranks. Similar results were seen with the MFR B and MFR C mid-deployment data capture efforts. The total numbers of soldiers that were able to be surveyed after their deployment was less due to soldier availability and commitments but nonetheless the team was able to gather feedback from a number of different units and a variety of different ranks (both commissioned and non-commissioned).

The structure of this data collection effort also allowed the project team to collect data using a variety of methods. Data was mainly collected using questionnaires (both mid and post-deployment) and focus group (for post-deployment only) but other methods were also used. The access to soldiers during the middle of the deployment allowed the project team to capture photographs of their load placement, as well as, get the soldiers to document, in almost real-time, the loads they carry on their MFRs and within their small pack. The loads carried on each of the MFRs were fairly consistent across the battle groups. The MFR that had the heaviest average load carried on the MFR was for MFR with an average load of 10.8 kg. The MFR that had the lightest average load carried on the MFR was MFR B with an average load of 9.1 kg indicating a mean difference between the heaviest and lightest average weight of only 1.7 kg. However, some loads carried by participants reached over 16 kg for each MFR indicating that the loads do vary amongst individual soldiers. More importantly it indicates the ability of each of the MFRs to carry much heavier loads than the average soldier may carry. During the mid-deployment survey participants also indicated what pouches they wore. Across all the MFRs the two most common pouches were the first aid pouch and the triple mag pouches. The triple mag pouches allows the soldiers to carry a large number of rounds in either a low profile way or a way that takes up the least amount of PALS webbing channels. Commonly used pouches (used by more than 50% of participants) were fairly consistent across the three battle groups and the three MFRs. Across all three MFRs commonly used pouches in addition to the first aid pouch and the triple mag pouches included, the grenade pouch, large utility pouch, PRR pouch, tourniquet, hydration cover, and small accessories / Nalgene pouch.

Since the new MFR that will be issued to the Canadian Forces has to be compatible for a variety of different roles and missions we needed to gather that data during this study. Collecting data during the middle of the deployment allowed the project team to capture the type of environments / missions the

MFRs were used in. The primary roles of the soldiers appeared to change slightly throughout each deployment. Soldiers that were issued MFR A took part in more patrolling and combat tasks. Soldiers that were issued MFR B and MFR C in following deployments had roles that were mostly training, mentoring, and advising. Even though, the primary roles of these deployment were not combat oriented there were still a portion of the soldiers that indicated that they did take part in quick reaction force missions / convoy operations (10% for MFR B and 25% for MFR C). All three of the MFRs were used in both combat and non-combat roles, as well as, during mounted and dismounted operations. This suggests the feedback on the performance of the MFRs is based on its use over a variety of situations.

Throughout the course of this project, similar questionnaires were administered. The rationale to this was not only to assess the performance of a single MFR but to track its performance longitudinally and also compare it across the different MFRs. Results from the questionnaires indicated consistency among the ratings not only across the same MFRs but also amongst the different MFRs. For instance, the results from the mid-deployment and post-deployment questionnaires showed very little variance between the two questionnaires (only MFR A and MFR B). There were only a small number of instances where the difference between the two questionnaires, for a single MFR, was greater than one acceptance point. Additionally, there were no instances in which the polarity of the ratings changed between the two questionnaires. One reason for the consistency between the two questionnaires is that the participants that completed the post-deployment questionnaires were a possible sub sample of the participants that completed the mid-deployment questionnaire. Another reason could be that the fact that the ratings given to each criteria accurately assesses the performance of the MFR for that criteria. Therefore, the administration of the same questionnaire for both the mid-deployment and post-deployment data capture efforts was able to validate the acceptable performance of the MFRs longitudinally across a number of months.

Using the same questionnaire to track the performance of each MFR allowed us to measure the acceptability of each of the MFRs compared to the other MFRs. We cannot simply say one MFR is better than the other based on the acceptability ratings because separate groups of participants completed the questionnaires for each MFR. That being said there was some consistent results across the questionnaires when comparing the ratings between the MFRs. Across the vast majority of criteria MFR A had higher acceptability ratings compared to MFR B and MFR C. In most cases MFR A these higher acceptability ratings were found to be statistically significant. This may be due to MFR A being a preferred system over the other MFRs but it may also be due to a number of factors such as, a higher mental model of what 'borderline' is or lack of experience using other modular systems. Nonetheless, the majority of ratings for MFR A were between 'reasonably acceptable' and 'completely acceptable'. The performance of the other MFRs were also acceptable with the majority of the ratings being between 'barely acceptable' and 'reasonably acceptable'. There were only two instances of ratings that were unacceptable and they were both for MFR C (stability while in prone, and ease of donning). The performance of these MFRs longitudinally across an operational deployment adds validity to the process taken to select the MFRs. Each of the MFRs was originally selected by staff at the Directorate of Land Requirements using soldier feedback, expert knowledge, and market analysis. A wide selection of MFRs was then down selected to these three using experienced soldiers and a controlled experimental setting. The results of this uncontrolled evaluation show that the MFRs selected are acceptable for operational but there may be areas of improvement as not one of the MFRs consistently had ratings that were 'completely acceptable'.

Participants provided ratings of acceptability on specific features for each of the MFRs. It is hard to compare the ratings of specific features between MFRs as participants only had access to one of the MFRs. Additionally; those participants that were given MFR A had a choice as to what front and

back panels they selected so we would assume that their ratings would be positive as it was their choice. Nonetheless all of the features for MFR A and MFR B were found to be acceptable. The features for MFR A tended to have higher acceptability ratings compared to those for MFR B. There was a slight preference to a side opening vest style compared to a front opening vest style. Participants indicated that the rationale for this was that it allowed for more room to mount pouches. One of the negatives to a side opening vest style is the potential increase in difficulty when having to doff it quickly. None of the participants encountered a situation that they had to doff it quickly so they could not comment on its functionality. This presents a potential trade off of the amount of real estate to mount pouches versus ease of doffing/donning. This trade-off is the major difference between MFR A2 and MFR B. MFR B is theoretically easier to get on and off but requires some pouches to be stacked onto one another because it decreased real estate creating a potential increase in bulk. While the increase in real estate for MFR A2 allows pouches to be mounted one pouch deep (not on top of another pouch) it may create difficulty getting into and out of the vest.

Despite the positive ratings the majority of participants indicated that all of the MFRs require minor modifications prior to being fielded to the entire Canadian Forces. One of the modifications to MFR A2 that most of the participants agreed upon is to make the side attachment system more accessible by either reversing the buckles or by lengthening the webbing strap on the rear buckle. Participants indicated that they had difficulty reaching back for the buckle, especially while wearing the fragmentation vest, and it made it more difficult to don the vest. Another feature from MFR A that should be altered is the size of the extraction handle. Currently, the area available to grab onto is quite small and is difficult to grasp when wearing gloves. Making the extraction handle larger increases the likelihood that soldiers can grasp it during emergency situations. For MFR A2 participants would also like to integrate the front webbing loops from MFR A1 into this design as it creates another point to mount equipment onto. With regards to MFR B, participants indicated that increasing the MOLLE real estate would likely decrease the bulk issue of mounting pouches onto pouches. MFR B came with a centre adaptor that bridged the gap in the middle of the vest in an attempt to increase the amount of MOLLE real estate. However, when participants mounted a pouch with considerable weight (i.e. a 5.56 single mag pouch) the Velcro tended to wear out causing the adaptor to flap around. Increasing the security of this centre adaptor is another alternative to increasing the MOLLE real estate. One of the lowest rated criteria for MFR B was its compatibility with the rucksack. Participants indicated that the mounting location of the PRR was directly where the straps of the rucksack sit causing interference issues. Therefore, an alternative method of mounting the PRR should be investigated to prevent compatibility issues with the rucksack.

5.1 Limitations

No study or experimental evaluation is completed without limitations. One limitation to this study was that it was not a repeated measures design meaning the same participants were not able to evaluate each of the MFRs. Due to the complexity of this experiment and the overall goal of testing the MFRs during combat deployments there was no way we could have participants test each MFR for an entire deployment. Instead we were able to have a large number of participants test each of the MFRs for an extended period of time within a combat environment. Another limitation to this study was the lack of control the project team over a number of factors such as: 1) no control over tasks performed; 2) no control over what load was carried, and where; and 3) no control on proper fitting of MFRs. Due to this being an uncontrolled evaluation the project team was not able to control many factors which may play a role in the soldiers evaluation of the MFRs. However, this was a known risk that is countered by the large number of benefits that collecting data from a large number of soldiers using a piece of equipment for an extended period of time in combat. Lastly, each MFR was issued to



800 soldiers for use during their deployment. Due to operational demands and commitments the data presented in this report is from a small sample of the soldiers that actually wore it. It would extremely beneficial to gather feedback from all of the soldiers that wore the MFR but that would be almost impossible to carry out due to the very demanding schedules soldiers during deployment and post-deployment.

6. Conclusion and Recommendations

Overall, all of the MFRs selected for this study from the previous SME jury and pilot trial were found to be acceptable across the vast majority of criteria that were evaluated. Based on the results of this study and the feedback from the participants neither of the MFR systems are ready to be fielded by the Canadian Army without modifications. For instance, changes to MFR A2 could include:

- Reversing the buckles, or making the rear strap longer;
- Increase the size of the extraction handle; and
- Integrate webbing loops to the front panel.

Potential changes to MFR B could include:

- Increase MOLLE real estate;
- Increase security and stability of centre adaptor;
- Lower MOLLE on shoulder strap area; and
- Lengthen the back panel.

No matter which changes, if any, are incorporated into a new design they will have to be validated for their usability, acceptability to soldiers, and for compatibility with all soldier equipment and tasks.



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7. References

1. Chamberland, A., Carrier, R., Forest, F., and Hachez, G. (1997). Anthropometric Survey of the Land Forces, DCIEM Report No. 98-CR-15.
2. Ste-Croix, C., Morton, A., and Angel, H. (2009). Modular Fighting Rig and Pouches Subject Matter Expert Jury 14-16 July 2009. DRDC Toronto No. CR2010-208.
3. Ste-Croix, C., Morton, A., and Angel, H. (2010). Modular Fighting Rig Pilot Trial Report. DRDC Toronto No. CR2010-XXX.



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- The Modular Fighting Rig (MFR) extended user evaluation took the form of a series of surveys and focus groups conducted with three task forces. Each task force drew from one of the infantry regiments (PPCLI, R22ER, and RCR) from across Canada, who were the primary target for collection of feedback on the MFRs. A total of three MFRs (800 sets of each) were evaluated in this study, all of which were issued by the Directorate of Land Requirements (DLR) regardless of this study. Once DLR issued the MFRs to the battle group they determined which soldiers would be issued the MFRs. The three MFR design alternatives under evaluation in this study have been labelled Alpha (A), Bravo (B), and Charlie (C). MFR A is a multi-part system that uses interchangeable front and back panels. Three front panels (A1, A2, A3) and two back panels are provided with MFR Alpha. All of the trial vests performed well across the duration of the trial. The majority of the ratings for each criterion for each of the MFRs were acceptable for both the mid-deployment and post-deployment questionnaires. In terms of the mid deployment data collection we received feedback from 265 soldiers for MFR A (33%), 239 soldiers for MFR B (29.9%), and 226 soldiers for MFR C (28.3%). In terms of the post deployment data collection we had responses from 96 soldiers for MFR A (12%) and 140 soldiers for MFR B (17.5%). Across the vast majority of criteria MFR A had higher acceptability ratings compared to MFR B and MFR C. The majority of participants who were given MFR A to use chose to use the MFR A2 front panel for its increased real estate to mount pouches. There were only two instances of ratings that were unacceptable across all of the MFRs and they were both for MFR C (stability while in prone, and ease of donning during the mid-deployment questionnaire). Despite the positive ratings the majority of participants indicated that the MFRs require minor modifications prior to being fielded to entire Canadian Forces. One of the modifications to MFR A2 that most of the participants agreed upon is to make the side attachment system more accessible by either reversing the buckles or by lengthening the webbing strap on the rear buckle. All of the vests in this trial were proved to be an acceptable alternative for the in-service tactical vest during an operational tour.
- (U) LTMévaluation approfondie de la veste de combat modulaire (VCM) par l'utilisateur a pris la forme de sondages et de groupes de discussion menés auprès de trois groupes de travail. Chacun de ces groupes était constitué de soldats provenant d'un des régiments d'infanterie (PPCLI, R22eR et RCR) de partout au Canada. Ces soldats ont été désignés comme étant les participants cibles pour recueillir des commentaires sur les VCM. Au total, trois VCM (800 ensembles de chaque) ont fait l'objet d'une évaluation dans le cadre de la présente étude. La Direction des besoins en ressources terrestres (DBRT) a fourni toutes les vestes sans tenir compte de l'étude. Après avoir remis les VCM au Groupement tactique, la Direction a déterminé quels soldats recevraient les VCM. Les trois options de conception de VCM soumises aux évaluations dans le cadre de la présente étude ont été étiquetées Alpha (A), Bravo (B), and Charlie (C). La VCM A est un système multipièce qui utilise trois panneaux avant (A1, A2, A3) et deux panneaux arrière interchangeables. Toutes les vestes soumises aux essais ont obtenu un bon rendement. Pour chaque VCM, la majorité des notes obtenues pour chacun des critères d'évaluation étaient acceptables pour les questionnaires remis à mi déploiement et après le déploiement. En ce qui a trait aux données recueillies à mi-déploiement, nous avons reçu les commentaires de 265 soldats pour la VCM A (33 %), de 239 soldats pour la VCM B (29,9 %) et de 226 soldats pour la VCM C (28,3 %). Pour les données recueillies après le

déploiement, les réponses obtenues provenaient de 96 soldats pour la VCM A (12 %) et de 140 soldats pour la VCM B (17,5 %). Pour la grande majorité des critères, la VCM A a obtenu un taux d'acceptation plus élevé que la VCM B et la VCM C. La majorité des participants qui ont reçu une VCM A ont préféré la VCM A2 (deux panneaux avant) parce qu'il y a plus d'espace pour fixer une pochette. Pour l'ensemble des VCM, il n'y a qu'à deux reprises où le résultat a été inacceptable. Dans les deux cas, il s'agissait de la VCM C (stabilité en position couchée et facilité à enfiler pour le questionnaire remis à mi-déploiement). Malgré les résultats positifs, la majorité des participants ont indiqué que de légères modifications devraient être apportées aux VCM avant leur mise en service dans l'ensemble des Forces canadiennes. La plupart des participants s'entendent pour dire qu'il faudrait accroître l'accessibilité du système d'attache latéral de la VCM A2 en inversant les boucles ou en allongeant la sangle de la boucle arrière. Toutes les vestes soumises à cet essai se sont avérées une solution acceptable pour remplacer la veste tactique présentement utilisée pendant une affectation opérationnelle.

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(U) Modular Fighting Rig

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