ARMY RESEARCH LABORATORY

Future Force Warrior, Engineering Design Event Number 4

by Daniel D. Turner, Christian B. Carstens, and Joseph Torre

ARL-TR-3626 October 2005

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14. ABSTRACT

The Human Research and Engineering Directorate of the U.S. Army Research Laboratory conducted an experiment to evaluate the form, fit, and user acceptance of the Future Force Warrior (FFW) body systems and headgear system ensembles (without functional electronics). The ensembles included new components and the addition of leader and Soldier variations. They were evaluated in the context of dismounted Infantry tactical activities. Additionally, the experiment investigated the form, fit, and comfort, of a chemical and biological (CB) over-garment with a functional personal air ventilation system (PAVS) and a functional personal air-purifying respirator (PAPR). The experiment was executed from 9 to 13 May 2005, with one Infantry squad as participants. Soldiers received familiarization training on the prototype equipment. The exercises included an overland open terrain environment, an urban warfare environment, and an individual movement techniques course.

Results indicated that the Soldiers liked many aspects of the FFW equipment and concepts; however, some refinements are needed to improve the overall comfort of the components and further human factors evaluations are required. During the event, it became apparent that proper sizing of the chassis and ballistic belt will be critical to the overall success of the FFW program. The FFW chassis allowed the Soldier increased flexibility in "customizing" his equipment for mission-specific tasks. The Soldiers liked the ballistic belt and often used it to carry additional equipment. The Soldiers accepted the "up-armor" items for specific mission scenarios, but they almost universally disliked the neck "up armor" option. The Soldiers felt the CB over-garment and two ventilation systems (PAVS and PAPR) provided a significant improvement over current gear. The ventilation systems reduced Soldier mobility and capabilities; however, the Soldiers felt the improved comfort was well worth the extra weight and reduction in capabilities. Two life sign detection system (LSDS) configurations were evaluated, and the consensus was that a combination of the two systems (strap system of the LSDS 1-C plus the Hidalgo monitoring device) will provide the most comfortable configuration. Two variations of design cycle III helmets were evaluated. The leader variation was very well received by the Soldiers who felt the added weight was not significant, considering the comfort of the helmet and the potential of added capabilities. The Soldier variation had some initial heat and perspiration issues which engineers appeared to have solved during the evaluation.

Overall, the FFW ensembles need human factors refinements in order to meet comfort and fit issues. Future evaluations need to focus on the increased capabilities offered by functional systems and need to be conducted with functional electronics.

15. SUBJECT TERMS

body armor; chemical-biological ensemble; future force warrior; future helmets; up armor

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Executive Summary

This event was conducted to evaluate the form, fit, and user acceptance of the Future Force Warrior (FFW) body systems and headgear system ensembles (without functional electronics). The ensembles included new components and the addition of leader and Soldier variations. They were evaluated in the context of dismounted Infantry tactical activities. Additionally, the experiment investigated the form, fit, and comfort, of a chemical and biological (CB) over-garment with a functional personal air ventilation system (PAVS) and a functional personal air-purifying respirator (PAPR).

The experiment was executed from 9 to 13 May 2005, with one Infantry squad as participants. Soldiers received familiarization training about the prototype equipment. They were briefed at the start of each exercise to explain the event requirement. The exercises included an overland open terrain environment, an urban warfare environment, and an individual movement techniques course.

Results indicated that the Soldiers liked many aspects of the FFW equipment and concepts; however, some refinements are needed to improve the overall comfort of the components, and further human factors evaluations are required. Specifically, results indicated that the material used for most of the FFW uniform was considered "too hot". The shirt torso material, however, was comfortable and helped "cool" the Soldier. The Soldiers did not like the zippers as they are currently configured, but they did like the ventilation concept offered by the zippers. The built-in elbow and knee pads are a good concept but need further refinement to reduce shifting and rubbing issues.

The Soldiers liked the FFW chassis ventilation capability but did not like the "stock lock" concept and they experienced some difficulty with the chassis latching system.

During the event, it became apparent that proper sizing of the chassis and ballistic belt will be critical to the overall success of the FFW program. The chassis must accommodate individual differences in torso length in order to maximize Soldier protection and comfort. There was some concern by test personnel about the protection coverage of the chassis. It was observed that with some Soldiers, the chassis seemed short and did not cover the lower torso (between the chassis and ballistic belt) adequately. There were concerns about protection at the upper chest and underarms as well.

The FFW chassis allowed the Soldier increased flexibility in "customizing" his equipment for mission-specific tasks. Generally, the Soldiers preferred to allocate electronic components to the back of the chassis. They reserved the front of the chassis for items one might need quickly, such as ammunition and grenades. The Soldiers did not like "hard components," such as batteries and electronic gear, mounted under their arms, because such configurations were

uncomfortable and hindered arm movement and sighting of weapons. When given the option, Soldiers placed electronic items on the rear of the chassis.

The Soldiers liked the ballistic belt and often used it to carry additional equipment. It became apparent that if the belt is used to carry heavy items, it needs suspenders in order to prevent the belt from riding too low on the hips.

The Soldiers accepted the "up armor" items for specific mission scenarios, but they almost universally disliked the "neck up armor" option. It restricted movement and vision and tended to reduce ventilation while increasing heat.

The Soldiers felt the CB over-garment and two ventilation systems (PAVS and PAPR) provided a significant improvement over current gear. The ventilation systems reduced Soldier mobility and capabilities; however, the Soldiers felt the improved comfort was well worth the extra weight and reduction in capabilities. One Soldier experienced a total malfunction with his CB over-garment. The trousers split along the inseam from knee to knee.

The only issue with access to ammunition magazines occurred during the CB events when Soldiers experienced difficulty acquiring magazines and even more difficulty stowing magazines.

Two life sign detection system (LSDS) configurations were evaluated and the consensus was that a combination of the two systems (strap system of the LSDS 1-C[1] plus the Hidalgo[2] monitoring device) will provide the most comfortable configuration.

Two variations of design cycle III[3] helmets were evaluated. The leader variation was very well received by the Soldiers who felt the added weight was not significant, considering the comfort of the helmet and the potential of added capabilities. The Soldier variation had some initial heat and perspiration issues, which engineers appeared to have solved during the evaluation.

The Soldiers also contributed to the development process by suggesting additions to the FFW ensemble. They proposed "ammunition magazine drop bags" and a method to attach their weapon directly to the FFW chassis, in order to aid in the one-arm firing of their weapon.

Overall, the FFW ensembles need human factors refinements in order to meet comfort and fit issues. Future evaluations need to focus on the increased capabilities offered by functional systems and need to be conducted with functional electronics.

[1]Congressional special interest funded strap.

[2]Named for the man who developed the system.

[3]Design cycle III is a programmatic definition of the phase ARL was in at the time of the evaluation.

1. Introduction

1.1 Background

The primary purpose of the Future Force Warrior (FFW) engineering design event (EDE) No. 4 was to identify and evaluate emerging problems or issues with the form, fit, and user acceptance of the FFW ensembles and prototype chemical and biological (CB) garment/gear. The FFW ensembles did not have functional electronics. The personal air ventilation system (PAVS) and the personal air-purifying respirator (PAPR), components of the CB system, were the only FFW functional equipment used during the experiment.

1.1.1 Previous FFW Evaluations

Design evaluation (DE1) took place on 17 to 20 November 2003 at Aberdeen Proving Ground (APG), Maryland. The FFW baseline load carriage, uniform ensemble, integrated headgear, and components of the war fighter physiological status monitor (WPSM) were evaluated for physical interference between components, comfort, and Soldier acceptability.

The second FFW design evaluation (DE2) was a user jury conducted 1 to 4 March 2004 at the McKenna military operations in urban terrain (MOUT) site, Fort Benning, Georgia. The primary purpose of the user jury was to provide the FFW program's design engineers with an opportunity to present and solicit feedback about their current Soldier-borne systems and system of systems engineering design concepts.

The third FFW design evaluation (DE3) was held on 13 to 17 September 2004 at APG. DE3 evaluated the effect of the FFW ensemble on the Soldiers' ability to fire weapons in a stationary position and in a react-to-fire exercise and gathered Soldier input regarding the stowable eyewear system during weapons firing and on the individual movement techniques (IMT) course. This evaluation compared FFW equipment to current gear, including interceptor body armor (IBA), advanced combat helmet (ACH), and current eyewear.

Additionally, the FFW Soldier protection and individual equipment system integrated product team (IPT) conducted a series of "roll-around[4]" events to assess equipment/gear comfort and physical "fight-ability". The final "roll-around" was conducted at Camp MacKall, Fort Bragg, North Carolina, on 18 to 22 October 2004.

1.1.2 FFW Integrated Product Teams (IPTs)

Two FFW IPTs participated in the evaluation: body systems and headgear systems.

[4]Informal evaluations conducted by product designers.

1.1.3 Phases

After the initial training and fitting of the FFW ensembles and other FFW equipment on day 1, the design event was conducted in three phases.

Phase I – During this phase, one Infantry squad, organized with one FFW fire team and one baseline fire team, conducted a movement to contact and attack on an objective mission. These were conducted on days 2 and 4. A medic from the 1st Battalion, 29th Infantry Regiment (1/29th) was available and on site with the Soldiers. He participated in all activities but not as a test Soldier.

Phase II – During this phase, fire teams conducted room-clearing operations in a MOUT situation with FFW and baseline equipment. One side event was conducted, which consisted of Soldiers entering a building through simulated breaches in an exterior wall.

Phase III – During this phase, four selected Soldiers were fitted to the available CB over-garment systems with the FFW ensemble. Each Soldier completed two iterations of the U.S. Army Research Laboratory's (ARL) Woodland IMT course at McKenna MOUT.

Phase IIIa - A side event consisting of two grenadiers (FFW ensemble) and two fire team leaders (baseline) traversing a 1.2-km cross-country course was conducted during this phase.

1.1.4 Participants

One nine-man Infantry squad plus one medic from the 1/29th Infantry participated in the design event. Actual evaluations were conducted over a 4-day period. Soldiers were required to wear candidate FFW ensemble equipment and their standard equipment throughout the design event. They also carried their individual weapons.

1.1.5 Apparatus

1.1.5.1 Body Systems IPT Equipment

Body systems equipment IPT for this experiment did not have functional electronics except for the PAVS and PAPR. All systems were loaded to appropriate weights as determined by body systems and confirmed by the Analysis and Experimentation Team and ARL. Body systems provided a combat uniform for each Soldier during the event (figures 1 and 2).

The squad automatic weapon (SAW) and rifleman variation had essentially the same electronics layout, with pockets to address the SAW's specific load needs.

The grenadier variation had essentially the same electronics layout as the leader, with pockets to address the grenadier's specific load needs.

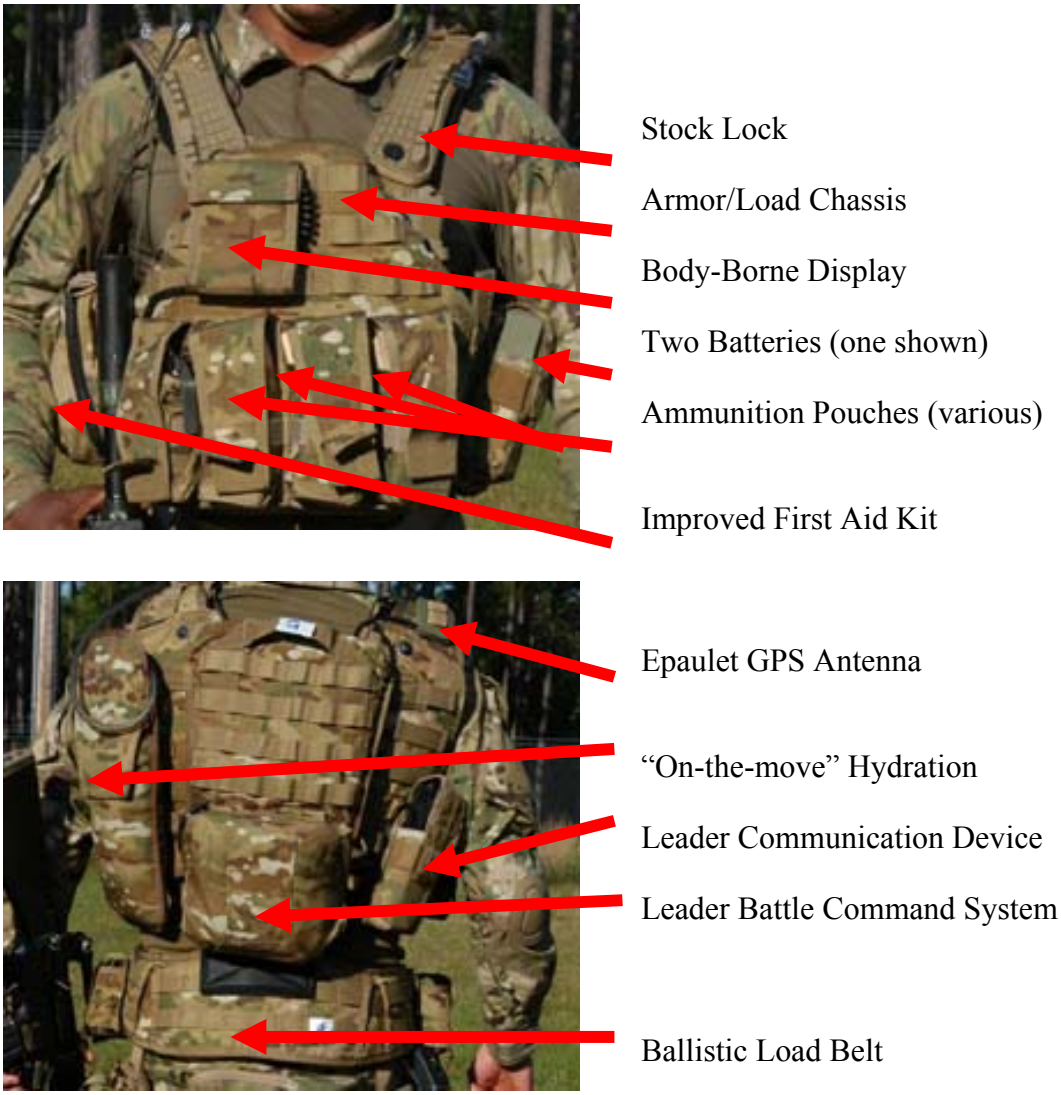

Figure 1. Body systems, leader variation.

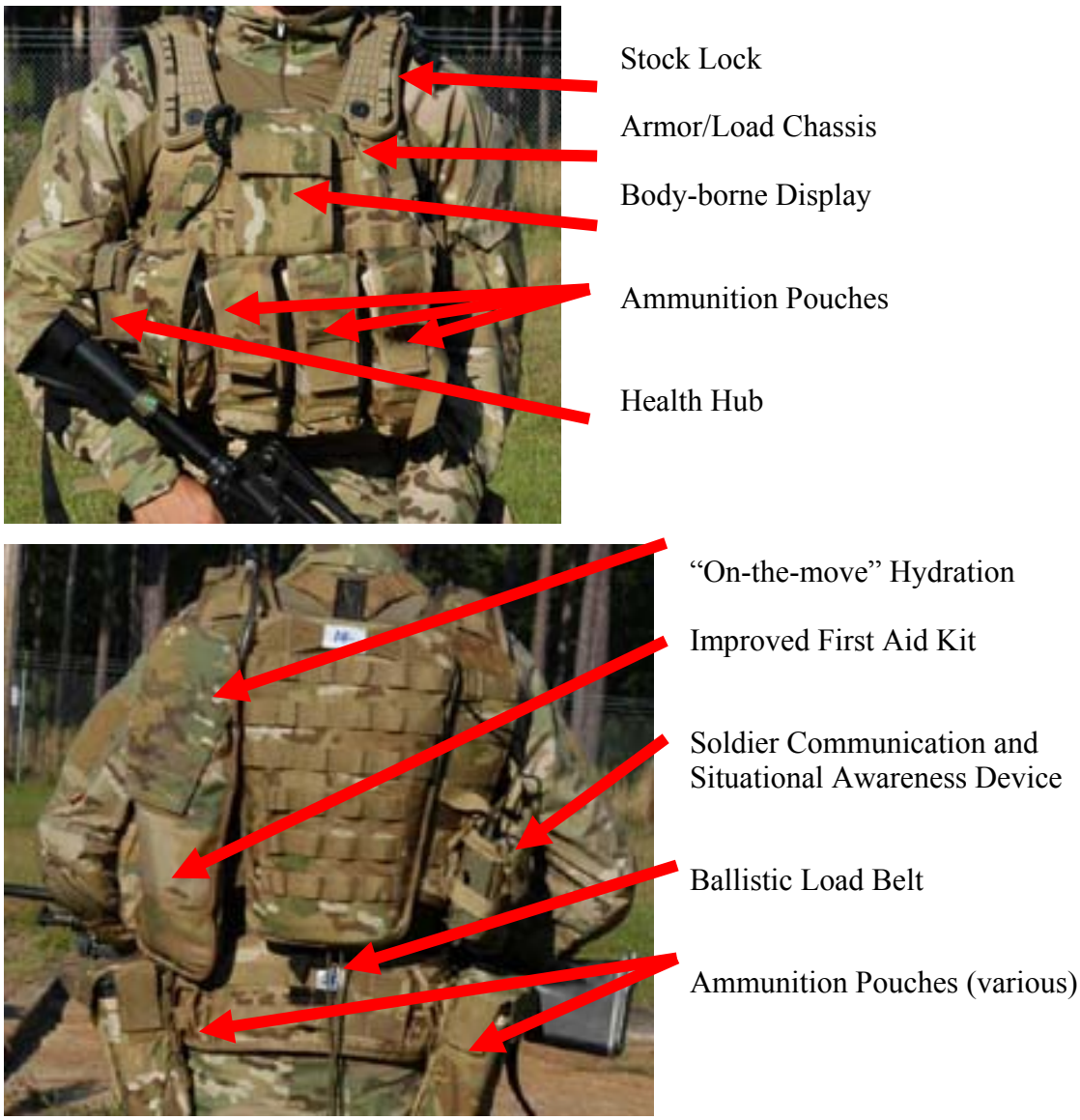

Figure 2. Body systems, Soldier variation.

1.1.5.2 Chemical and Biological (CB) Equipment

In addition to the various load carriage variations, body systems also supplied two sets of prototype CB equipment. This consisted of a one-piece selectively permeable membrane (SPM) garment with a joint service general service mask (JSGPM) (XM50) (figure 3), a PAPR, and a PAVS. There were two CB suits, sets of gloves, integrated PAVS and PAPR available for evaluation. No over-boots were available for evaluation.

Two variations of the PAPR and PAVS were tested (figures 4 and 5). One variation of the PAVS had a hip inlet (medium suit) with PAVS and PAPR carried on the ballistic belt and leg. The other variation had an abdomen inlet (large suit) with the PAVS and PAPR carried on the ballistic belt and leg. The CB suit was worn only on the Woodland IMT course.

Figure 3. CB SPM garment with JSGPM (XM50) mask.

Figure 4. PAVS and PAPR (belt) and PAVS hip inlet.

Figure 5. PAVS and PAPR (leg) and PAVS abdomen inlet.

1.1.5.3 Headgear Systems IPT Equipment

The headgear systems IPT provided two types of helmets, a leader and a Soldier variations. There were also two types of impact liners, a Brock[5] and a Skydex[6] (clear plastic looking). The leader configuration included the sensor mock-ups. The helmets were adjusted by head band type of strapping and/or pads inside the helmets. Figures 6 and 7 show the two variations.

[5]Brock is a trademark of Brock USA.

[6]Skydex is a trademark of SKYDEX Technologies, Inc.


Figure 6. FFW design cycle III[7] (leader).

Figure 7. FFW design cycle III (Soldier).

1.1.5.4 Body Systems (Health and Sustainment) IPT Equipment

Eight nonfunctional WPSM systems (figure 8) were evaluated during the EDE No. 4. The WPSM consisted of several parts, including a health hub, LSDS (figures 9 and 10), elastic strap with the ballistic impact detection system (BIDS) and a sleep monitor. Two versions of the LSDS evaluated: the Hidalgo[8] and the LSDS 1-C[9].

[7]Design cycle III is a programmatic definition of the phase ARL was in at the time of the evaluation.

[8]Named for the man who developed the LSDS.

[9]Congressional special interest funded strap.

Figure 8. WPSM health hub.

Figure 9. LSDS 1-C.

Figure 10. LSDS Hidalgo (front and back).

1.2 Purpose

1.2.1 Chassis Loads

The purpose was to evaluate the form, fit, comfort, load distribution, and load distribution options (how each Soldier loaded his system) of Soldier variations (leader, rifleman, SAW, grenadier, and medic).

1.2.2 Ammunition Access

To evaluate the Soldiers' abilities to access ammunition pouches while firing weapons.

1.2.3 Chassis Components

To solicit feedback from Soldiers about comfort, fit, and location of the ensemble components (including "up-armor" options, chassis closure mechanism, gear, electronics locations, power and personal area network (this is not an exhaustive list) while they wore the fighting and/or approach loads. During this event, the "up armor" is defined as

- The entire base FFW ensemble, including the chassis and ballistic belt.
- Shoulder-up armor.
- Neck-up armor.
- Abdomen-up armor.
- Drop leg panel with soft ballistic up armor.

1.2.4 CB Gear

To collect limited data about the form, fit, comfort, and wear and tear of the CB gear, as applicable during this event.

1.2.5 CB and Weapons Firing Interaction

To evaluate the interaction between the CB gear with various weapons and the chassis during weapons firing (blanks).

1.2.6 Helmets and Weapons Firing Interaction

To evaluate the interaction between the design cycle III helmet with various weapons and the chassis during weapons firing (blanks).

1.2.7 Design Cycle III Helmets

To evaluate the fit and comfort of the design cycle III helmet.

1.2.8 LSDS

To evaluate the form, fit, and comfort of the LSDS.

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2. Methodology

The experiment was conducted over a 5-day period in existing weather and light conditions at Fort Benning. Table 1 shows the event schedule. The movement to contact was conducted on two separate days, but for ease of understanding, the results are reported together.

Table 1. Experiment event schedule.

Day	Event
1	Demographics and Anthropometrics
2	Movement to Contact
3	MOUT and Side Experiment
4	Movement to Contact
5	IMT Course and Side Experiment

2.1 Demographics and Anthropometrics

The Soldiers were given an orientation about the purpose of the study and their participation. They were briefed about the objectives and procedures for each day, as well as the equipment they would use. They were also told how the results would be used and the benefits that the military expected from this investigation.

Investigators asked the Soldiers if any had a medical profile or history that would jeopardize their participation in the study. Soldiers also completed a medical status form.

In addition, the volunteer agreement affidavit was explained and its contents were verbally presented.

Demographic data and anthropometric measurements were gathered for each Soldier. Data concerning their Infantry experience and training were included in the demographic data sheet.

2.2 Training/Fitting: Day 1

2.2.1 Training

Before training, the Soldiers received a roster number, which was used to identify them throughout the assessment. Representatives from the FFW IPTs presented courses on the use, fit, and adjustment features of the FFW ensembles and head gear.

2.2.2 Fitting

Following the training session, each Soldier was fitted to the FFW equipment and gear that he would wear during the evaluation. Each Soldier received a pair of FFW pants and a shirt which he wore throughout the experiment whenever FFW gear was being evaluated. Upon completion of the training and fitting session, the Soldiers were given a questionnaire with questions designed to solicit their acceptance and thoughts about the training received as well as the initial comfort of the FFW ensemble. The CB equipment was not presented nor fitted during the day 1 session.

2.3 Movement to Contact: Days 2 and 4

The movement-to-contact phase was conducted on days 2 and 4. During this 2-day event, the fire teams traversed their assigned routes as shown in table 2. The fire team members wore one of the LSDS every day. The two LSDS were rotated by the fire team on a daily basis, so the Soldiers wore the LSDS with both the FFW and baseline.

Table 2. Route and equipment matrix.

Day	Time of Day	FFW Ensemble	Baseline
2	Morning – Route 1	Fire Team A	Fire Team B
2	Afternoon – Route 2	Fire Team B	Fire Team A
4	Morning – Route 2	Fire Team B	Fire Team A
4	Afternoon – Route 2	Fire Team A	Fire Team B

Upon arrival at Griswold range, the squad was issued a fragmentary order (FRAGO) to move cross country to an intermediate objective and to continue to an objective rally point (ORP). At the ORP, the squad prepared to assault a final objective. There were two different courses approximately 2 km long, as shown in figure 11.

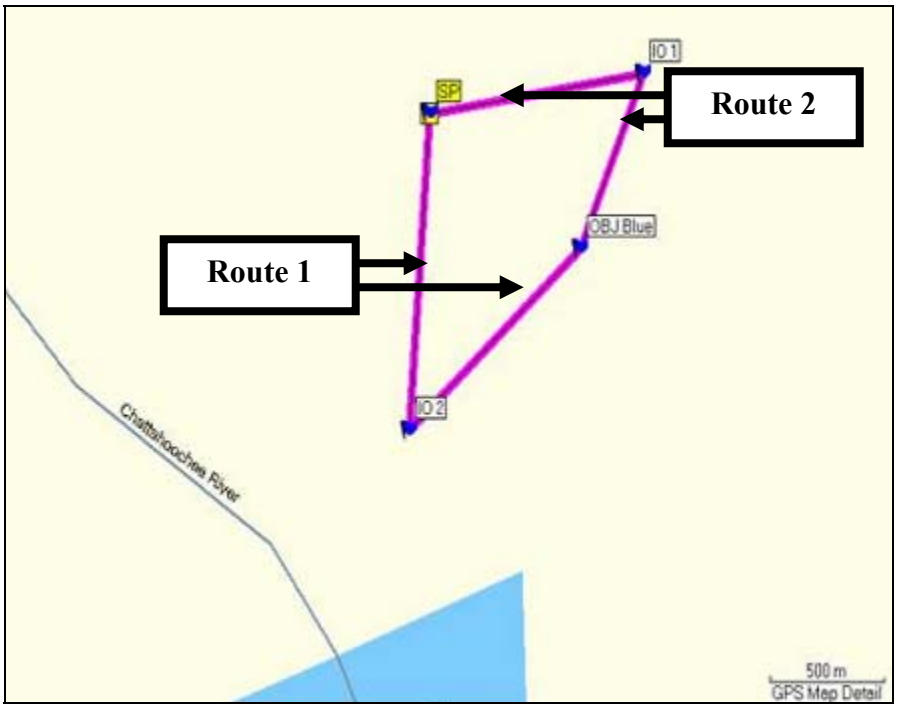


Figure 11. Movement-to-contact routes.

The squad was organized with one fire team wearing the experimental load carriage ensemble, headgear, and WPSM components (FFW) and one fire team wearing the current equipment fighting loads and the WPSM components (baseline) (table 2). Each Soldier in the fire team, who wore the FFW experimental load carriage ensemble, was allowed to configure the mission-specific pouches on his chassis to his preference. On day 2, Soldiers were allowed to configure their FFW gear with optional items. On day 4, the Soldiers wore the prescribed equipment on their carriage ensemble. Table 3 shows what each man wore on day 4.

The squad was controlled by a white cell platoon leader (performed by test personnel) and responded to his commands. The Soldiers carried their fighting loads over a pre-planned 2-km course. The squad was accompanied by two observer/controllers (data collectors) and a video cameraman. IPT personnel were situated at the intermediate objective, the ORP, and the objective to assist in FFW equipment adjustments, if requests for adjustments were initiated by the Soldiers. Observer/controllers interviewed the Soldiers at the intermediate objective and the ORPs. Additionally, the Soldiers were allowed to re-configure their load at the ORP before the final assault on the objective.

During the movement to contact and before the assault, the Soldiers carried physical mock-ups of ammunition magazines that were weight and volume accurate (figure 12). At the ORP, the mock-up ammunition was replaced by magazines and drums loaded with blank rounds. Data collectors were present at the ORP to record any changes in equipment configuration that the Soldiers made between the movement to contact and the assault.

Table 3. Day 4 movement to contact (what they wore).

Position	FFW	Base
Team leader	Leader variation helmet with glasses Chassis with Three ammunition pouches/six magazines front One smoke front Individual first aid kit (IFAK) left side One battery left side 70-oz. hydration back left Leader's computer back Battery right side Radio right side Display right side Ballistic belt Shoulder armor Belly armor	IBA with First aid kit front Three ammunition pouches with six magazines One smoke front Camel back
Grenadier	Soldier variation helmet with drop-down Chassis with Four 40-mm rounds right side Four 40-mm rounds on left front Four 40-mm rounds on right front Three ammunition pouches lower front SA display right front Combat lifesaver (CLS) left side One battery under left arm 70-oz. hydration back Computer lower back One battery on right rear One radio right side Ballistic belt Belly armor Shoulder armor	IBA with Six 40-mm rounds front Three ammunition pouches with six magazines Four 40-mm rounds left side IFAK back Camel back Two 40-mm rounds right side
SAW	Leader variation helmet with glasses Chassis with Two 100 rd on belt left and right Display right side CLS left side Battery lower back Health hub beside battery SA box lower right rear 70-oz. hydration Shoulder armor Belly armor Ballistic belt with suspenders	ACH helmet Protective eye ware IBA with First aid pouch upper left front Four 100 rd ammunition lower front Two grenade pouches upper front Camel back
Rifleman	Soldier variation helmet with drop-down Chassis with Three ammunition pouches front One smoke front IFAK left side 70-oz. hydration back CLS back Butt pack back Health hub back Radio right side Display right side Ballistic belt Belly armor Shoulder armor	IBA with Three ammunition pouches front One smoke front IFAK left side Camel back CLS back

Figure 12. Mock ammunition.

As the Soldiers assaulted the objective at Kunzig Range, a two-man opposing force (OPFOR) engaged the assaulting Soldiers (figure 13).

Figure 13. Assault: Kunzig range.

The Soldiers conducted this event twice per day on days 2 and 4. Upon completion, Soldiers completed a subjective questionnaire soliciting comments about form, fit, comfort, load carriage, and overall comments concerning the equipment.

After each day of testing, an after-action review (AAR) and focus group session gathered additional comments and addressed issues that developed during the day. All sessions were video taped.

2.4 MOUT: Day 3

During this phase, the Soldiers operated as independent fire teams and wore the baseline equipment, the FFW ensemble with ballistic belt, or the FFW ensemble with "up armor" configuration. This phase consisted of two separate events. One event was "clearing a room" and the other was "clearing a second story loft". Table 4 shows the order of conduct for the MOUT activities. An extra run was conducted for each fire team. During this extra run, the fire team members were allowed to configure their FFW ensemble to fit their preference.

Table 4. MOUT operations matrix.

Fire Team	Time of Day	Objective	Configuration
B	0850	Loft	Belt
A	0904	Room	Base
B	0925	Room	Up Armor
A	0940	Loft	Base
B	0950	Loft	Up Armor
B	1015	Room	Belt
B	Extra	Room	Self
A	1330	Room	Belt
B	1345	Room	Base
A	1355	Loft	Belt
B	1415	Loft	Base
A	1435	Room	Up Armor
A	1457	Loft	Up Armor
A	Extra	Room	Self

Upon completion, Soldiers completed a subjective questionnaire soliciting comments about form, fit, comfort, load carriage, and overall comments concerning the equipment.

2.4.1 Room Clearing

During this event, a fire team entered a "partially" secured building and received a FRAGO from an observer/controller acting as a platoon sergeant (PSG) to "clear" a specific room. Both baseline and FFW fire teams executed this event. A two-man OPFOR defended each room.

2.4.2 Loft Clearing

During this event, a fire team entered a "partially" secured building and received a FRAGO from an observer/controller acting as a PSG to "clear" a second story loft that was accessible by a

ladder. Both baseline and FFW fire teams executed this event. There were no OPFOR in the loft.

2.4.3 Excursion

After completing three iterations of room clearing and three of loft, each fire team conducted an excursion. The excursion consisted of each member of the fire team "personalizing" the FFW equipment for a room-clearing mission. Each Soldier modified the FFW components, deleting, modifying, or re-positioning items for the mission. Each Soldier was interviewed before and after the room-clearing operation.

2.5 IMT Course: Day 5

Soldiers were selected by size to fit a medium or large CB garment. The only difference between the medium and large garments was the PAVS inlet location. The medium CB garment had an "abdomen" PAVS inlet and the large garment had a "hip" PAVS inlet. Each Soldier completed two iterations of the Woodland IMT course as shown in table 5. At the completion of two iterations, the test officer stopped the exercise because of high wet bulb globe readings and high temperatures.

Table 5. IMT course matrix.

Iteration	Size	Configuration
1	Medium	A
1	Large	B
1	Medium	**C**
1	Large	A
2	Medium	B
2	Large	A
2	Medium	A
2	Large	**C**

A – FFW, CB, and mask
B – FFW, CB, mask and PAVS/PAPR belt mount
C – FFW, CB, mask and PAVS/PAPR leg mount

Soldiers were shown how to safely negotiate the IMT course and were trained in specific procedures as required. Additionally, each Soldier was provided the opportunity to walk the IMT course at a slow speed in order to familiarize him with the course and to reduce Soldier risk.

The Soldiers were required to fire multiple magazines at different locations on the IMT course, as shown in figure 14. They had to retrieve magazines from their ammunition pouches, place the magazines into their weapon, and replace the empty magazines in the proper pouch when finished.

Upon completion, subjects completed a subjective questionnaire soliciting comments on form, fit, comfort, load carriage, and overall comments concerning the equipment.

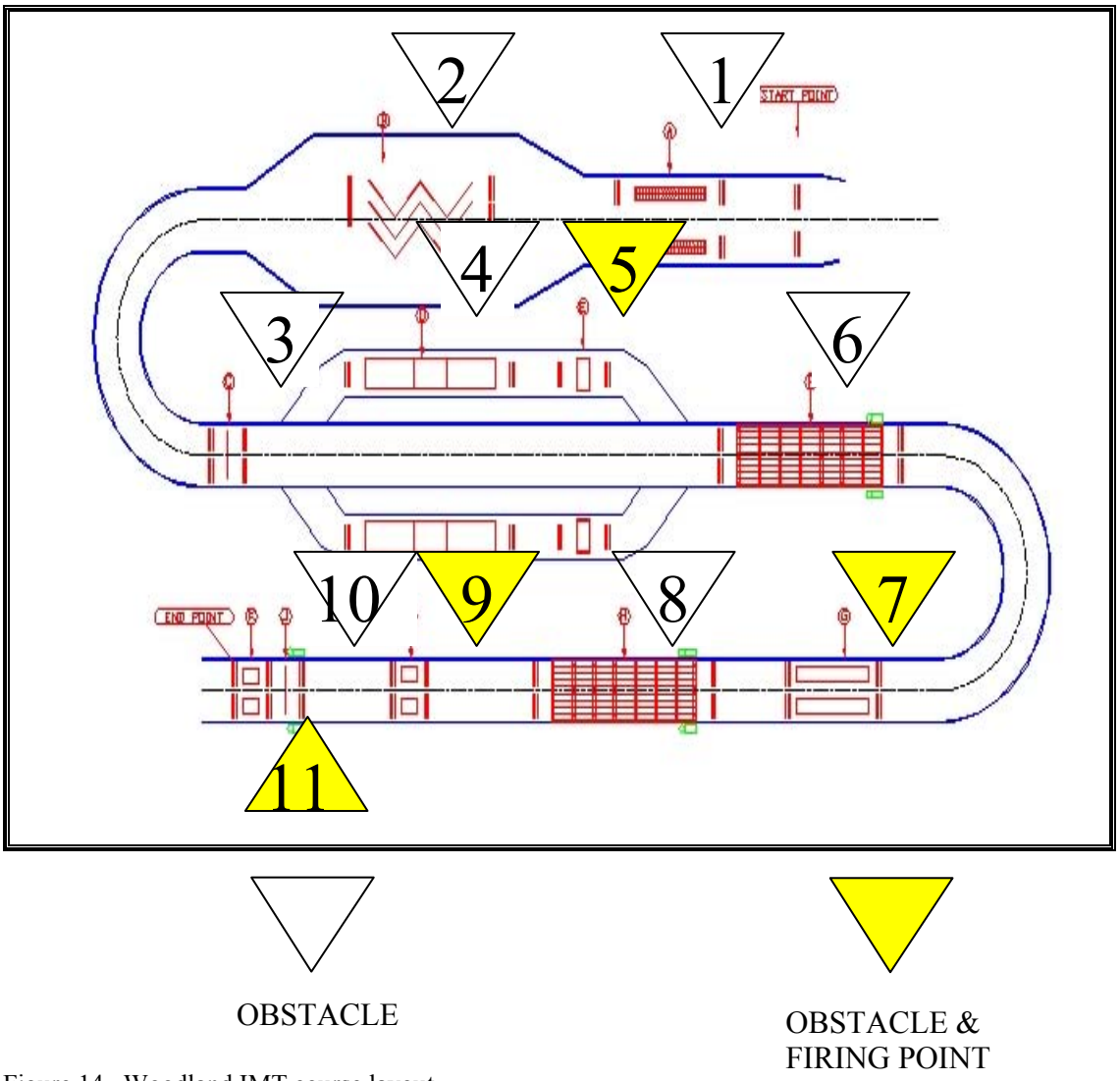


Figure 14. Woodland IMT course layout.

2.6 Side Experiments

2.6.1 Breaches: Day 3

A separate side test evaluated the fire teams' abilities to enter the building through three different simulated breaching holes. Figure 15 shows the three different sized breaching holes that the Soldiers traversed to enter the building.

Figure 15. Breaching holes.

2.6.2 M203 Side Event: Day 5

This event consisted of the two grenadiers wearing the FFW leader's variation and the two fire team leaders wearing their baseline equipment while traversing a cross-country course. This course consisted of thick underbrush, stream crossings, low crawl areas, and open woodland. The course, approximately 1 km long, was delineated in the vicinity of the IMT course. Figure 16 shows the course.

2.7 After-Action Reviews (AARs)

At the completion of each day's activities, all Soldiers participated in an AAR that covered the day's activities. These AARs were moderated by the test director. Before each AAR, the test director consulted with his staff and the IPTs to ensure that all areas of interest and concern were covered. When the AAR was completed, the test director relinquished the activity to the analysis and evaluation team leader, and the floor was opened to all unofficial questions that the IPTs might have had. All AARs were video taped.

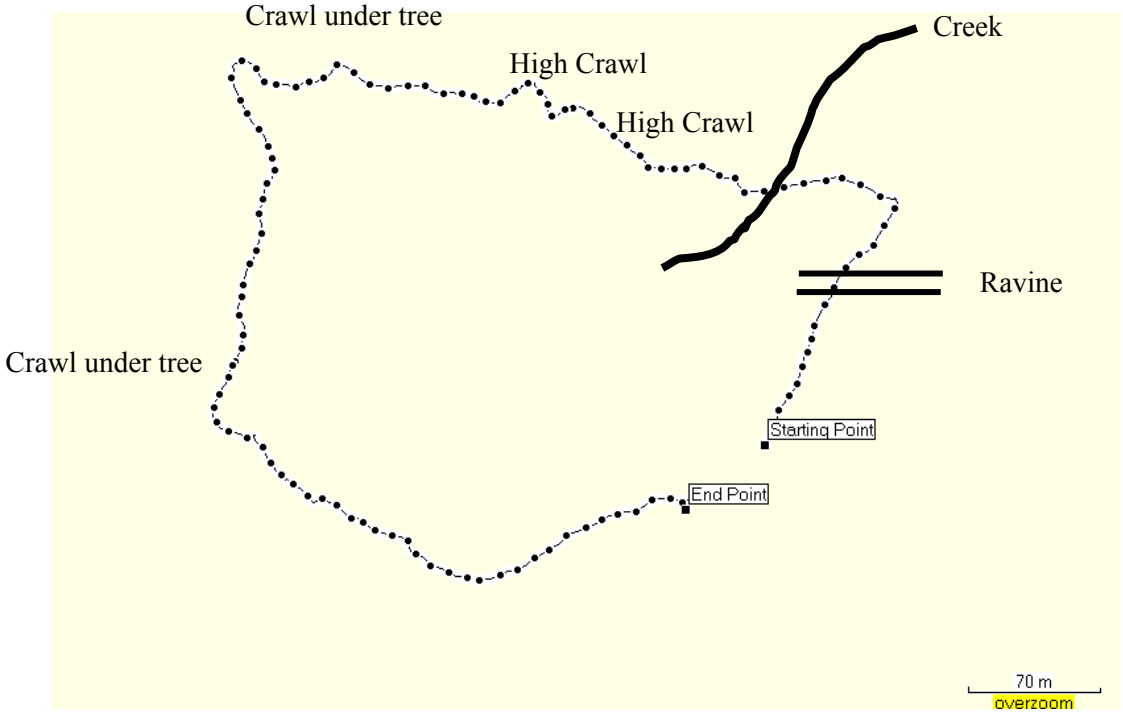


Figure 16. Cross-country course.

3. Results

The writers of this report performed more than 204 statistical tests at the 5% significance level on the tables in this paragraph. One might expect to find (0.05) (204) = 10.2 significant results just by chance alone. The number of significant tests that were reported is not much more than one would expect by chance alone, so the reader should be careful when interpreting these. The writers are concerned because the tests that were statistically significant were not significant on both days in the case of the movement to contact. These were attributed to a learning curve but could be attributable to chance. This is a typical problem with such small sample sizes.

3.1 Demographics and Anthropometrics (Day 1)

The Infantry squad from the 1st Battalion 29th Infantry Regiment consisted of a squad leader (E-6) and two complete fire teams for a total of nine personnel. A medic joined the group on day 2. The Soldiers had a mean time in service of 51 months and a mean of 15 months in their current jobs. They were physically fit with a mean of 267 of a possible 300 on their latest physical fitness test. Three of the 10 had some experience on the Land Warrior program. Three of the nine had served in a hostile fire zone, with three in Iraq and two of the three also serving in Afghanistan. All nine had trained or worn mission-oriented protective posture (MOPP) IV gear, with a mean time of four days for the longest time in MOPP IV.

In their self rating on knowledge, skills, and abilities related to Infantry duties, all rated themselves above average except in proficiency in CB operations and knowledge of reconnaissance, surveillance, and target acquisition procedures. All the Soldiers were currently issued an ACH. Five Soldiers wore modular lightweight load-carrying equipment (MOLLE) and four wore all-purpose lightweight individual carrying equipment (ALICE). The full demographics results are presented in appendix A.

The Soldiers were also measured on key anthropometrics, and the results are shown in table 6. There were three Soldiers (5, 6, and 7) who had an extremely small percentile (2) crotch height but a more normal stature percentile. As shown in figure 17, this translates into a “long-waisted” person or someone who may need special consideration when we are trying to fit into body armor chassis of any kind.

Table 6. Anthropometric measurements (percentile).

Roster	Chest Circum -ference	Crotch Height	Head Circum -ference	Head Breadth	Head Length	Sleeve Length: Spine-Wrist	Waist Circum-ference (omphalion)	Weight	Stature	Waist Back Length
1	Did not participate in event; not enough FFW ensembles									
2	96	43	60	34	65	62	77	98	87	10
3	91	12	92	90	80	73	92	96	87	38
4	12	43	85	34	90	34	20	25	76	10
5	48	2	15	15	19	30	65	30	22	2
6	97	2	75	75	65	18	92	93	43	23
7	91	2	30	5	19	2	95	77	23	10
8	30	55	35	15	19	40	38	50	90	10
9	72	72	95	75	85	68	72	88	98	48

Figure 17. Soldier with long waist.

Three of the anthropometric measurements were compared with measures taken from a sample of 1774 U.S. Army Soldiers in 1988 (Gordon et al., 1989). Table 7 shows the results of that comparison. The average crotch height of the Soldiers in the present study was significantly shorter as compared with the Army sample. There was a trend for the Soldiers in this study to be somewhat heavier than the Army sample. The two groups did not differ significantly in stature.

Table 7. Comparison of anthropometric measures with 1998 Army sample.

Measure	FFW n=8		Army n=1774		t	2-tailed p
	Mean	*SD*	Mean	*SD*		
Crotch height (in.)	31.2	*2.14*	33.0	*1.82*	2.17	< .05
Weight (lb)	192.6	*28.2*	173.0	*24.3*	1.84	< .10
Stature (in.)	70.6	*2.86*	69.1	*2.63*	1.38	ns

SD = standard deviation

3.2 Training and Fitting: Day 1

The Soldiers were all satisfied with the training received for the FFW ensemble, the headgear, and the medical items. The results of their questionnaire responses are shown in appendix B. All eight Soldiers indicated that they found no safety-related issues with the equipment and that they all understood how to use, wear, and carry the equipment.

When asked to rate the comfort of the FFW ensemble and other items of FFW equipment on a 7-point Likert scale (with one being extremely uncomfortable and 7 being extremely comfortable), the Soldiers responded as shown in table 8. Samples of the 7-point Likert scales used in this report are given in the appendices. The 7-point Likert scale used for this table is shown in appendix B.

Table 8. Mean response to training and fitting questions.

Item	n	Mean	SD
Combat pants	8	4.63	0.92
Combat shirt	8	4.75	0.89
Armor chassis	8	4.88	0.83
Armored load belt	6	5.17	0.98
FFW ballistic helmet shell	7	5.43	0.98
Headgear suspension and impact liner with integrated eyewear	6	6.00	0.63
On-the-move 70-oz. hydration system	7	5.86	1.21
IFAK	8	5.38	1.30
Electric components pouch	8	4.50	1.31
Battery pouch	8	4.50	1.31
Pre-configured components	8	4.63	1.30
Soldier radio	7	4.71	1.38
200-round drum pouches	2	4.00	2.83
Grenadier load pack	2	6.33	0.58
Combat lifesaver load pack	5	5.80	1.30
Assault pack	4	6.00	0.82
Wiring harness	6	5.00	1.55
Ammunition pouches	6	5.83	1.17
Overall comfort	8	5.38	1.19
WPSM: LSDS	7	4.00	1.73
WPSM: Sleep watch	4	4.25	1.26

The Soldiers initially found these items to be very comfortable: headgear suspension and impact liner with integrated eyewear; “on-the-move” hydration 70 ounce; 200-round drum pouch; grenadier load pack; combat lifesaver pack; assault pack; ammunition pouches; and sleep watch.

The chasses were sizes 1 through 3, with 3 being the largest. There were no sizes that took into consideration the different torso lengths. As a result, test personnel noticed some problems with fitting all the Soldiers. Soldier number 6 was too big for size 2 and a little too small for size 3. There was some question about the length of the torso fit also, as the chassis seemed to ride too low. There were similar problems with Soldiers 2 and 3. Their chasses did not fit properly. Both Soldiers 2 and 3 stated that their chasses felt comfortable at the end of the training and fitting event. Later in the experiment when the Soldiers had worn the FFW chasses during the cross-country movement and on other activities, there were some changes in the responses to

comfort. There is a big difference in initial impressions and wearing any equipment for a short period of time versus wearing and using it in a field environment for extended periods of time.

A comparison of Soldier-load weights between FFW-equipped Soldiers and baseline-equipped Soldiers is shown in table 9. The weights the Soldiers carried in their fighting loads are excessive for both FFW and baseline as prescribed by the Infantry School. In all cases, the FFW-configured Soldier's weight is more than the baseline. However, for those Soldiers configured with the Soldier variation, the delta was significantly less than for those configured with the leader variation. The leader variation worn by the team leader and the grenadier was 17 pounds heavier than the baseline. This is significant. In the continuing design effort of the leader variation, the program team must be aware of the question, "Is the extra capability worth the extra weight?" The added weight will have a noticeable effect on the team leader and the grenadier over the long run on extended operations.

Table 9. Typical weight differences (FFW versus baseline).

ID	Pos	Load Types	Weight	ID	Pos	Load Types	Weight	Delta FFW vs. Base
2	A-TL	FFW Fighting Load	294.75	6	B-TL	Baseline Fighting Load	261.5	
		Body Weight with BDU*	230			Body Weight with BDU	214.5	
		Delta	64.75			Delta	47	17.75
3	G	FFW Fighting Load	293.75	7	G	Baseline Fighting Load	245.75	
		Body Weight with BDU	220			Body Weight with BDU	189	
		Delta	73.75			Delta	56.75	17.0
4	AR	FFW Fighting Load	218.25	8	AR	Baseline Fighting Load	229	
		Body Weight with BDU	156			Body Weight with BDU	171	
		Delta	62.25			Delta	58	4.25
5	R	FFW Fighting Load	214.75	9	R	Baseline Fighting Load	251.5	
		Body Weight with BDU	160			Body Weight with BDU	201	
		Delta	54.75			Delta	50.5	4.25

*BDU = battle dress uniform

3.3 Movement to Contact: Days 2 and 4

3.3.1 Movement to Contact: Day 2, General Results

When the Soldiers arrived at Griswold Range, Fire Team A was fitted into the FFW chassis. This took longer than expected (about 2 hours). Figure 18 shows the Soldiers donning the FFW ensemble before movement to contact began.

Figure 18. Soldiers donning gear.

The squad was then given a FRAGO and shown (via a map reconnaissance) their intermediate and final objectives (figure 11). Fire Team A wore the FFW ensemble and Fire Team B wore the baseline equipment, as shown in table 1. The squad leader and both fire team leaders understood the mission and the routes they were expected to traverse.

Because of the shortage of FFW ensembles, the squad leader did not wear the FFW ensemble. He did wear the new combat shirt and pants and was closely involved with his squad members and their reactions to the FFW ensemble. This reduced the sample size to eight on most activities.

The body systems IPT fabricated suspenders for the ballistic belt and other comfort and convenience items. This resulted in some Soldiers with suspenders for their ballistic belts and

some without. On the morning of day 2, two of the Soldiers (4 and 8, grenadiers) chose to use the belts with suspenders (figure 19). As a result of this selective uniform configuring, the sample size for each Soldier configuration became one. It was not feasible to compare any data from fire team to fire team because each member of each fire team configured his system personally. Therefore, all data from day 2 are a sample size of one. On day 4, the Soldiers were not allowed to configure their own FFW chassis systems but were told what and where to wear the FFW equipment, based on the comments of the Soldiers on day 2.

Figure 19. Soldier wearing suspenders.

The test personnel made a concerted effort to ensure that the IPTs had access to the Soldiers, within limits, to obtain independent information concerning the Soldiers' preferences for the form, fit, and comfort of the FFW ensemble and other equipment in the experiment.

Also on day 2, the test personnel found that one of the SAW gunners was too slender to be properly fitted with a ballistic belt. There were insufficient numbers of size 1's to fit the two "small-waisted" Soldiers. Using a belt that was too big caused pinching in front/side areas. Therefore, the IPTs and the Soldier decided that he should not wear a ballistic belt, but that he would attach his leg panels, with ammunition, to his standard trousers' belt. This resulted in serious problems with the Soldier trying to keep his trousers up in a normal position (figure 20).

Figure 20. Soldier: no ballistic belt with leg panels.

During the fitting and sizing, the IPT trainers determined the uniform sizes for all Soldiers to be within tolerance of good fit. However, as pointed out earlier, there is usually a big difference in the way equipment fits and feels in the field versus the classroom so this issue should continue to be evaluated.

3.3.2 Day 2, Specific Results

The results of the Soldier questionnaires are shown in appendix C. As stated before, the responses for the FFW were initially treated as a sample size of one because every Soldier configured his ensemble differently. However, when we considered the issue of form, fit, and comfort, the FFW and baseline responses were consolidated into a sample size of eight. Table 10 shows the descriptive statistics for questions about the Soldiers' abilities to complete specific tasks. A complete listing of Soldier responses to all questions is provided in appendix C. The Soldiers reported the biggest disadvantages with FFW in the areas of leg movement and ability to do basic movement techniques. They reported a slight disadvantage with the FFW in the areas of assuming a kneeling position, running, and movement through thick under brush. Conversely, they reported

a slight advantage in their ability to use hand and arm signals with the FFW. All other areas were virtually a tie.

Table 10. Mean responses to task completion.

Ability to Complete Tasks						
	Baseline			FFW		
Question	n	Mean	SD	n	Mean	SD
Ease of leg movement	9	6.22	1.09	9	4.00	1.87
Ease of assuming prone position	8	5.88	0.99	7	5.57	0.98
Ease of assuming kneeling position	9	6.22	1.09	9	5.11	1.54
Ease of arm movement	9	5.11	0.93	9	5.11	1.17
Ease of torso movement	8	5.00	1.31	9	5.11	1.27
Ease of head movement	8	6.00	0.93	9	6.11	1.05
Ability to run	9	5.78	1.20	9	4.22	2.49
Use of hand and arm signals	9	5.56	0.88	9	6.11	0.78
Move through swampy areas or streams	6	5.67	1.03	8	5.50	1.31
Move through thick brush and vines	8	5.50	1.20	9	4.89	1.69
Ability to obtain a good sight picture	9	5.67	1.22	9	5.89	1.27
Target identification	9	5.67	1.22	9	5.89	1.17
Conducting IMT	7	5.00	1.15	8	3.50	0.76

Soldier comments on their ability to complete tasks include:

FFW

- The 203 belt needs suspenders.
- A lot of things on the vest get hung up, especially in the gap between the vest and belt.
- The leg panels were very heavy; running and jumping were very difficult, overall "smoked" (exhausted) the legs.
- Had a hard time running, clips on thigh mount kept rubbing together.
- Assault pack kept coming undone.
- SAW ammunition pouch under left arm is no good.
- Need something to prevent sweat from entering eyes.

BASELINE

- The IBA is much more mobile and the load is distributed better.
- Put the pads from the new one in there to create the same space, combine the IBA with the new vest and you guys will have some real good stuff.
- We are used to working with the IBA so it's hard to say it's harder or easier.

Table 11 shows the mean responses from the Soldier questionnaires on problems they may have encountered. Most responses revealed very few problem areas. However, the Soldiers reported more problems with the baseline in the areas of hot spots, torso chafing, ability to breathe, and overall comfort. With the FFW, the Soldiers reported problems with weight shifting, hindrance in movement, and equipment pinching.

Table 11. Mean responses to problem areas encountered.

Question	Baseline			FFW		
	n	Mean	SD	n	Mean	SD
Problem Areas Encountered						
Pressure points	9	5.78	1.56	9	5.67	1.41
Hot spots	9	4.22	1.92	9	5.67	1.66
Bruising on your body	9	5.78	1.64	9	5.44	1.67
Torso chafing in front	9	4.22	2.28	9	5.11	1.69
Torso chafing in back	9	5.00	2.18	9	5.78	1.30
Arm/shoulder chafing	9	5.22	1.79	9	6.11	1.05
Leg/thigh chafing	9	6.33	1.00	9	5.33	1.50
Neck/head chafing	9	5.11	1.54	9	6.11	1.27
Equipment snagging	9	5.44	1.33	9	5.33	1.41
Equipment hindering movement	9	5.67	1.12	9	4.44	1.67
Weight shifting	9	5.00	1.73	9	4.44	2.30
Equipment pinching	9	5.00	1.73	9	4.89	2.09
Load adjustment	9	5.78	1.30	9	5.56	1.24
Access to stowed items	9	5.22	1.20	9	6.22	0.67
Ability to breathe	9	4.78	1.79	9	6.22	0.67
Overall comfort	9	4.22	1.64	9	4.78	0.83

Soldier comments on problem areas encountered include:

FFW

- Torso stayed cool, but arms were hot (2).
- Elbow pads felt weird and the straps would not stay in place.
- Legs were very hot (2).
- Knee pads rubbed shins.
- Zipper on the shirt digs into the chest.
- Knee pad shifted out of place and loosened (2).
- Not use to waist belt.
- Knee pads need more cushion.
- Vest does not stay fastened.
- Shirt collar rubbed my neck a little raw.
- Heart monitor was good; you don't realize it's there until you take your stuff off.
- Helmet needs some work in the band; it doesn't size right for my head.
- Pinching between belt and vest (2).
- Heavy on shoulders after awhile.
- Knee pads move too much and don't have the protection of the old ones.
- Batteries dig into arm.
- Zipper on pants digs into butt while I'm sitting.
- Pants need front pockets.
- Heart monitor chafed my neck (Hidalgo).
- Movement and weight shifting with leg panels; every step I took, the leg panels moved my legs.
- Leg panels came loose, snagging on clips.

BASELINE

- IBA causes lower back pain and stiff shoulders.
- IBA needs more padding, mostly in the shoulder area.

- IBA puts pressure on your shoulders.
- Neck is too high on the IBA and it's too hot and hard to breathe.
- Hidalgo stinks; sticks to the skin and rubbing causing chafing (2). (Note: Soldiers wore LSDS with both FFW and baseline.)
- The IBA has no way of allowing air to come in so the heat buildup is extremely high.

Table 12 shows the mean responses to questions about whether the Soldiers encountered any pain.

Table 12. Mean response to pain levels.

Question	Baseline			FFW		
	n	Mean	SD	n	Mean	SD
Level of Pain (if any) Experienced						
Upper back	9	5.89	1.27	9	5.67	1.22
Lower back	9	4.56	1.67	9	5.78	1.56
Neck	9	5.44	1.33	9	6.44	0.88
Head	9	5.89	1.54	9	6.89	0.33
Torso front	9	5.44	1.81	9	5.78	1.64
Groin	9	6.78	0.44	9	6.67	0.50
Legs	9	6.56	0.73	9	4.89	2.47
Arms	9	6.33	1.00	9	6.11	0.78
Eyes	9	6.89	0.33	9	6.56	0.73

Soldier comments on pain levels include:

FFW

- Knee pads rubbed shins.
- Lack of padding in shoulders caused pain (2).
- Zipper on shirt digs into chest.
- Weight of the 203 rounds on leg panels isn't much, but moving through the terrain we just went through was rough (2).
- All that stuff seems to centralize on your hips.
- Torso pain is from the Hidalgo heart monitor, it rubs all over the side (2).
- If you could come up with something that attached to the body armor itself, it would be good. The leg panel is just a bad idea for all the 40-mm rounds.
- Sweat in eyes.
- Leg clips rubbing together, possible chafing.

BASELINE

- Heart monitor piece bothered by back part of IBA.
- LSDS stinks (Hidalgo).
- IBA has no padding on shoulders
- Back plate rides too high and bounces off lower back.
- IBA rubs your head and neck raw.
- The heart monitor dug into my chest and pushed into my sternum.
- IBA rubbed neck.
- Weight shifted from one shoulder to the other (3).
- Heat buildup is extremely high.

The Soldiers reported that nothing interfered with their ability to complete the mission and they reported no unsafe incidents. However, one stated that even though the FFW ensemble did not interfere, it caused more irritation than necessary. One Soldier commented on the questionnaire and others verbally that they did not like the ammunition pouches. The top of the ammunition pouch was too tight, and they had difficulty replacing magazines.

Three of the Soldiers reported they shifted and re-tightened the knee pads because of problems with rubbing their shins and coming loose while they moved through the woods. Several mentioned the ballistic belt and that they had to continuously adjust it.

The Soldiers did not like the location of the electronics. They overwhelmingly wanted all electronics moved to the back. All but one Soldier disliked the "stock lock" and its location on the shoulder strap. Several pointed out that it was useless because of its location. The butt of the weapon, when drawn to the shoulder, is not as high toward the neck as the "stock lock" is situated. Figure 21 shows the location of the "stock lock". The Soldiers would like an attachment between the chassis and the weapon that would allow them to pull the weapon up into the firing position with one hand. Figure 22 shows a makeshift example of this method of attaching the weapon. This allows the Soldier to have both hands free but also allows him to bring the weapon into a firing position with one hand.

Figure 21. Stock lock.

Figure 22. Shoulder weapons attachment.

The Soldiers were quizzed about their preferences for wearing the "up-armor" configuration on different missions.

Figure 23 shows a Soldier with the "up armor," and figure 24 shows a Soldier with the base FFW ensemble.

At this point, the Soldiers had not worn the FFW with up armor, but they were asked about wearing it on typical missions. They had worn the leg-up armor panels without the inserts. The leg-up armor panels were used primarily as a means to carry 40-mm rounds or SAW ammunition. Table 13 shows their responses for the shoulder-up armor inserts. Table 14 shows their responses for the neck-up armor. Table 15 shows their responses for abdomen-up armor. Table 16 shows their responses for leg-up armor.

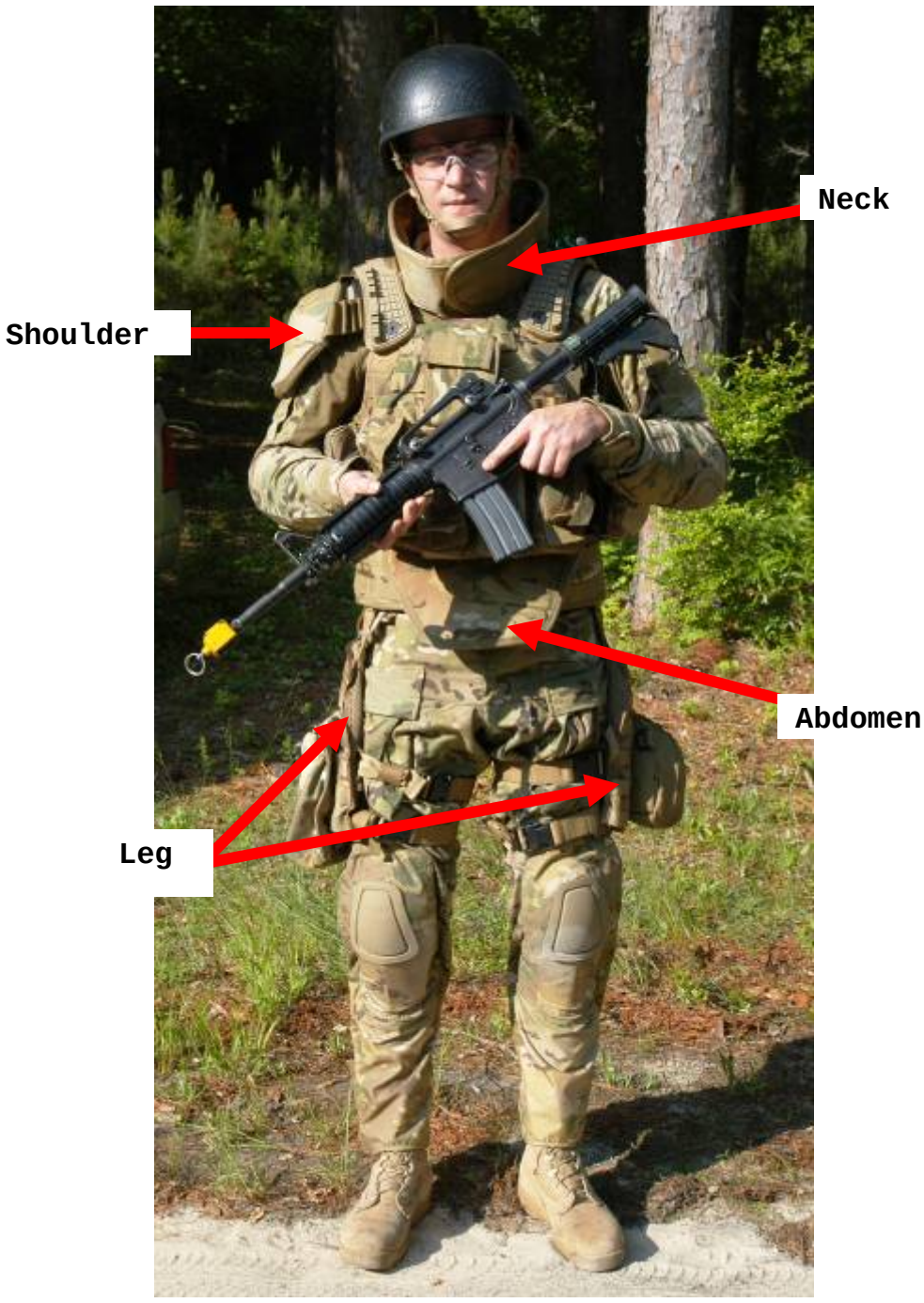


Figure 23. “Up” armor.

Figure 24. FFW basic chassis and ballistic belt.

Table 13. Soldiers' responses for shoulder-up armor.

Shoulder Plate Inserts	Number of Responses								
	FFW								
Roster No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Movement to contact	0	0	1	0	0	0	0	0	0
Reconnaissance	0	0	1	0	0	0	0	0	0
Attack	0	0	1	0	1	1	1	0	0
Defense	1	1	1	1	0	1	0	1	0
Counter-attack	0	0	1	0	1	0	0	0	0

1 = yes 0 = no

Table 14. Soldiers' responses for neck-up armor.

Neck Protector Inserts	Number of Responses								
	FFW								
Roster No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Movement to contact	0	0	0	0	0	0	0	0	0
Reconnaissance	0	0	0	0	0	0	0	0	0
Attack	0	0	0	0	0	1	0	0	1
Defense	1	0	0	0	0	1	0	0	0
Counter-attack	0	0	0	0	0	0	0	0	1

Table 15. Soldiers' responses for abdomen-up armor.

Belly Panel Inserts	Number of Responses								
	FFW								
Roster No.	1	2	3	4	5	6	7	8	9
Movement to contact	0	0	0	0	0	0	0	0	1
Reconnaissance	0	0	0	0	0	0	0	0	1
Attack	0	0	0	0	0	1	1	0	1
Defense	1	0	0	0	0	1	0	0	1
Counter-attack	0	0	0	0	0	0	0	0	1

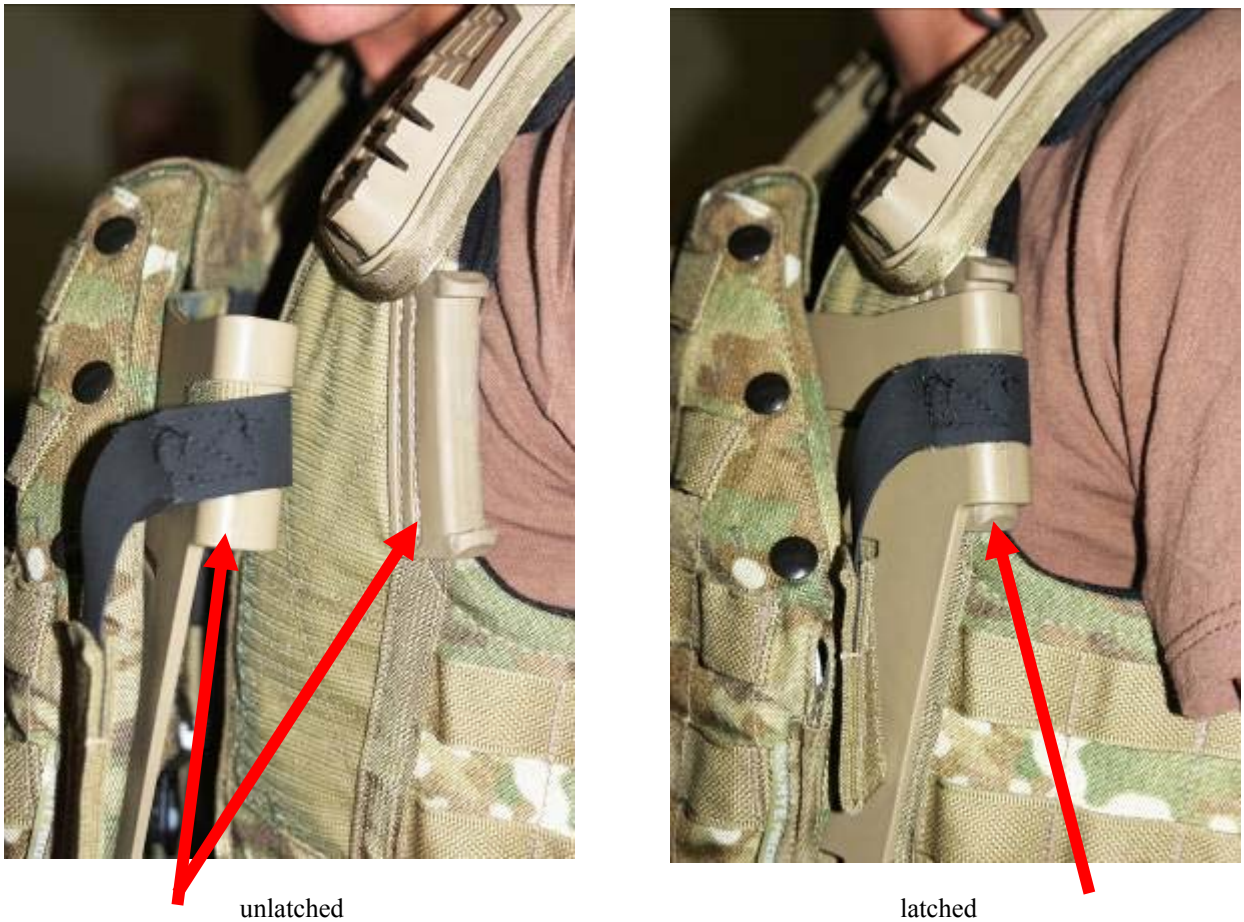
Table 16. Soldiers' responses for leg-up armor.

Thigh Inserts	Number of Responses								
	FFW								
Roster No.	1	2	3	4	5	6	7	8	9
Movement to contact	0	0	1	0	1	0	1	1	0
Reconnaissance	0	0	0	0	0	0	1	1	0
Attack	1	0	1	1	1	0	1	1	1
Defense	1	0	0	1	0	0	0	1	1
Counter-attack	0	0	1	0	1	0	0	1	1

Most of the Soldiers did not like the up-armor option, especially the neck-up armor. Their biggest complaints were that it was too heavy and restricted head movement as well as vision. These comments came before they had a chance to wear the up armor on any tactical mission. Additional Soldier comments include

- All the extra protectors would be most beneficial to a gunner on a high mobility multi-purpose wheeled vehicle.
- Thigh panels should remain completely optional since they don't help the SAW gunners at all.

When asked about donning the chassis, five Soldiers reported problems. The biggest problem was the latching system. Figure 25 shows the FFW chassis latching system. The Soldiers did not like this means of attaching the chassis because it was so difficult to latch and unlatch. Some Soldiers asked the IPTs to file the latching system to allow easier latching and unlatching, and some systems became worn and easier to latch and unlatch by week's end. The Soldiers had similar problems in doffing the chassis.



unlatched latched

Figure 25. Chassis latching system.

When asked how they would change the FFW chassis if they could, the Soldiers had the following comments:

- Use a lighter material for the pants and shirt (too hot) (2).
- Make the knee pads shorter to lessen the rubbing of the shins.
- Find a way to remove the zipper from the shirt or pad somehow.
- The pants need some sort of mesh to stop bugs when you unzip them for ventilation.
- Get rid of the little stuff like the wires on the side.
- Get rid of the butt stock skid plate; use something like the non-slip fabric on a shooting vest.
- Do something to get the cords that tighten the chassis out of the way; they just dangle now.
- Better latch for chassis and move it around where you can get to it.
- The water hydration system needs to have more capacity.

- Can't get to pants pockets when wearing leg panels.
- The ballistic belt needs suspenders.
- Make the leg panels lighter.

3.3.3 Day 2, FFW Helmet Assembly Results

The Soldiers had a few problems with the Soldier variation helmet during the movement to contact. This was primarily attributed to heat accumulation and perspiration problems. It is believed that during the day 2 activities, the helmets that had a Skydex liner contributed to this problem (figure 26). On subsequent days, it became apparent that the lining had been changed (Brock) (figure 27). The Soldier complaints were fewer after this action was taken. The Soldiers liked the leader variation helmet and accepted the extra weight for the extended capability potential.

Figure 26. Skydex impact liner.

Figure 27. Brock impact liner.

Soldier comments on the helmet include the following:

- The FFW is very hot; it allows air to flow through, but I think it is hotter than the IBA while I'm moving.
- Need something to catch sweat from entering eyes.
- Sweat a big problem, irritates the eyes while moving or in motion.
- Helmets are hot; it is Georgia, and there is nothing you can do.

3.3.4 Comparison of FFW and Baseline Equipment, Day 2

The Likert scale means from the questionnaires were categorized with the system shown in table 17. Then the preferences of the FFW ensemble over the baseline are shown (tables 18 through 22).

Table 17. Categorization of the questions.

Preference	Difference
Strong Preference	> .99
Moderate Preference	.25 - .99
No Clear Preference	< .25

Items for which there was a strong preference for the FFW system (table 18):

Table 18. Items of strong preference for the FFW ensemble.

Question	Base	FFW	Diff
Hot spots	3.88	5.50	-1.63
Ability to breathe	4.50	6.13	-1.63
Torso chafing in front	3.88	5.00	-1.13
Neck/head chafing	4.88	6.00	-1.13
Arm/shoulder chafing	5.00	6.00	-1.00

Items for which there was a moderate preference for the FFW system (table 19):

Table 19. Items of moderate preference for the FFW ensemble.

Question	Base	FFW	Diff
Torso chafing in back	4.75	5.63	-0.88
Access to stowed items	5.25	6.13	-0.88
Use of hand and arm signals	5.50	6.00	-0.50
Overall comfort	4.25	4.75	-0.50

Items for which there was no clear preference for either system (table 20):

Table 20. Items with no clear preference.

Question	Base	FFW	Diff
Ability to obtain a good sight picture with your weapon	5.50	5.75	-0.25
Target identification	5.50	5.75	-0.25
Ease of head movement	5.86	6.00	-0.14
Ease of torso movement	5.00	5.13	-0.13
Ease of arm movement	5.13	5.13	0.00
Equipment snagging	5.25	5.25	0.00
Pressure points	5.63	5.50	0.13
Equipment pinching	4.75	4.63	0.13

Items for which there was a moderate preference for the baseline system (table 21):

Table 21. Items with moderate preference for baseline.

Question	Base	FFW	Diff
Ease of assuming prone position	5.88	5.57	0.30
Bruising on your body	5.63	5.25	0.38
Move through swampy areas or streams	5.67	5.29	0.38
Load adjustment	5.88	5.38	0.50
Move through thick brush and vines	5.29	4.63	0.66
Leg/thigh chafing	6.25	5.38	0.88
Weight shifting	5.00	4.13	0.88

Items for which there was a strong preference for the baseline system (table 22):

Table 22. Items with strong preference for baseline.

Question	Base	FFW	Diff
Ease of assuming kneeling position	6.13	4.88	1.25
Equipment hindering movement	5.75	4.38	1.38
Conducting IMT	5.00	3.50	1.50
Ability to run	5.63	3.88	1.75
Ease of leg movement	6.13	3.75	2.38

3.3.5 Subject Matter Expert (SME) Observations

During the Day 2 movement-to-contact activities, two subject matter experts (SMEs) accompanied the squad. These SMEs were also observing and collecting data for the patrols. Table 23 shows the SME observations and comments from the morning patrol and table 24 for the afternoon patrol.

Table 23. SME observations, day 2, morning movement to contact.

Day 2 Morning	
ID No.	**Comments**
1	Knee pads were too long and rubbed his shin. His torso was nice and cool, but arms were too hot.
2	Ballistic belt offers some support to his back, but caused too many problems when used.
3	Grenadier had problems keeping ballistic belt pulled up above his hips. Had to continuously pull belt up. He was not wearing suspenders, some were, but it was a request from Soldiers that the IPT did. Had problems with the weight of 40-mm rounds on his leg panels, weighed him down too much and hindered mobility.
4	Had problems with helmet, it caught all the sweat and then at an inopportune time when he moved his head just right, the sweat would drain down into his eyes. He thought the zippered vents on the pants were a good idea, but allowed bugs access to his legs and groin. Weight of the SAW ammunition on the belt pulled it around when he got in prone. His knee pads were tight when he started but became loose and bothered him. Battery box under right arm caused loss of mobility and caused a lot of pain. His arm became numb. Did not mind the first aid kit under left arm because it was soft. Said the suspenders on the ballistic belt helped, but still too much weight on leg panels (SAW ammunition).
5	Couldn't unzip ventilation in pants because leg panels prohibited him from reaching the zippers. Didn't like the leg panels, he was wearing them with a regular belt, no ballistic belt small enough to fit him. He did like the extra padding from the leg panels when going through thorn bushes.

Table 24. SME observations, day 2, afternoon movement to contact.

Day 2 Afternoon	
ID No.	**Comments**
6	Battery under left arm pushed against bicep and changed weapon carry position. The battery kept his right arm too high. Ballistic belt must be kept high up to keep from pinching. Ballistic belt dropped down and caused pinching between belt and chassis. Pants and shirt too hot, but airflow under chassis is good.
7	Used suspenders to keep ballistic belt up. It worked for awhile but belt started to fall down. Leg panels with 40-mm rounds too heavy and interfered with his mobility on assault. Right leg strap loosened on assault. Pants and shirt too hot, but airflow under chassis was good.
8	Leg straps fell out of keepers on leg panels. Health hub wire broke off during assault. SAW drum under left arm bound on bicep. Will move SAW drum to leg panel. Liked his helmet better than his ACH. Good fit, stable, straps keep it in place. Liked the chin strap. Lateral strap on right side came loose during assault. Knee pads would not stay in place during movement. Straps holding side panels came loose during movement.
9	Knee pads turned outward. Pinched between belt and chassis. Pants zipper chafed back of thighs and butt. Knee pads would not stay in place during movement. Straps holding side panels came loose during movement.

3.3.6 Likert Scale Questionnaire Statistics, Day 2, Movement to Contact

Table 25 shows the descriptive statistics for the 1-7 Likert scale items for baseline and FFW ensembles during movement-to-contact exercises on day 2. Paired samples t-tests were conducted on each of the questions. For t-values $\geq$1.00, partial eta squared (η^2_p) was computed. This statistic provides an estimate of effect size; it is interpreted as the percent of variance in the dependent variable that is accounted for by the independent variable. Soldiers rated the baseline gear as being significantly better than the FFW equipment in terms of ease of leg movement: $t(8)= 3.08$, $p = .015$, $\eta^2_p = .54$. There was also a significantly higher mean rating for the baseline equipment with regard to conducting IMT: $t(6)= 3.67$, $p = .010$, $\eta^2_p = .69$. The FFW ensemble was rated significantly better than the baseline gear in terms of eliminating hot spots on the body ($t(8)= 3.04$, $p = .016$, $\eta^2_p = .54$), access to stowed items ($t(8) = 2.68$, p - .028, $\eta^2_p = .47$), and ability to breathe ($t(8) = 2.39$, $p = .044$, $\eta^2_p = .42$.)

Table 25. Descriptive statistics, Day 2, Movement to Contact.

Question	Baseline		FFW		t-tests			
	Mean	SD	Mean	SD	t	df	p	η^2_p
Ease of leg movement	6.22	1.09	4.00	1.87	3.08	8	0.015	0.54
Ease of assuming prone position	5.88	0.99	5.57	0.98	0.79	6	0.457	
Ease of assuming kneeling position	6.22	1.09	5.11	1.54	2.17	8	0.062	0.37
Ease of arm movement	5.11	0.93	5.11	1.17	0.00	8	1.000	
Ease of torso movement	5.00	1.31	5.11	1.27	-0.28	7	0.785	
Ease of head movement	6.00	0.93	6.11	1.05	-0.23	7	0.826	
Ability to run	5.78	1.20	4.22	2.49	1.83	8	0.105	0.29
Use of hand and arm signals	5.56	0.88	6.11	0.78	-1.47	8	0.179	0.21
Move through swampy areas or streams	5.67	1.03	5.50	1.31	0.88	4	0.426	
Move through thick brush and vines	5.50	1.20	4.89	1.69	0.70	7	0.504	
Ability to obtain a good sight picture with your weapon	5.67	1.22	5.89	1.27	-0.69	8	0.512	
Target identification	5.67	1.22	5.89	1.17	-0.39	8	0.708	
Conducting IMT	5.00	1.15	3.50	0.76	3.67	6	0.010	0.69
Pressure points	5.78	1.56	5.67	1.41	0.14	8	0.892	
Hot spots	4.22	1.92	5.67	1.66	-3.04	8	0.016	0.54
Bruising on your body	5.78	1.64	5.44	1.67	0.67	8	0.524	
Torso chafing in front	4.22	2.28	5.11	1.69	-1.45	8	0.184	0.21
Torso chafing in back	5.00	2.18	5.78	1.30	-1.42	8	0.193	0.2
Arm/shoulder chafing	5.22	1.79	6.11	1.05	-1.36	8	0.212	0.19
Leg/thigh chafing	6.33	1.00	5.33	1.50	2.00	8	0.081	0.33
Equipment hindering movement	5.67	1.12	4.44	1.67	2.14	8	0.065	0.36
Weight shifting	5.00	1.73	4.44	2.30	0.56	8	0.589	
Equipment pinching	5.00	1.73	4.89	2.09	0.14	8	0.894	
Load adjustment	5.78	1.30	5.56	1.24	0.30	8	0.772	
Access to stowed items	5.22	1.20	6.22	0.67	-2.68	8	0.028	0.47
Ability to breathe	4.78	1.79	6.22	0.67	-2.39	8	0.044	0.42
Overall comfort	4.22	1.64	4.78	0.83	-0.86	8	0.416	
Pain in upper back	5.89	1.27	5.67	1.22	0.36	8	0.729	
Pain in lower back	4.56	1.67	5.78	1.56	-1.28	8	0.236	0.17
Pain in neck	5.44	1.33	6.44	0.88	-2.45	8	0.040	0.43
Pain in head	5.89	1.54	6.89	0.33	-1.81	8	0.108	0.29
Pain in torso front	5.44	1.81	5.78	1.64	-0.37	8	0.720	
Pain in groin	6.78	0.44	6.67	0.50	0.55	8	0.594	
Pain in legs	6.56	0.73	4.89	2.47	1.83	8	0.105	0.29
Pain in arms	6.33	1.00	6.11	0.78	0.55	8	0.594	
Pain in eyes	6.89	0.33	6.56	0.73	1.15	8	0.282	0.14

3.3.7 Movement to Contact, Day 4, Specific Results

On day 4, the Soldiers were configured as similarly as possible. Each person (i.e., fire team leaders, grenadiers, etc.) wore the same equipment in both runs. Table 26 shows what each person wore for his fighting load.

Table 26. What the Soldiers wore, day 4.

Position	FFW	BASE
Team leader	Chassis with Three ammunition pouches/six magazines front One smoke front IFAK left side One battery left side Camelback[10] left back side Leader's computer back Battery right side Radio right side Display right side Ballistic belt Shoulder armor Belly armor	IBA with First aid kit front Three ammunition pouches with six magazines One smoke front Camel back
Grenadier	Soldier variation helmet with drop down Chassis with Four 40-mm rounds right side Four 40-mm rounds on left front Four 40-mm rounds on right front Three ammunition pouches lower front SA display right front CLS left side One battery under left arm Camel back Computer lower back One battery on right rear One radio right side Ballistic belt Belly armor Shoulder armor	IBA with Six 40-mm rounds front Three ammunition pouches with six magazines Four 40-mm rounds left side IFAK back Camel back Two 40-mm rounds right side
SAW	Leader variation helmet with glasses Chassis with Two 100-rd on belt left and right Display right side CLS left side Battery lower back Health hub beside battery SA box lower right rear Shoulder armor Belly armor Ballistic belt with suspenders	ACH helmet Protective eye wear IBA with First aid pouch upper left front Four 100-rd ammunition lower front Two grenade pouches upper front Camel back
Rifleman	Chassis with Three ammunition pouches front One smoke front IFAK left side Camel back CLS back Butt pack back Health hub back Radio right side Display right side Ballistic belt Belly armor Shoulder armor	IBA with Three ammunition pouches front One smoke front IFAK left side Camel back CLS back

[10]trade name

The complete list of Soldier and SME comments is shown in appendix C. During this phase, the data were viewed as a sample size of two as discussed before (fire team leaders, grenadiers, etc.). When asked if there was anything that hindered their ability to complete basic tasks, the Soldiers responded as shown in table 27.

Table 27. Mean responses to task completion.

Tasks	Mean Response							
	FFW				Baseline			
	FTL	AR	G	R	FTL	AR	G	R
Ease of leg movement	6.50	6.00	6.00	7.00	7.00	7.00	7.00	5.00
Ease of assuming prone position	5.00	6.50	6.50	7.00	5.50	6.50	7.00	6.00
Ease of assuming kneeling position	5.50	6.50	6.50	7.00	6.50	6.50	6.50	6.50
Ease of arm movement	5.50	5.50	6.50	6.50	6.50	6.00	6.50	6.00
Ease of torso movement	5.50	5.50	6.50	7.00	6.50	6.00	6.00	5.50
Ease of head movement	6.00	6.50	6.50	7.00	6.50	6.50	6.50	6.50
Ability to run	6.00	6.00	6.00	5.50	7.00	7.00	6.00	6.50
Use of hand and arm signals	7.00	6.50	7.00	6.50	7.00	6.50	6.50	5.50
Move through swampy areas or streams	6.50	7.00	7.00	7.00	7.00	7.00	7.00	5.00
Move through thick brush and vines	6.50	6.50	6.00	6.50	6.50	6.00	6.50	5.50
Ability to obtain a good sight picture with your weapon	6.50	6.50	6.50	7.00	6.00	6.50	7.00	6.00
Target identification	7.00	6.00	6.50	7.00	7.00	6.50	7.00	6.50
Conducting IMT	6.50	6.00	5.50	7.00	6.50	7.00	7.00	6.00

The Soldiers' comments included:

FFW-G - Without the leg panels, I had no trouble at all moving through the brush or running, with putting all the gear on the chassis, it was a lot easier to move all around.

FFW-R - The ballistic belt fell around the outside of my hips and restricted me from sprinting.

BASELINE-AR - Try using some fog-resistant Rainex[11] on eye protection to help reduce fogging and sweat buildup.

Table 28 shows the mean responses from the Soldier questionnaires about problems they may have encountered. Most responses revealed very few problem areas. There were some minor problems shown in the chafing, hot spots, weight shifting, and pinching areas. Two of the Soldiers had a difficult time with pinching between the ballistic belt and the chassis.

[11]trade name used by Soldier

Table 28. Mean responses to problem areas encountered.

Problem Areas	Mean Response							
	FFW				Baseline			
	FTL	AR	G	R	FTL	AR	G	R
Pressure points	6.50	6.00	5.50	7.00	6.50	6.50	6.00	5.50
Hot spots	6.50	4.50	5.50	7.00	6.50	6.00	5.00	5.50
Bruising on your body	5.50	4.50	6.00	7.00	6.50	6.50	7.00	6.00
Torso chafing in front	6.50	6.00	4.50	5.50	6.50	5.50	4.00	5.50
Torso chafing in back	6.50	5.00	6.50	7.00	6.50	6.50	6.00	6.50
Arm/shoulder chafing	4.00	4.50	6.50	7.00	5.00	5.50	6.50	6.00
Leg/thigh chafing	5.50	4.50	6.50	6.00	6.50	7.00	6.50	6.50
Neck/head chafing	6.00	4.00	6.50	5.50	6.50	6.00	7.00	5.50
Equipment snagging	6.00	6.00	6.50	7.00	6.50	6.00	7.00	6.50
Equipment hindering movement	6.00	5.50	6.50	7.00	6.50	6.50	7.00	6.50
Weight shifting	4.50	6.00	6.50	7.00	6.50	6.50	5.50	4.50
Equipment pinching	4.50	4.50	4.50	7.00	6.50	7.00	5.50	5.50
Load adjustment	6.00	6.50	6.50	7.00	6.50	7.00	7.00	6.00
Access to stowed items	6.00	6.50	6.50	7.00	5.50	7.00	4.50	6.50
Ability to breathe	6.00	6.50	6.50	7.00	6.50	7.00	5.50	4.50
Overall comfort	5.00	5.50	6.00	6.50	5.50	7.00	4.50	4.00

The Soldiers' comments include:

FFW-FTL - Shoulder and belly panel hold in the heat and don't let air flow.

FFW-AR - Left leg knee pad rubbed

Lower back being rubbed by back belt.

FFW-G – Four-strap heart monitor scratches the collar bone and side.

A few times, the belly armor and the chassis pinched the abdominal area, but it was nothing that was too uncomfortable.

FFW-R - I have no complaints.

The flat heart monitor band scratched the side of my body under my left arm, back, and it rubbed my neck.

BASELINE-AR - The two-strap heart strap stinks because it eats your neck away.

Table 29 shows the mean responses to questions about whether the Soldiers encountered any pain.

Table 29. Mean response to pain levels.

Pain	Mean Response							
	FFW				Baseline			
	FTL	AR	G	R	FTL	AR	G	R
Upper back	6.00	6.50	5.50	7.00	4.00	7.00	4.50	6.00
Lower back	7.00	4.50	4.50	7.00	5.00	6.00	6.50	4.00
Neck	7.00	5.00	6.00	6.50	4.50	5.50	7.00	4.50
Head	7.00	6.50	7.00	7.00	6.00	7.00	7.00	6.00
Torso front	7.00	6.50	4.50	6.50	5.00	5.50	7.00	6.00
Groin	7.00	7.00	7.00	7.00	6.00	7.00	4.50	6.50
Legs	7.00	6.50	6.00	7.00	6.00	7.00	7.00	6.50
Arms	7.00	7.00	6.50	7.00	6.00	7.00	7.00	6.50
Eyes	7.00	7.00	7.00	7.00	6.00	7.00	7.00	6.50

Soldier comments on pain levels include:

FFW-FTL - Pinching between belt and vest.

FFW-AR - Back was rubbed by belt.

Lower leg was rubbed by knee pad.

FFW-G - Back pain is just from wearing the gear and getting used to how the weight is set up.

None of the Soldiers reported problems with their equipment that prevented them from completing their mission or any thing that was unsafe about the equipment.

When asked if they adjusted any of their equipment while en route to the objective, two responded “yes” for the FFW and two responded “yes” for the baseline. Their comments were

FFW-AR - Electronics to the lower back.

FFW-R - Abdomen plate prevented pinching.

Move the belt up, my belt didn’t have any suspenders.

BASELINE-AR - The glasses got too sweaty, I stuck them in my vest.

BASELINE-R - Shifted my IBA around on my shoulders.

The Soldiers had no problems reaching their magazines, but two reported difficulty returning the magazines to the ammunition pouches.

The Soldiers had very few problems donning and doffing the FFW chassis. Most of the problems centered on latching the chassis. Only one Soldier stated he would wear the neck-up armor on any type of mission and that was a defensive only mission. The Soldiers really disliked the neck-up armor after they wore it. All thought the neck-up armor was too uncomfortable and retained heat. There were also several comments about the “stock lock” and the uselessness of it. All but one Soldier disliked the “stock lock” and recommended getting rid of it.

One fire team leader had problems with the wiring running from his chassis to his helmet. Sometime during day 4 activities, the wire connection was broken (figure 28). He had the same problems during the MOUT activities.

Figure 28. Broken connector.

3.3.8 Comparison of FFW and Baseline Equipment, Day 4

The Likert scale means from the questionnaires were categorized with the system shown in table 30. Then the preferences of the FFW ensemble over the baseline are shown (tables 31 through 32).

Table 30. Categorization of the questions.

Preference	Difference
Strong Preference	> .99
Moderate Preference	.25 - .99
No Clear Preference	< .25

Items for which there was a moderate preference for the FFW system (table 31):

Table 31. Items of moderate preference for the FFW ensemble.

Question	Base	FFW	Diff
Access to stowed items	5.88	6.50	-0.63
Ability to breathe	5.88	6.50	-0.63
Move through swampy areas or streams	6.20	6.80	-0.60
Overall comfort	5.25	5.75	-0.50
Use of hand and arm signals	6.38	6.75	-0.38

Items for which there was no strong preference for either system (table 32):

Table 32. Items with no clear preference.

Question	Base	FFW	Diff
Move through thick brush and vines	6.13	6.38	-0.25
Ability to obtain a good sight picture with your weapon	6.38	6.63	-0.25
Torso chafing in front	5.38	5.63	-0.25
Weight shifting	5.75	6.00	-0.25
Ease of assuming prone position	6.25	6.43	-0.18
Ease of torso movement	6.00	6.13	-0.13
Pressure points	6.13	6.25	-0.13
Hot spots	5.75	5.88	-0.13
Ease of head movement	6.50	6.50	0.00
Ease of leg movement	6.50	6.38	0.13
Ease of assuming kneeling position	6.50	6.38	0.13
Target identification	6.75	6.63	0.13
Torso chafing in back	6.38	6.25	0.13
Equipment snagging	6.50	6.38	0.13
Load adjustment	6.63	6.50	0.13
Ease of arm movement	6.25	6.00	0.25
Arm/shoulder chafing	5.75	5.50	0.25

Items for which there was a moderate preference for the baseline system (table 33):

Table 33. Items with moderate preference for baseline.

Question	Base	FFW	Diff
Equipment hindering movement	6.63	6.25	0.38
Conducting IMT	6.67	6.17	0.50
Ability to run	6.63	5.88	0.75
Bruising on your body	6.50	5.75	0.75
Neck/head chafing	6.25	5.50	0.75

Items for which there was a strong preference for the baseline system (table 34):

Table 34. Items with strong preference for baseline.

Question	Base	FFW	Diff
Leg/thigh chafing	6.63	5.63	1.00
Equipment pinching	6.13	5.13	1.00

3.3.9 Likert Scale Questionnaire Statistics, Day 4 Movement to Contact

As in the day 2 results, the FFW equipment was preferred with regard to the ability to breathe, access to stowed items, use of hand and arm signals, and overall comfort. Unlike the day 2 results, the FFW gear was slightly preferred for moving over rough terrain.

The baseline equipment was preferred over the FFW gear on most of the questions concerning movement: the ability to run, conducting IMT, leg/thigh chafing, and equipment pinching and hindering movement.

Table 35 shows the descriptive statistics for the 1-7 Likert scale questions used to evaluate the baseline and FFW ensembles. The results of paired samples t-tests are also included in the table. There was one significant pair-wise comparison: the FFW equipment was rated as significantly more comfortable than the baseline gear in terms of pain to the front of the torso: $t(7) = 2.50$, $p = .041$, $\eta^2_p = 0.47$.

Table 35. Likert scale questionnaire statistics, day 4, movement to contact.

Question	Baseline		FFW		t-tests			
	Mean	SD	Mean	SD	t	df	p	η^2_p
Ease of leg movement	6.50	*1.07*	6.38	*0.92*	0.22	7	0.836	
Ease of assuming prone position	6.25	*1.04*	6.43	*0.79*	-1.00	6	0.356	0.14
Ease of assuming kneeling position	6.50	*0.53*	6.38	*0.74*	0.55	7	0.598	
Ease of arm movement	6.25	*0.71*	6.00	*1.07*	0.80	7	0.451	
Ease of torso movement	6.00	*0.93*	6.13	*1.13*	-0.28	7	0.785	
Ease of head movement	6.50	*0.53*	6.50	*0.76*	0.00	7	1.000	
Ability to run	6.63	*0.74*	5.88	*1.25*	1.53	7	0.170	0.25
Use of hand and arm signals	6.38	*0.74*	6.75	*0.46*	-2.05	7	0.080	0.38
Move through swampy areas or streams	6.20	*1.30*	6.80	*0.45*	-1.00	3	0.391	0.25
Move through thick brush and vines	6.13	*0.83*	6.38	*0.74*	-1.00	7	0.351	0.13
Ability to obtain a good sight picture with your weapon	6.38	*0.74*	6.63	*0.52*	-1.00	7	0.351	0.13
Target identification	6.75	*0.46*	6.63	*0.74*	0.55	7	0.598	
Conducting IMT	6.67	*0.52*	6.17	*1.17*	0.59	4	0.587	
Pressure points	6.13	*1.13*	6.25	*1.16*	-0.20	7	0.850	
Hot spots	5.75	*1.58*	5.88	*1.13*	-0.18	7	0.862	
Bruising on your body	6.50	*0.76*	5.75	*1.16*	1.34	7	0.222	0.21
Torso chafing in front	5.38	*2.07*	5.63	*1.77*	-0.51	7	0.626	
Torso chafing in back	6.38	*0.74*	6.25	*1.04*	0.28	7	0.785	
Arm/shoulder chafing	5.75	*1.16*	5.50	*1.60*	0.68	7	0.516	
Leg/thigh chafing	6.63	*0.52*	5.63	*1.30*	2.00	7	0.086	0.36
Neck/head chafing	6.25	*0.89*	5.50	*1.77*	1.82	7	0.111	0.32
Equipment snagging	6.50	*0.76*	6.38	*0.74*	0.42	7	0.685	
Equipment hindering movement	6.63	*0.52*	6.25	*0.89*	1.43	7	0.197	0.22
Weight shifting	5.75	*1.28*	6.00	*1.07*	-0.33	7	0.749	
Equipment pinching	6.13	*1.36*	5.13	*1.81*	1.28	7	0.240	0.19
Ability to breathe	5.88	*1.55*	6.50	*0.76*	-1.05	7	0.329	0.14
Overall comfort	5.25	*1.28*	5.75	*0.89*	-0.73	7	0.487	
Pain in upper back	5.88	*1.36*	6.25	*0.89*	-0.66	7	0.528	
Pain in lower back	5.50	*1.77*	5.75	*1.58*	-0.25	7	0.812	
Pain in neck	5.38	*1.41*	6.13	*1.46*	-1.21	7	0.265	0.17
Pain in head	6.50	*0.76*	6.88	*0.35*	-1.16	7	0.285	0.16
Pain in torso front	5.25	*1.67*	6.13	*1.73*	-2.50	7	0.041*	0.47
Pain in groin	6.63	*0.74*	7.00	*0.00*	-1.43	7	0.197	0.22
Pain in legs	6.63	*0.74*	6.63	*0.74*	0.00	7	1.000	
Pain in arms	6.63	*0.74*	6.88	*0.35*	-0.80	7	0.451	
Pain in eyes	6.63	*0.74*	7.00	*0.00*	-1.43	7	0.197	0.22

** $p < .05$, 2-tailed*

The pattern of results across the two days of movement-to-contact exercise suggests that there was a learning curve with respect to the Soldiers' mobility in the FFW ensemble (table 36). There was a substantial increase in average Likert scale ratings for the FFW gear from days 2 to 4. This increase occurred for all four duty positions. The increase was most notable on the questions regarding ease of movement of the lower body.

Table 36. Comparison of FFW gear, days 2 and 4.

Question	n	Day 2	Day 4
Ease of leg movement	8	3.75	6.38
Ease of assuming prone position	7	5.57	6.43
Ease of assuming kneeling position	8	4.88	6.38
Ability to run	8	3.88	5.88
Move through thick brush and vines	8	4.63	6.38
Conducting IMT	8	3.50	6.17
Equipment hindering movement	8	4.38	6.25
Overall comfort	8	4.75	5.75
Mean		**4.42**	**6.20**

There was also an increase in Likert ratings for lower body movement for the baseline gear but not as large as the increase for FFW gear (table 37):

Table 37. Comparison of baseline gear, days 2 and 4.

Question	n	Day 2	Day 4
Ease of leg movement	8	6.13	6.50
Ease of assuming prone position	8	5.88	6.25
Ease of assuming kneeling position	8	6.13	6.50
Ability to run	8	5.63	6.63
Move through thick brush & vines	8	5.29	6.13
Conducting IMT	6	5.00	6.67
Equipment hindering movement	8	5.75	6.63
Overall comfort	8	4.25	5.25
Mean		**5.50**	**6.32**

Figure 29 shows the comparison of days 2 and 4 for the Soldiers' responses to FFW and their ability to move.

Figure 30 shows the comparison of days 2 and 4 for the Soldiers' responses to baseline and their ability to move.

There was an improvement over the Soldiers' reported ability to move using both the FFW ensemble and their baseline fighting loads. However, there was a noticeable difference in improvement with the FFW ensemble day 4 over day 2. This is a strong indication that the Soldiers were becoming more comfortable with the FFW ensemble on the third day of wear. To better evaluate this, an extended operational experiment involving multiple day wear and greater distances of movement will be required.

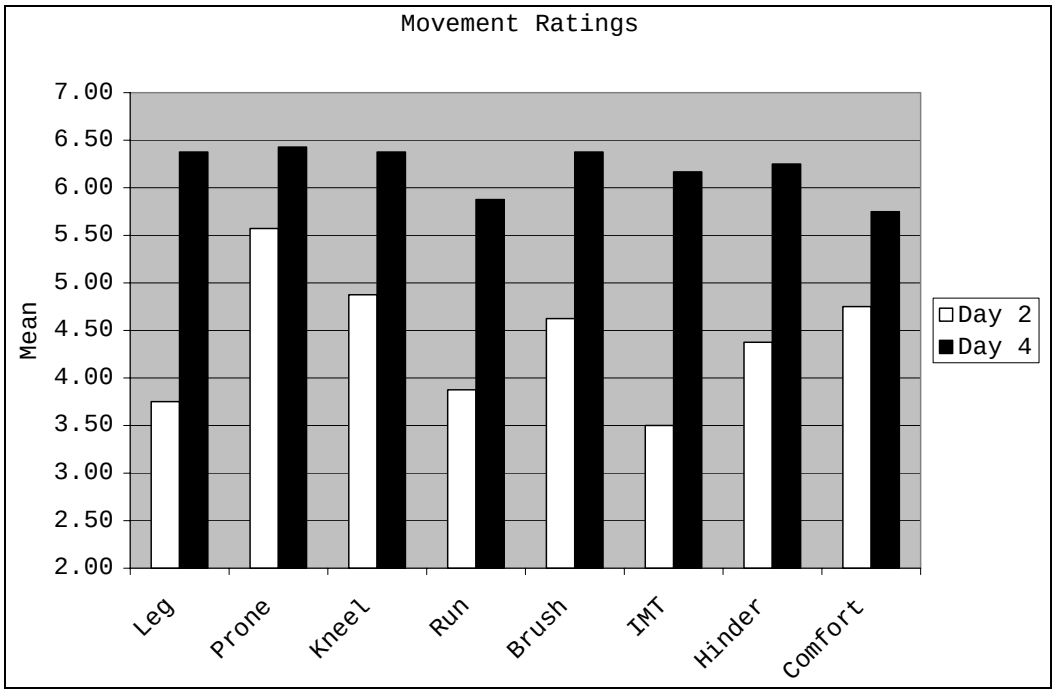


Figure 29. Soldiers' ratings of FFW and effects of movement.

Baseline Gear:

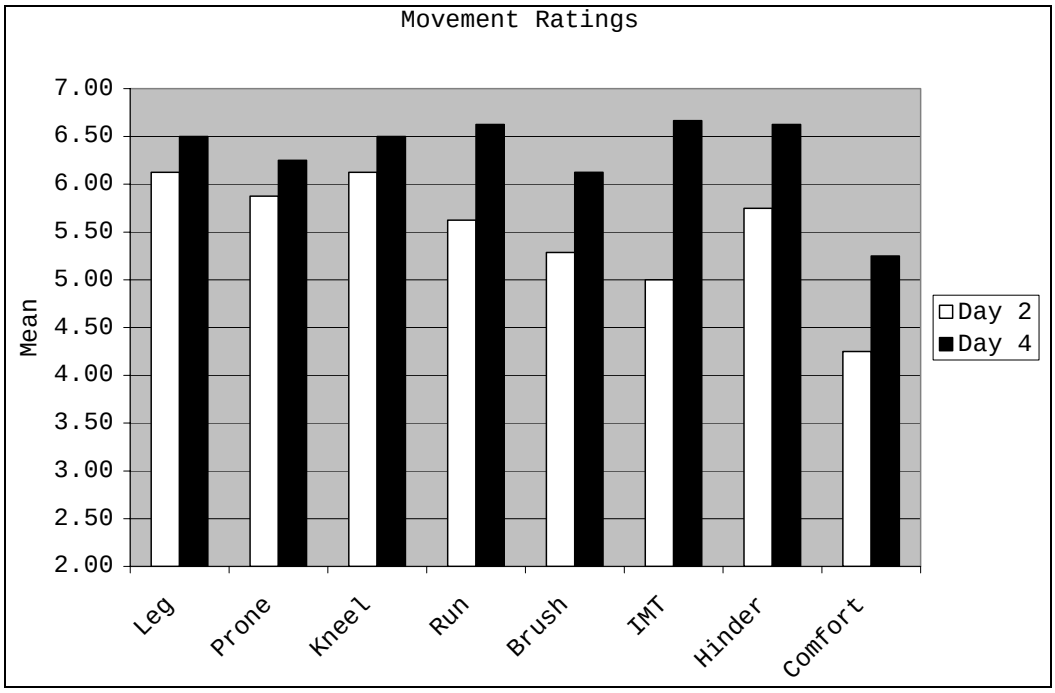


Figure 30. Soldiers' ratings of baseline and effects of movement.

3.4 MOUT Operations, Day 3

3.4.1 MOUT Operations, Room Clearing, Day 3

When the Soldiers arrived at Eiler Hall, they were shown the area and the rooms and loft they would be clearing for this event. They were then given a FRAGO and an order of operation matrix (table 4). The Soldiers were instructed what to wear on the three different configurations (baseline, FFW with belt, and FFW up armor), and the equipment worn in the morning by the Fire Team B was the same as the equipment worn by the Fire Team A in the afternoon. Figures 31 through 34 show the fire team configurations by position and configurations.

Figure 31. Team leaders and grenadiers (baseline and FFW).

Figure 32. Riflemen and SAW gunners (baseline and FFW).

Figure 33. Team leader and grenadier ("up" armor).

Figure 34. Rifleman and SAW gunner ("up" armor).

3.4.2 Specific Results, Day 3

The complete results of the Soldier questionnaires are shown in appendix D. Table 38 shows the descriptive responses to the questions of the Soldiers' abilities to complete specific tasks expressed in a mean for the three configurations worn. The Soldiers reported difficulty in completing the tasks of running, movement through mouse holes, and movement through one of three breach holes with both the FFW configurations (figure 35).

Table 38. Soldiers' mean response to task completion.

Tasks	Mean Response		
	FFW with Belt	FFW with Up Armor	Baseline
Ease of leg movement	5.12	5.00	5.88
Ease of assuming prone position	5.33	4.00	6.25
Ease of assuming kneeling position	5.80	5.00	6.33
Ease of arm movement	5.50	5.13	6.00
Ease of torso movement	5.75	5.38	5.50
Ease of head movement	5.75	3.13	5.75
Ability to run	4.75	4.29	6.13
Use of hand and arm signals	6.33	5.17	6.00
Move through doorways	5.75	5.38	5.75
Move through mouse holes	4.50	4.00	5.43
Ability to conduct reflexive shooting	5.63	5.50	6.00
Ability to engage enemy	5.88	5.50	6.25
Conducting IMT	6.00	5.25	6.25
Move through windows	4.00	3.25	6.00
Ability to ascend and descend stairs	6.00	4.50	6.67
Assume the standing/ready or "stacked position"	6.00	5.88	6.13
Ability to crouch (bend and maintain reduced exposure position)	5.71	5.25	5.63

Figure 35. Soldier entering building.

They rated the FFW with up armor slightly worse. They also reported a worse than average ability to move their heads with the FFW with up armor (figure 36).

Figure 36. Neck-up armor, head movement.

Soldier comments on their ability to complete tasks include:

A-FFW WITH BELT

- Can't run well with the drop armor on the legs.
- Pants are ridiculously hot; I would rather fight naked but could be good for fall and winter.
- Knee pads bothering me today, some chafing in the calves.
- Leg panels restrict speed.
- Legs being restricted when running.

B-FFW WITH UP-ARMOR KIT

- "Dog collar" does not allow me to look up. Blocks ventilation and traps heat in more.
- My situational awareness was decreased because of the addition of the neck collar. It gave me an enclosed feeling.
- Neck brace prevents me from moving my neck.

- The neck guard takes away from the mobility of the head, but it would be good for a 50 cal. gunner. I didn't like the shoulder or gut plate.
- Up armor for turrets only.

C-BASELINE

- Heart monitor too bulky for the IBA.
- My heart monitor opened my IBA up.
- The IBA is pretty constraining to mobility.

Table 39 shows the mean responses from the Soldier questionnaires about problems they may have encountered. Most responses revealed very few problem areas. However, the Soldiers reported difficulty with the equipment hindering movement, ability to breathe, and overall comfort with the FFW up-armor configuration. They also reported that the baseline caused chafing in back, interfered with their ability to breathe, and armor prevented flexing.

Table 39. Mean responses to problem areas encountered.

Tasks	Mean Response		
	FFW with Belt	FFW with Up Armor	Baseline
Pressure points	6.25	6.25	6.00
Hot spots	5.63	5.50	5.86
Bruising on your body	5.88	5.50	5.43
Torso chafing in front	5.88	5.75	4.50
Torso chafing in back	6.00	5.63	5.29
Arm/shoulder chafing	5.88	4.88	5.71
Leg/thigh chafing	5.63	5.63	5.83
Neck/head chafing	6.38	5.37	5.71
Equipment snagging	6.50	5.00	5.71
Equipment hindering movement	5.63	3.88	6.29
Weight shifting	6.13	6.25	5.29
Equipment pinching	5.38	5.63	5.14
Load adjustment	5.75	6.00	5.71
Access to stowed items	5.88	6.00	5.86
Ability to breathe	5.75	4.88	4.33
Overall comfort	5.25	4.13	4.57
Armor preventing flexing	6.00	5.38	4.86

Soldier comments include:

A-FFW WITH BELT

- Bottom of shin guard rubbed my shin and it's starting to become sensitive.
- I had a little rubbing of my neck and thighs and a slight discomfort from the straps.

- Fix the pants, way too hot, but the ventilation in the chassis is the one really good thing you have going.
- Shoulder straps rubbing collar bone.
- Vest makes it hard to breathe because it is tight around the upper body.

B-FFW WITH UP ARMOR KIT

- Dog collar restricts head movement with leader helmet.
- I do not like the neck piece.
- The neck "up armor" was just too constraining to movement.
- Torso chafing once again with Hidalgo heart monitor.
- Movement is slightly restricted by leg panels.

C-BASELINE

- Heart monitor was pressed against skin by IBA.
- Medic strap pushed in my chest with the IBA on it. Also hurts me on breathing.
- The heart monitor was definitely pressing down on my chest under the IBA.
- The IBA tends to shift from shoulder to shoulder.

When asked if any of the equipment hindered their ability to complete the mission, four Soldiers wearing the FFW up armor stated "yes" (figure 37), and two with the FFW with belt stated "yes". All wearing the baseline responded "no". Their comments include:

A-FFW WITH BELT

- My drop armor slowed my run big time.
- The stack was way too big moving on the building while running.
- I couldn't run as fast as normal because of the drop leg.

B-FFW WITH UP ARMOR KIT

- Dog collar stops head movement and neck movement.
- Neck "up armor" just took away from situational awareness.

Figure 37. Fire team, wall stack.

Several Soldiers reported that the addition of a drop bag to place empty magazines contributed to their being able to complete the mission (figure 38). The Soldiers liked the idea of a drop bag, especially with the tight openings on the magazine pouches. Many have adopted a makeshift drop bag for use with their baseline equipment on a daily basis.

Figure 38. Drop bag.

One Soldier believed that the restriction that the FFW with belt placed on him was unsafe as he "could not run; could not hide". Another Soldier believed that the FFW with up-armor was unsafe because the neck-up armor restricted his ability to acquire targets.

When asked if there were any items on the FFW chassis that they would move if able, more than half the Soldiers stated they would move some of the equipment. These included

A-FFW WITH BELT

- All electronics to the back except the little display screen.
- For guys with bigger upper bodies, I would widen the shoulder part of the chassis.
- Medical computer.
- The batteries.

B-FFW WITH UP-ARMOR KIT

- Batteries.
- Medical monitor.

The Soldiers disliked the neck-up armor kit (figure 39) and stated that the only mission during which they would consider wearing it was in a defensive position or on convoy operations. Wearing the neck "up armor" was especially recommended for the gunner, who is more exposed than the rest of the vehicle crew. Several of the Soldiers commented verbally that the neck-up armor held heat in and deflected the heat from their exhaled breath down into their body, causing even more heat buildup.

Figure 39. Neck-up armor.

All Soldiers reported no difficulty accessing their first aid kit. Two Soldiers reported difficulty donning and doffing the FFW with up armor. These complaints came from the difficulty in donning and doffing the neck-up armor. They also reported difficulty with the chassis latching system but less on day 3 than day 2. Several reported they asked the IPTs to file the latching systems to allow easier latching.

Most of the Soldiers liked the shoulder- and abdomen-up armor and stated they would wear them in most missions. However, there was a strong dislike of the neck-up armor, and only three of the nine Soldiers would wear the neck-up armor and then only in defensive missions. They also reported much difficulty with donning the neck armor. The neck collar needs some design modifications before it will be accepted by the Soldiers.

When asked what they would change if they could, the Soldiers responded with

A-FFW WITH BELT

- I would put the interior pads in the IBA to create ventilation and ditch the rest, especially the pants which get more and more uncomfortable by the day.
- I like the air flow.

B-FFW WITH UP ARMOR KIT

- I like the shoulder and gut plates.
- Lose the dog collar.
- Stack all the electronic equipment in the back; that way, you have more room to stow other equipment.
- Shoulder and lower abdomen "up armor" are good; the neck is not good for dismounted Soldiers.

3.4.3 Likert Scale Questionnaire Statistics: Room Clearing

Table 40 shows the means and standard deviations for the room clearing questions. Repeated measures analyses of variance (ANOVAs) on the questionnaire data are summarized in table 41. There were three statistically significant ANOVAs. There was a significant difference among means for ease of leg movement ($F(2,12) = 3.96$, $p = .048$, $\eta^2_p = .40$.) An ensuing comparison using Dunnett's test indicates a significant difference between the baseline and the two FFW conditions; for both comparisons, $t(6) = 2.43$, $p < .05$, one-tailed. The baseline gear was preferred over the two FFW ensembles in terms of ease of leg movement. For ease of arm movement, $F(2,12) = 4.61$, $p = .033$, $\eta^2_p = .43$. The Dunnett's ensuing comparisons show that the baseline gear was rated significantly higher than the FFW up-armor kit: $t(6) = 3.02$, $p < .05$, two-tailed. The difference in ratings between the FFW with belt and the baseline configurations was not statistically significant. For the question about head movement, there was a significant

ANOVA: $F(2,12) = 16.4$, $p < .001$, $\eta^2_p = .73$. Dunnett's ensuing comparisons show that the up-armor kit had a significantly lower rating than the baseline configuration: $t(6) = 5.21$, $p < .01$, two-tailed. In summary, the FFW up-armor kit was rated significantly lower than the baseline gear for leg, arm, and head movement.

Table 40. Summary statistics questionnaire data, room clearing.

Question	Baseline		FFW w/Belt		FFW Up Armor	
	Mean	***SD***	**Mean**	***SD***	**Mean**	***SD***
Ease of leg movement	5.88	*1.13*	5.13	*1.46*	5.00	*1.20*
Ease of assuming prone position	6.25	*0.96*	5.33	*1.15*	4.00	*1.41*
Ease of assuming kneeling position	6.33	*0.82*	5.80	*1.10*	5.00	*1.58*
Ease of arm movement	6.00	*1.20*	5.50	*0.93*	5.13	*1.36*
Ease of torso movement	5.50	*1.51*	5.75	*0.71*	5.38	*1.06*
Ease of head movement	5.75	*1.28*	5.75	*0.71*	3.13	*1.25*
Ability to run	6.13	*1.36*	4.75	*2.25*	4.29	*1.60*
Use of hand and arm signals	6.00	*1.15*	6.33	*0.52*	5.17	*0.98*
Move through doorways	5.75	*1.28*	5.75	*1.16*	5.38	*0.92*
Move through mouse holes	5.43	*1.51*	4.50	*1.64*	4.00	*1.58*
Ability to conduct reflexive shooting	6.00	*1.20*	5.63	*1.06*	5.50	*1.07*
Ability to engage enemy	6.25	*0.89*	5.88	*0.83*	5.50	*1.41*
Conducting IMT	6.25	*0.96*	6.00	*0.00*	5.25	*0.96*
Move through windows	6.00	*1.41*	4.00	*2.31*	3.25	*2.06*
Ability to ascend and descend stairs	6.67	*0.58*	6.00	*0.00*	4.50	*1.29*
Assume the standing/ready or "stacked position"	6.13	*1.13*	6.00	*0.76*	5.88	*0.99*
Ability to crouch (bend and maintain reduced exposure position	5.63	*1.30*	5.71	*0.95*	5.25	*1.28*
Pressure points	6.00	*1.15*	6.25	*1.04*	6.25	*1.16*
Hot spots	5.86	*1.35*	5.63	*1.19*	5.50	*1.51*
Bruising on your body	5.43	*1.40*	5.88	*1.25*	5.50	*1.85*
Torso chafing in front	4.50	*2.26*	5.88	*1.36*	5.75	*1.16*
Torso chafing in back	5.29	*2.36*	6.00	*1.41*	5.63	*1.30*
Arm/shoulder chafing	5.71	*0.95*	5.88	*1.36*	4.88	*1.89*
Leg/thigh chafing	5.83	*0.98*	5.63	*1.30*	5.63	*1.06*
Neck/head chafing	5.71	*1.25*	6.38	*0.52*	5.38	*1.60*
Equipment snagging	5.71	*0.95*	6.50	*0.76*	5.00	*2.33*
Equipment hindering movement	6.29	*0.76*	5.63	*1.85*	3.88	*1.73*
Weight shifting	5.29	*1.60*	6.13	*1.13*	6.25	*1.04*
Equipment pinching	5.14	*1.57*	5.38	*1.77*	5.63	*1.77*
Load adjustment	5.71	*1.11*	5.75	*1.28*	6.00	*1.20*
Access to stowed items	5.86	*0.69*	5.88	*1.13*	6.00	*0.93*
Ability to breathe	4.33	*1.86*	5.75	*1.75*	4.88	*1.89*
Overall comfort	4.57	*0.79*	5.25	*1.04*	4.13	*1.25*
Armor preventing flexing	4.86	*1.57*	6.00	*1.07*	5.38	*1.41*

Table 41. Repeated measures ANOVAs, room clearing questionnaires.

Question	F	df	p	η^2_p
Ease of leg movement	3.96	2,12	0.048*	0.40
Ease of assuming prone position	*x*	*x*	*x*	*x*
Ease of assuming kneeling position	< 1.00	2,4	0.605	0.22
Ease of arm movement	4.61	2,12	0.033*	0.43
Ease of torso movement	1.28	2,12	0.313	0.18
Ease of head movement	16.4	2,12	< .001*	0.73
Ability to run	2.1	2,10	0.173	0.3
Use of hand and arm signals	3.18	2,8	0.096	0.44
Move through doorways	1.03	2,12	0.382	0.15
Move through mouse holes	1.04	2,4	0.432	0.34
Ability to conduct reflexive shooting	2.92	2,12	0.092	0.33
Ability to engage enemy	2.4	2,12	0.133	0.29
Conducting IMT	*x*	*x*	*x*	*x*
Move through windows	*x*	*x*	*x*	*x*
Ability to ascend and descend stairs	*x*	*x*	*x*	*x*
Assume the standing/ready or "stacked position"	1.97	2,12	0.183	0.25
Ability to crouch (bend and maintain reduced exposure position	< 1.00	2,10	0.416	0.16
Pressure points	< 1.00	2,10	0.538	0.12
Hot spots	< 1.00	2,10	0.974	< .01
Bruising on your body	< 1.00	2,10	0.513	0.12
Torso chafing in front	2.63	2,8	0.133	0.4
Torso chafing in back	1.19	2,10	0.345	0.19
Arm/shoulder chafing	3.64	2,10	0.065	0.42
Leg/thigh chafing	1	2,10	0.402	0.17
Neck/head chafing	1.39	2,10	0.294	0.22
Equipment snagging	3.61	2,10	0.066	0.42
Equipment hindering movement	2.69	2,10	0.116	0.35
Weight shifting	< 1.00	2,10	0.613	0.09
Equipment pinching	< 1.00	2,10	0.79	0.05
Load adjustment	< 1.00	2,10	0.917	0.02
Access to stowed items	< 1.00	2,10	0.819	0.04
Ability to breathe	1.7	2,8	0.243	0.3
Overall comfort	2.22	2,10	0.159	0.31
Armor preventing flexing	1.23	2,10	0.332	20

p < .05
x = insufficient data

3.4.4 FFW Helmet Assembly

During the MOUT activities, the Soldiers had little or no pain while wearing the two FFW helmets. One Soldier had difficulty adjusting the helmet to his head and another had some difficulty and pain with the ear plugs. There were some complaints of heat buildup and perspiration problems but not as much as the day before. There was an indication that the Soldiers were becoming accustomed to the helmets (see appendix D). One Soldier stated that he liked the FFW helmet more than his current ACH.

3.4.5 Room Excursion

When the Soldiers were allowed to configure the FFW systems to their own liking, few problems were encountered (table 42). They rated their ability to complete tasks as very to extremely easy (appendix D). Their comments included

- Everything was extremely comfortable, allowing for smooth mission execution.

- I got rid of the leg panels and positioned everything on the chassis; I moved more freely and a lot faster and smoother.
- Movement was great for all in team.
- Moving the battery to the back right of vest was great. I wouldn't change it.
- Got rid of the leg panels and positioned all rounds on front of chassis.
- The way we were allowed to configure helped 100%.

Table 42. FFW configuration for room excursion.

Grenadier B	No. 7 Did not wear neck protection or leg panels Why: Neck protection is hot and covers mouth when in a crouching position. Hampers breathing and interferes with air flow (hot). Leg panels slow my movement. Would only wear if there was no place else to store equipment. How Configured: Move 40-mm rounds to the sides and front of vest. Move magazines to middle front of vest. Move PDA panel to chest protector.	Grenadier A	No. 3 Did not wear neck protection and leg panels. Why: Neck protection restricts my head movement too much. Leg panels are neat to carry ammunition, but they restrict my movement too much, especially while running. How Configured: Move 40-mm rounds to side and front of vest and some on belt. Put three magazines in front on vest.
SAW B	No. 8 No up armor at all Why: Interfered with head movement and too hot How Configured: Chassis with belt and suspenders. SAW ammunition pouches on belt First Aid Move electronics to back, Smoke and frags on front of vest. Open all zippers for ventilation.	SAW A	No. 4 No neck protection Why: Too hot, restricts movement. How configured: Chassis Up armor shoulder pad Up armor leg panels – drum pouches on each First aid kit on left leg panel. Move electronics from under arm to back. Would add more drums to belt for more ammunition. Smoke on vest.
Rifleman	No. 9 No up armor. Why: Too hot, restricts movement. How Configured: Remove left leg panel. Remove ballistic belt. Move CLS bag to upper rear. Keep right leg panel.	Rifleman	No. 5 No Neck protection. Why: Too hot. How Configured: Liked everything except the neck collar. Did not move any pouches. Wanted suspenders for the ballistic belt.
BTL	No. 6 Did not like the location of the battery; it irritated his bicep and his movement. He would move it to the back of the chassis or reshape the batteries so they would not be as bulky. Would wear all up armor in MOUT except the neck armor. Would never wear neck armor, restricts head movement, retains heat, breath comes back into face and fogs goggles. For one room clearing known situation would wear chassis only, trade speed, flexibility and coolness for protection.	ATL	No. 2 In urban environment would use chassis only because belt was so uncomfortable and he never used his leg panels to carry equipment or ammunition. Leader's radio (left side) interferes with movement. Wanted more ammunition. Move radio to right front of chassis. Add more ammunition on front of chassis. Move IFAK to right rear of chassis.

3.4.6 MOUT Operations, Loft Clearing, Day 3

The loft clearing was conducted concurrently with the room clearing operations as shown in table 4. The task required the fire team to move as quickly as possible up a makeshift ladder and through a small opening to gain access to a loft area (figure 40).

Figure 40. Fire team clearing loft.

The times to accomplish this task are shown in table 43. When fire teams A and B were wearing the FFW up armor, it took fire team A 24 seconds longer to complete the task than fire team B, and it took fire team A 7 seconds longer with the FFW and belt.

Table 43. Times to enter and exit the loft.

Iteration	Fire Team	Mission	Configuration	Loft Time In	Loft Time out
3	A	Loft	Up Armor	1:24:72	1:36:50
4	B	Loft	FFW with belt	1:07:24	1:35:50
7	A	Loft	FFW with belt	1:14:21	1:52:69
8	B	Loft	Up Armor	1:00:06	1:42:56
11	A	Loft	Base	1:07:78	1:42:56
12	B	Loft	Base	1:08:93	1:15:84

When the teams completed the tasks, they completed the questionnaires. Their mean responses when asked about their ability to complete standard tasks are shown in table 44. The responses are very similar to the problems encountered with the room-clearing operations. The Soldiers had difficulty with moving through small holes and seeing with the up-armor option. It is surprising that their difficulty with movement through small holes was more pronounced in the FFW with belt option than with the FFW with up-armor option.

Table 44. Soldiers' mean responses to ability to complete tasks.

Tasks	Mean Response		
	FFW with Belt	FFW with Up-Armor Kit	Baseline
Ease of leg movement	4.88	5.50	6.13
Ease of assuming prone position	5.50	4.75	6.33
Ease of assuming kneeling position	5.71	6.00	6.17
Ease of arm movement	5.63	5.63	6.13
Ease of torso movement	5.88	6.00	5.63
Ease of head movement	6.13	4.13	6.13
Ability to run	5.12	4.63	6.00
Use of hand and arm signals	6.17	5.67	5.86
Move through doorways	5.71	5.75	5.88
Move through mouse holes	2.88	3.63	4.50
Ability to conduct reflexive shooting	5.14	6.25	5.88
Ability to engage enemy	5.29	5.17	6.29
Conducting IMT	6.00	5.75	5.83
Move through windows	4.00	3.50	5.75
Ability to ascend and descend stairs	4.29	4.38	5.71
Assume the standing/ready or "stacked position"	6.25	6.13	6.13
Ability to crouch (bend and maintain reduced exposure position)	5.00	5.13	5.75

The Soldiers' comments on ability to complete tasks include

FFW WITH BELT

- Going through narrow doorways is hard because side of chassis a little bulky.
- Leg straps came undone somewhere along the mission.
- Got snagged up in the window.
- In the mouse hole of the loft, had problems getting through. Battery kept getting stuck on way out and on way in, sides of chassis got stuck.
- When I went through the mouse hole, the CLS bag caught.
- The weight makes it harder to maintain a crouched position for an extended period of time.

FFW WITH UP-ARMOR KIT

- Neck guard stopped head movement (two Soldiers made the same comment).

BASELINE

- Going into the loft with the RFI (rapid fielding initiative) on was no problem; nothing got snagged like the FFW gear.
- The gear is in front so movement through small spaces is a lot easier.

Table 45 shows the mean responses the Soldiers had for problem areas they might have encountered. They had similar responses for the room-clearing activity. The Soldiers continued to have problems with equipment hindering movement and weight shifting with the FFW ensembles.

Table 45. Soldiers' mean responses to problem areas encountered.

Problem Areas	Mean Response		
	FFW with Belt	FFW with Up Armor Kit	Baseline
Pressure points	5.00	5.88	6.29
Hot spots	5.75	6.13	6.29
Bruising on your body	6.25	5.25	5.71
Torso chafing in front	5.71	5.75	5.29
Torso chafing in back	5.75	5.75	6.00
Arm/shoulder chafing	6.00	4.88	5.57
Leg/thigh chafing	4.88	5.37	6.29
Neck/head chafing	5.38	4.75	5.29
Equipment snagging	5.63	4.25	5.29
Equipment hindering movement	3.75	4.00	4.86
Weight shifting	3.88	6.00	5.57
Equipment pinching	6.25	5.38	6.00
Load adjustment	5.25	6.13	6.00
Access to stowed items	6.25	6.00	6.33
Ability to breathe	6.25	5.00	4.00
Overall comfort	6.13	5.00	5.00
Armor preventing flexing	4.75	5.75	5.14

Soldiers' comments on the problem areas encountered include:

FFW WITH BELT

- Cannot breathe in well.
- Chafing is due to Hidalgo heart monitor.
- Equipment just snagged on mouse hole to loft.
- Shoulder straps starting to be irritating to shoulders.
- Equipment snagging in little cubby doorways.

FFW WITH UP-ARMOR KIT

- Chafing is from Hidalgo heart monitor.
- Leg panels snagged through the loft.

- Medical computer needs to be moved.
- Neck "up armor" got in the way.
- We got caught going through the mouse hole because of our size.

BASELINE

- Heart monitor stinks when I'm wearing IBA. Too much rubbing
- Medic belt pushes in on chest.
- Hard to get through hole with IBA.

Six of the Soldiers had difficulty in completing their mission while wearing the FFW ensembles. Their comments include

FFW WITH BELT

- Going through the loft entry, I got stuck in the hole.
- Leg restriction.
- Vest too wide for small openings.

FFW WITH UP ARMOR KIT

- Dog collar.
- Neck guard and CLS bag snagged going through the hole.
- Neck guard gives limited range of head neck movement.

BASELINE

- My butt pack snagged when I climbed the stairs to get through the mouse hole.

A complete list of Soldier comments and SME comments is presented in appendix D.

3.4.7 Likert Scale Questionnaire Statistics: Loft Clearing

Table 46 shows the means and standard deviations for each of the 1-7 Likert scale questions administered after each of the three treatment conditions in the loft-clearing exercise. A repeated measures ANOVA was conducted for each question (table 47). There was a statistically significant F-value for four of the questions. For ease of head movement, $F(2,14) = 6.58$, $p = .010$, $\eta^2_p = .48$. Ensuing pair-wise comparisons indicate that the FFW up-armor kit received a significantly lower mean rating than either the baseline gear or the FFW with belt ensemble (table 48). For the question about moving through mouse holes, $F(2,14) = 7.35$, $p = .007$, $\eta^2_p = .51$. Ensuing comparisons (table 49) indicate that the FFW with belt kit was rated significantly lower than the baseline gear. There was also a significant ANOVA for ability to conduct reflexive shooting:

$F(2,14) = 4.67$, $p = .032$, $\eta^2_p = .44$. As shown in table 50, no significant pair-wise differences emerged from the ensuing comparisons. The non-significant trend was that the FFW with up-armor kit received the highest mean rating, while the FFW with belt received the lowest mean rating. Finally, there was a statistically significant ANOVA for the question about ability to breathe (table 51): $F(2,14) = 4.69$, $p = .031$, $\eta^2_p = .44$. The ensuing comparisons yielded no significant pair-wise differences, although there was a trend for baseline to have the lowest rating and FFW with belt to have the highest rating.

Table 46. Summary statistics questionnaire data, loft clearing.

Question	Baseline		FFW with Belt		FFW Up Armor	
	Mean	***SD***	**Mean**	***SD***	**Mean**	***SD***
Ease of leg movement	6.13	*1.13*	4.88	*1.36*	5.50	*1.51*
Ease of assuming prone position	6.33	*0.58*	5.50	*1.00*	4.75	*2.06*
Ease of assuming kneeling position	6.17	*1.17*	5.71	*0.95*	6.00	*1.55*
Ease of arm movement	6.13	*0.83*	5.63	*1.19*	5.63	*1.30*
Ease of torso movement	5.63	*1.30*	5.88	*0.83*	6.00	*1.07*
Ease of head movement	6.13	*1.13*	6.13	*0.83*	4.13	*1.89*
Ability to run	6.00	*1.15*	5.13	*1.73*	4.63	*1.51*
Use of hand and arm signals	5.86	*1.21*	6.17	*0.75*	5.67	*1.21*
Move through doorways	5.88	*1.36*	5.71	*1.25*	5.75	*1.39*
Move through mouse holes	4.50	*1.31*	2.88	*0.99*	3.63	*1.41*
Ability to conduct reflexive shooting	5.88	*1.13*	5.14	*0.90*	6.25	*0.89*
Ability to engage enemy	6.29	*0.76*	5.29	*0.95*	5.17	*1.33*
Conducting IMT	5.83	*1.17*	6.00	*0.00*	5.75	*0.50*
Move through windows	5.75	*1.50*	4.00	*1.41*	3.50	*2.38*
Ability to ascend and descend stairs	5.71	*1.50*	4.29	*1.70*	4.38	*1.77*
Assume the standing/ready or "stacked position"	6.13	*1.13*	6.25	*0.89*	6.13	*0.99*
Ability to crouch (bend and maintain reduced exposure position)	5.75	*1.49*	5.00	*1.20*	5.13	*1.36*
Pressure points	6.29	*1.11*	5.75	*1.28*	5.88	*1.36*
Hot spots	6.29	*1.11*	6.25	*0.89*	6.13	*0.99*
Bruising on your body	5.71	*1.11*	5.71	*1.60*	5.25	*1.49*
Torso chafing in front	5.29	*1.60*	5.75	*1.58*	5.75	*1.28*
Torso chafing in back	6.00	*0.58*	6.00	*1.41*	5.75	*1.28*
Arm/shoulder chafing	5.57	*0.98*	4.88	*1.25*	4.88	*1.36*
Leg/thigh chafing	6.29	*0.76*	5.38	*1.41*	5.38	*1.30*
Neck/head chafing	5.29	*1.11*	5.63	*1.30*	4.75	*1.58*
Equipment snagging	5.29	*1.11*	3.75	*2.05*	4.25	*1.58*
Equipment hindering movement	4.86	*0.90*	3.88	*1.64*	4.00	*1.51*
Weight shifting	5.57	*1.27*	6.25	*0.71*	6.00	*1.20*
Equipment pinching	6.00	*0.58*	5.25	*1.98*	5.38	*1.60*
Load adjustment	6.00	*0.82*	6.25	*0.71*	6.13	*0.83*
Access to stowed items	6.33	*0.82*	6.25	*1.04*	6.00	*0.93*
Ability to breathe	4.00	*1.29*	6.13	*1.13*	5.00	*1.77*
Overall comfort	5.00	*0.82*	4.75	*0.71*	5.00	*0.93*
Armor preventing flexing	5.14	*1.07*	6.13	*0.83*	5.75	*1.58*

Table 47. Repeated measures ANOVAs, loft clearing questionnaires.

Question	F	df	p	η^2_p
Ease of leg movement	1.84	2,14	0.195	0.21
Ease of assuming prone position	< 1.00	2,14	0.621	0.21
Ease of assuming kneeling position	1	2,14	0.402	0.17
Ease of arm movement	< 1.00	2,14	0.513	0.09
Ease of torso movement	< 1.00	2,14	0.742	0.04
Ease of head movement	6.58	2,14	0.010*	0.48
Ability to run	1.09	2,14	0.366	0.15
Use of hand and arm signals	< 1.00	2,14	0.542	0.12
Move through doorways	< 1.00	2,14	0.69	0.6
Move through mouse holes	7.35	2,14	0.007*	0.51
Ability to conduct reflexive shooting	4.67	2,14	0.032*	0.44
Ability to engage enemy	1.75	2,14	0.223	0.26
Conducting IMT	< 1.00	2,14	0.79	0.11
Move through windows	3	2,14	0.16	0.6
Ability to ascend and descend stairs	< 1.00	2,14	0.44	0.15
Assume the standing/ready or "stacked position"	< 1.00	2,14	0.952	< .01
Ability to crouch (bend and maintain reduced exposure position)	< 1.00	2,14	0.417	0.12
Pressure points	< 1.00	2,14	0.443	0.13
Hot spots	< 1.00	2,14	0.99	< .01
Bruising on your body	< 1.00	2,14	0.658	0.08
Torso chafing in front	< 1.00	2,14	0.465	0.12
Torso chafing in back	1.35	2,14	0.296	0.18
Arm/shoulder chafing	1.61	2,14	0.24	0.21
Leg/thigh chafing	2.34	2,14	0.138	0.28
Neck/head chafing	2.4	2,14	0.133	0.29
Equipment snagging	1.62	2,14	0.235	0.21
Equipment hindering movement	1.69	2,14	0.226	0.22
Weight shifting	1	2,14	0.397	0.19
Equipment pinching	1.41	2,14	0.281	0.19
Load adjustment	< 1.00	2,14	0.641	0.07
Access to stowed items	< 1.00	2,14	0.647	0.08
Ability to breathe	4.69	2,14	0.031*	0.44
Overall comfort	< 1.00	2,14	0.84	0.03

$p < .05$

Table 48. Ensuing comparisons, "ease of head movement," loft clearing.

Comparison	df	t	required p	obtained p
Base versus Belt	7	0	0.0500	0.99
Base versus Up Armor	7	3.53	0.0167	0.010*
Belt versus Up Armor	7	2.83	0.025	0.025*

$p < .05$, 2-tailed

Table 49. Ensuing comparisons, "moving through mouse holes," loft clearing.

Comparison	df	t	required p	obtained p
Base versus Belt	7	3.26	0.0167	0.014*
Base versus Up Armor	7	2.20	0.025	0.064
Belt versus Up Armor	7	2.05	0.05	0.08

$p < .05$, 2-tailed

Table 50. Ensuing comparisons, "ability to conduct reflexive shooting," loft clearing.

Comparison	df	t	required p	obtained p
Base versus Belt	7	2.29	0.0167	0.062
Base versus Up Armor	7	0.89	0.05	0.402
Belt versus Up Armor	7	2.29	0.025	0.062

Table 51. Ensuing comparisons, "ability to breathe," loft clearing.

Comparison	df	t	required p	obtained p
Base versus Belt	6	3.04	0.0167	0.023
Base versus Up Armor	6	0.83	0.05	0.441
Belt versus Up Armor	7	2.05	0.025	0.08

3.5 IMT and CB Event

3.5.1 IMT and CB Activities

The Soldiers were shown how to negotiate each obstacle on the IMT course and were fitted for the CB equipment. Only four of the Soldiers were able to fit into the CB garments, two into the medium and two into the large CB garments. Figures 41 and 42 show the differences in the medium and large CB garments. The medium CB garment had a hip inlet for the PAVS. The large CB garment had an abdomen inlet for the PAVS.

Figure 41. PAVS, medium (hip inlet), belt and leg mounts.

Figure 42. PAVS, large (abdomen inlet), belt and leg mounts.

There were two configurations for mounting the PAVS and the PAPR. Figure 43 shows the PAVS and the PAPR mounted on the belt, and figure 44 shows the PAVS and PAPR mounted on the leg.

Figure 43. PAVS and PAPR belt mount.

Figure 44. PAVS and PAPR leg mount.

3.5.2 Specific Results, Day 5

The complete results of Soldiers' comments and SME observations are shown in appendix G. The sample size was small for this event and was made even smaller than originally planned because of the temperature rising above safe levels. Table 52 shows the limited descriptive statistics about the Soldiers' responses to the questionnaires. The Soldiers indicated they had "some" to "a lot of difficulty" with the replacement of magazines into their ammunition pouches while they wore the CB over-garments (figure 45).

Table 52. Descriptive statistics about Soldiers' responses.

Question	CB + Mask n = 3		Belt Mount n = 3		Leg Mount n = 2	
	Mean	***SD***	**Mean**	***SD***	**Mean**	***SD***
Pipe Crawl						
Running/dashing	5.67	*1.53*	6.33	*0.58*	5.50	*0.71*
Negotiating pipe crawl	6.33	*0.58*	5.33	*1.53*	5.50	*0.71*
Leg movement	5.33	*2.08*	5.33	*2.08*	4.50	*0.71*
Arm movement	5.33	*2.08*	6.00	*1.00*	6.00	*1.41*
Torso movement	6.33	*0.58*	5.67	*1.53*	6.00	*1.41*
Head movement	4.67	*3.21*	4.67	*2.08*	5.50	*2.12*
Crawling	6.33	*0.58*	5.33	*1.53*	4.00	*1.41*
Zig-Zag						
Negotiating the zig-zag	6.33	*0.58*	6.00	*1.00*	6.00	*0.00*
Negotiating the 2-ft jump	6.33	*0.58*	6.33	*0.58*	6.50	*0.71*
Negotiating the hill	6.00	*1.00*	6.00	*1.00*	6.50	*0.71*
Head movement	4.67	*3.21*	4.67	*2.52*	6.00	*1.41*
Running	6.33	*0.58*	6.33	*0.58*	5.00	*0.00*
Seeing/scanning left and right	6.00	*1.00*	5.33	*2.08*	4.50	*2.12*
Seeing/scanning up and down	3.67	*2.52*	5.67	*2.31*	5.50	*2.12*
Foxhole Firing Position						
Getting into the foxhole	6.67	*0.58*	7.00	*0.00*	6.50	*0.71*
Assuming good foxhole firing position	5.67	*1.53*	6.67	*0.58*	6.50	*0.71*
Retrieving magazines from ammunition pouches while in foxhole firing position	6.33	*0.58*	5.00	*2.00*	5.50	*2.12*
Kneeling Firing Position						
Assuming a good kneeling firing position	6.33	*0.58*	6.33	*1.15*	6.00	*1.41*
Leg movement	6.00	*1.00*	5.33	*2.08*	6.00	*1.41*
Arm movement	6.33	*0.58*	5.67	*2.31*	6.00	*1.41*
Torso movement	6.00	*1.00*	5.67	*1.53*	6.00	*1.41*
Acquiring targets from kneeling firing position	6.33	*0.58*	5.67	*2.31*	6.00	*1.41*
Retrieving magazines from ammunition pouches while in kneeling position	5.33	*2.08*	5.67	*1.53*	5.50	*2.12*
Replacing empty magazines in ammunition pouches while in kneeling position	3.67	*3.06*	4.33	*1.53*	4.50	*3.54*
High Wall						
Negotiating high wall	6.00	*1.00*	6.00	*1.00*	4.50	*0.71*
Assuming prone firing position	5.33	*2.08*	6.00	*1.73*	6.00	*1.41*
Leg movement	5.67	*1.53*	5.33	*2.08*	5.00	*1.41*
Arm movement	6.33	*0.58*	6.00	*1.73*	6.50	*0.71*
Torso movement	6.33	*0.58*	6.00	*1.73*	6.00	*1.41*
Prone Firing Position						
Acquiring targets from the prone firing position	5.67	*1.53*	5.67	*2.31*	6.50	*0.71*
Retrieving magazines from ammunition pouches while in prone position	5.33	*2.08*	4.00	*2.65*	4.50	*3.54*
Seeing/scanning up and down	4.67	*3.21*	5.00	*2.65*	5.00	*2.83*
Replacing empty magazines in ammunition pouches while in prone position	3.67	*3.06*	2.33	*1.15*	4.00	*2.83*
Seeing/scanning left and right	6.33	*0.58*	5.33	*2.08*	5.00	*1.41*
Seeing/scanning up and down	4.67	*3.21*	5.67	*2.31*	6.50	*0.71*
Pressure points	6.67	*0.58*	7.00	*0.00*	6.00	*1.41*
Hot spots	4.67	*3.21*	5.00	*3.46*	6.00	*1.41*
Bruising on your body	6.33	*0.58*	7.00	*0.00*	6.00	*1.41*
Torso chafing in front	6.67	*0.58*	7.00	*0.00*	6.00	*1.41*
Torso chafing in back	6.67	*0.58*	6.67	*0.58*	6.00	*1.41*

Arm/shoulder chafing	6.33	*0.58*	6.67	*0.58*	6.00	*1.41*
Leg/thigh chafing	6.67	*0.58*	6.67	*0.58*	6.00	*1.41*
Neck/head chafing	6.67	*0.58*	6.67	*0.58*	6.00	*1.41*
Equipment catching	6.67	*0.58*	5.33	*2.08*	5.50	*0.71*
Equipment hindering movement	5.33	*2.08*	6.00	*1.00*	3.00	*1.41*
Weight shifting	6.67	*0.58*	5.67	*2.31*	6.00	*1.41*
Equipment pinching	6.33	*0.58*	6.00	*1.73*	6.00	*1.41*
Armor preventing flexing	6.00	*1.00*	6.33	*1.15*	6.00	*1.41*
Hoses restricting movement (too short)	7.00	.	5.67	*2.31*	6.00	*1.41*
Hoses snagging (too long)	7.00	.	7.00	*0.00*	6.00	*1.41*
Face	4.33	*0.58*	5.00	*1.73*	6.50	*0.71*
Right arm	3.33	*1.15*	3.00	*1.73*	6.00	*0.00*
Left arm	3.33	*1.15*	3.00	*1.73*	6.00	*0.00*
Torso front	3.67	*0.58*	5.00	*2.65*	6.50	*0.71*
Torso back	3.67	*0.58*	4.33	*2.52*	6.50	*0.71*
Right leg	3.33	*1.15*	3.33	*2.08*	5.50	*0.71*
Left leg	3.33	*1.15*	3.33	*2.08*	5.50	*0.71*
Overall comfort	5.00	*1.00*	5.33	*2.08*	7.00	.
Control knobs on PAVS and PAPR with gloved hands	x	*x*	5.33	*2.08*	5.00	*0.00*
Connecting and disconnecting PAVS hose to and from manifold assembly	x	*x*	5.33	*2.08*	5.00	*0.00*
Exchange battery in PAVS	x	*x*	7.00	*0.00*	6.00	*1.41*
Overall comfort	5.33	*1.15*	5.33	*2.08*	6.00	*1.41*
The performance of the PAVS is worth carrying the extra weight	x	*x*	4.67	*2.52*	6.50	*0.71*
The best place to carry the PAVS is on the belt	x	*x*	4.33	*0.58*	6.50	*0.71*
The best place to carry the PAVS is on the hip	x	*x*	4.67	*1.15*	2.00	.
I would accept less performance of the PAVS in order to reduce the size and weight	x	*x*	2.67	*1.53*	4.00	.
The performance of the PAPR is worth carrying the extra weight	x	*x*	4.67	*2.52*	6.50	*0.71*
The best place to carry the PAPR is on the belt	x	*x*	4.67	*1.15*	6.50	*0.71*
The best place to carry the PAPR is on the leg	x	*x*	3.67	*0.58*	2.00	.
I would accept less performance of the PAPR in order to reduce the size and weight	x	*x*	2.00	*1.73*	4.00	.
The concept of an air ventilation system for a CB over-garment and mask is a good idea	x	*x*	7.00	*0.00*	7.00	*0.00*

The suggestion of a "drop bag" for the empty magazines was evident during this exercise because Soldiers had much difficulty with replacing their magazines in the ammunition pouches. Soldiers had a difficult time executing combat rolls and low crawling with the PAVS and the PAPR mounted on the leg and some difficulty when they were mounted on the belt. The Soldiers preferred the PAVS and the PAPR mounted on the belt slightly more than mounted on the leg. They would prefer that the PAVS and the PAPR be mounted on the back. They also agree that the extra weight was worth the effort. The Soldiers responded negatively when asked if they would accept less performance for less weight. All Soldiers stated the concept of a PAVS and a PAPR was excellent.

Figure 45. Soldier, magazine replacement.

Tables 53, 54, and 55 were constructed from table 52. Questions were included only if there was a difference of 1.00 or greater between any of the three means.

Table 53. Items in which the CB plus mask is the favored set of gear.

Negotiating pipe crawl
Seeing/scanning left and right
Retrieving magazines from ammunition pouches in foxhole and prone firing position
Executing combat rolls left and right
Equipment catching
Weight shifting
Hoses restricting movement (too short)

Table 54. Items for which the belt mount is the favored variation.

Assuming good foxhole firing position
Negotiating high crawl

Table 55. Items for which the leg mount has the highest rating.

Head movement
Replacing empty magazines in ammunition pouches in prone position
Hot spots
Air flow to the face
Air flow to the arms
Air flow to the front and back of the torso
Air flow to the legs
Overall comfort

The CB suit and mask alone was preferred for crawling, combat rolls, retrieving magazines, scanning left and right, and equipment not catching or restricting movement. In this configuration, there are no objects hanging from the belt or legs to hinder these movements.

The belt mount ensemble was preferred for the high crawl and for assuming the foxhole firing position.

The leg mount was preferred in terms of head movement, replacing magazines, air flow to the body, and overall comfort.

During this event, the Soldiers had the following comments:

FFW + CB + Mask

- Heat buildup (two Soldiers made the same comment).
- Change the placement of the magazine or add a magazine drop pouch.

FFW + CB + Mask + Belt Mount

- The magazines are hard to see with the gear on.
- I would add a drop pouch for expended magazines.

FFW + CB + Mask + Leg Mount

- The blower on the outside of my leg rolled to the inside while I was high crawling and slowed me down.
- The leg mounts shifted during the high crawl.
- The blowers can't go on your legs.
- Get the blowers off the legs; it makes movement too slow and sluggish.

Table 56 is a summary of SMEs' and experiment directors' data. Times were recorded at each firing point and for overall time to complete the course. There were no significant differences in the times to complete, especially given that roster 5's excess time resulted from his inability to replace the magazines into the ammunition pouches in a timely manner. This task, replacing magazines into ammunition pouches, caused the most problems and frustration for the Soldiers during this activity. The Soldiers also had problems with the CB garment tearing (figure 46) and

the hoses from the PAVS and PAPR coming loose (figure 47). In most cases, they did not realize the hoses had come loose until a SME stopped them and replaced the hose. The Soldiers also commented about the difficulty they had in turning the PAVS and PAPR on. The on/off switch was especially difficult to operate. One Soldier's chassis became unlatched while he was traversing the course. It is not known why it came unlatched, but the question of whether the latch had been filed too much or if there was excess wear on the latching system is unknown.

Table 56. SME and experiment directors' observations, day 5.

Iteration 1							
ID No.	**Config**	**Time to Complete**	**FP No. 1**	**FP No. 2**	**FP No. 3**	**FP No. 4**	**Notes**
5	A	07:43.0	01:03.9	00:51.1	01:09.0	01:33.3	Struggled replacing magazines into pouches
9	B	04:43.0	00:34.9	00:27.5	00:30.8	01:04.5	Had difficulty replacing magazines and caused extra time at firing points
4	FFW	06:48.0	00:59.1	00:42.5	01:07.9	00:33.9	Chassis came open and he could not re-connect; had to be reconnected by test personnel. Reconnected at foxhole firing position (FP).
8	A	05:53.0	00:47.2	00:44.4	00:44.2	00:59.3	PAVS hose came off and had to be reconnected after high crawl.
Iteration 2							
5	B	06:13.0	00:51.6	00:53.5	01:01.8	00:51.7	Blank adapter was loose, caused misfire at FP 1. Did not return used magazines to ammunition pouches at FP 2 and 4
9	A	05:09.0	00:45.8	00:43.1	00:29.9	00:39.7	
4	A	05:19.0	00:37.6	00:52.0	00:34.3	00:53.0	PAPR hose came off in foxhole, Soldier tried to fix it himself. Both PAPR and PAVS came off on high crawl, stopped Soldier reconnected.
8	FFW	05:28.0	00:33.2	00:53.0	00:40.6	00:48.6	

Figure 46. Torn CB garment.

Figure 47. Loose PAPR hose.

3.6 Side Experiment: Day 5, Cross Country

3.6.1 Grenadier's Cross-Country Movement

On day 4, the grenadiers did not carry a full basic load of 24 rounds. Therefore, a side experiment to evaluate their mobility with 24 rounds was conducted. Figure 16 shows the cross-country course. It was approximately 1 km long and consisted of low crawl areas, high crawl areas, a stream crossing, and open and close woodlands. The grenadiers were able to traverse the course with no problems.

The Soldier comments include

- Ear plugs on leader's helmet dangled around the Soldier's head. The Soldiers would like some way to secure them.
- Both grenadiers liked the elbow and knee pads when high crawling during cross-country movement.
- Grenadiers preferred mounting rounds on the belt as opposed to putting them on the leg panels.

3.7 Additional Information

Throughout the experiment, weight was a major concern. For each exercise on each phase, weights of the Soldiers were recorded (appendix F). The only comparison was conducted in phase I, movement to contact; however, the measured weights are available for review.

Also, every attempt was made to allow the IPTs access to the Soldiers throughout the event. They contributed to the success of the event and their input was used in this report. A complete listing of the IPT comments is shown in appendix G for the reader's review.

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4. Discussion

4.1 Chassis Loads

Evaluate the form, fit, comfort, load distribution, and load distribution options (how each Soldier loaded his system) of Soldier variations (leader, rifleman, automatic rifleman, grenadier, and medic).

4.1.1 Uniform

The Soldiers liked the shirt (torso only). They disliked the heavy material used in the sleeves of the shirt. There were many comments about the heat buildup and heavy material on the shirt. They really liked the synthetic material used in the torso portion of the shirt instead of the light wool blend material. The Soldiers also reported the zippers on the shirt caused irritation and should either be padded on the inside or changed to a different fastening system. They liked the pockets on the sleeves. The Soldiers generally liked the integrated elbow pads but thought they were too long.

The Soldiers disliked the trousers. They complained of the positioning of the pockets and the lack of normal type (on front) pockets. The zippered ventilation system received mixed comments. The zipper caused irritation and needs the same attention as the shirt's zipper. Also, the Soldiers liked the idea of ventilation but found the openings were blocked when they wore the up-armor leg panels, so the ventilation did not work. They disliked the knee pads and had a lot of difficulty keeping them in place as they walked. Four of the Soldiers reported that the knee pads were rubbing against their shins and caused irritation. It was believed that if an improved fastening system and shorter knee pads were incorporated, then the integrated knee pads might be acceptable.

4.1.2 Chassis

Initially, the Soldiers had much difficulty with the chassis fastening system. They did not like it and found it very difficult to latch and unlatch. Some of the Soldiers asked the IPTs to file the

latching system to allow easier latching and unlatching, and some systems apparently became worn and easier to latch and unlatch by week's end.

The Soldiers commented very favorably on the ventilation properties of the FFW chassis, and all recommended that it be adapted not only to FFW but to the current baseline equipment too. All the Soldiers found the chassis to be more comfortable than the baseline. Two of the Soldiers reported slight shifting problems with the FFW chassis, but four Soldiers reported shifting problems with the baseline. The Soldiers reported ease of adjusting the chassis and liked the suspension system used on the FFW chassis. However, they would like some quick way of stowing or securing the cords of the chassis suspension system.

All but one Soldier disliked the stock lock system. They found it to be useless and in most cases, the Soldier did not or would not place the butt of his weapon in this unusual place. They recommended that a non-slip material be incorporated into the uniform shirt (similar to that used by professional shooters) in its place. The stock lock system proved to be in the way more than an improvement over the baseline. The Soldiers also suggested developing a method of attaching their weapons to the chassis, which would allow the weapon to hang freely but remain attached to the chassis. Several of the Soldiers had a makeshift system and used it. The attachment would have to be of the correct length that would allow the Soldier to raise the weapon directly to the firing position with one hand.

The Soldiers liked the flexibility of the attachment system used on the chassis. Throughout the week, they experimented with moving electronic and mission-related items on the chassis, ballistic belt, and up-armor leg panels. The FFW ensemble allowed the Soldiers to configure their gear for specific mission requirements, such as attaching extra munitions to the ballistic belt.

The form, fit, and comfort were influenced by the initial fitting of the FFW ensembles. There appeared to be some fitting problems with the limited sizes available. The different torso lengths contributed to this. The Soldiers complained of pinching between the chassis and the ballistic belt. They also had problems with the ballistic belt slipping down on their hips while they moved through the woods. The initial fitting was and will remain critical.

If the FFW is to eventually be fielded, then design considerations must include appropriate sizing to accommodate the 5th through 95th percentile target audience. Procurement should be based on the quantity of individual sizes required (e.g., XS, S, M, L, XL) by component to accommodate the target audience with a reasonable amount of "spares" for exchange or replacement purposes. Soldiers must be measured and sized and then fitted with the correct item in order to maximize their own and FFW effectiveness. Complete attention to this "tariff" (5th to 95th) must be adhered to and completed. The lack of different sizes and inability to achieve correct sizing may have had serious impacts on this experiment. In future evaluations, the program should provide sufficient systems in different sizes to accommodate those Soldiers who participate. It is difficult to find Soldiers to fit available sizes.

4.1.3 Ballistic Belt

The Soldiers generally liked the ballistic belt and found it to be useful. The grenadiers and the SAW gunners liked the flexibility of having extra space to attach the 40-mm rounds and the SAW ammunition. However, most wanted suspenders to assist in keeping the ballistic belt in the proper position. Several Soldiers reported that the ballistic belt would not stay in place and caused discomfort when it slipped down during movement.

Some Soldiers had problems with the ballistic belt and the chassis pinching and causing irritation. This was partly attributable to the ill-fitting problem identified in paragraph 4.1.2 but also to ill-fitting problems with the ballistic belt. One Soldier was not issued a ballistic belt because the IPTs did not have one small enough. This Soldier had a 32-inch waist and was well with in the 5th to the 95th percentile.

4.2 Ammunition Accessibility

The goal was to evaluate the Soldiers' ability to access ammunition pouches while firing weapons.

The Soldiers did not report any problems with accessing their ammunition magazines during the attack on the objectives on days 2 and 4. However, on day 5 during the IMT course while Soldiers wore the CB equipment, they had extreme difficulty in retrieving and replacing magazines. In one case, a Soldier became so frustrated with attempting to replace magazines into the ammunition pouches, he carried all his magazines in his hand while completing the course (figure 45). The Soldiers had a simple solution to this problem, use a drop bag (figure 38). Several of them asked the IPTs to provide drop bags, and they used them to drop their magazines when finished. The test personnel did not allow them to use a drop bag on day 5; thus, all the problems surfaced. The drop bag is a good concept and should be adapted "officially" for the FFW and baseline. Currently, the Soldiers use expanded SAW ammunition bags.

4.3 Chassis Components

The goal was to solicit feedback from Soldiers about comfort, fit, and location of the ensemble components (including up-armor options, chassis closure mechanism, gear, electronics locations, power and personal area network; this is not an exhaustive list) while they wore the fighting and/or approach loads.

Overall, the Soldiers liked the flexibility of being able to move items around on the chassis. Most of the Soldiers disliked any hard objects, such as batteries, under their arms on the chassis. This tended to interfere with their ability to move their arms and obtain good sight pictures with their weapon. Therefore, most Soldiers moved all the items from under their arms, or they placed soft or small objects under their arms and on the side of the chassis.

When they were allowed to configure their chassis system, the Soldiers tended to put all the batteries and electronics on the back of the chassis. They had a preference for those items they would need quickly and often (ammunition) on the front. The Soldiers, especially the grenadiers and the SAW gunners, liked the flexibility of placing their ammunition on the chassis and some on the ballistic belts. They did not like putting anything heavy on the up-armor leg panels. However, they would put the IFAK and the CLS bag on the leg panels.

As mentioned previously, the Soldiers initially had much difficulty with the closure mechanism on the chassis. When the IPTs worked on the closure mechanism and it received some wear, the comments were fewer.

The Soldiers wore all components of the up armor only on day 3 during MOUT operations. They had very few problems with the shoulder, abdomen, and drop leg up armor. However, they all disliked the neck-up armor. It was cumbersome and retained heat. The leader variation helmet interfered with the neck-up armor and made it difficult to see upward (figure 36). All the Soldiers stated they would not voluntarily wear the neck-up armor, with the exception of three who stated they might wear it on convoy operations if they were the exposed gunner on top of the vehicle.

The proper fitting of the chassis was a problem from the beginning and caused some concern to the test personnel (test officers, SMEs, data collectors, observers, etc.). There were a few Soldiers who were not properly fitted because of the lack of proper sizing. One Soldier did not have a ballistic belt during the experiment because there was not one to fit him. This could have been the reason for the appearance that the FFW chassis did not provide the protection coverage of the baseline. An observation of the Soldiers showed areas of non-coverage in the upper chest, underarms, the abdomen, and lower back area between the chassis and ballistic belt. If proper fitting can resolve this perceived problem and provide more ballistic protection to the Soldier, then every attempt possible to have proper sizing for future events should be made.

4.4 CB Gear

The goal was to collect limited data about the form, fit, comfort, and wear and tear of the CB gear, as applicable during this event.

There were only limited opportunities for the Soldiers to wear the CB gear with the FFW ensemble. Four Soldiers participated in this event. They all stated that both the PAVS and the PAPR were a big improvement and they thought the additional weight was worth it for the ventilation properties they received.

There were some problems with the PAVS and PAPR when carried on the legs. The Soldier's movement was more restricted, and the PAVS and PAPR tended to flop around during running and crawling. One Soldier had problems conducting combat roles and one had difficulty in completing the low crawl.

One Soldier's CB over-garment was torn through the inseam while he was traversing the IMT course (figure 46). As mentioned previously, human factors design issues need to be addressed for the CB components.

4.5 CB and Weapons Firing Interaction

The goal was to evaluate the interaction between the CB gear with various weapons and the chassis during weapons firing (blanks).

The Soldiers did not report any difficulty in obtaining a sight picture and conducting the firing exercises required on the IMT course. However, as previously stated, they had extreme difficulty in replacing the magazines into the ammunition pouches and some difficulty in retrieving full magazines from the ammunition pouches to use in the firing exercises. The openings of the ammunition pouches were very small, and this made it difficult for the Soldiers to replace magazines because of the restricted vision while they wore the CB mask.

4.6 Helmets and Weapons Firing Interaction

The goal was to evaluate the interaction between the design cycle III helmet with various weapons and the chassis during weapons firing (blanks).

There were no reported problems with weapons firing while Soldiers wore helmets.

4.7 Design Cycle III Helmets

The goal was to evaluate the fit and comfort of the design cycle III helmet.

The Soldiers liked the leader variation helmet and stated that the extra weight was almost imperceptible. One team leader had problems with the wiring connection between the helmet and the chassis and broke it several times (figure 28). In working versions of this helmet and its chassis-mounted electronics, some basic human factors design must be completed to ensure that routing of the wires is workable.

There were some initial problems with the Soldier variation helmet. The Soldiers complained of excessive heat buildup and perspiration problems. These complaints came from the Soldier variation helmet with the Skydex impact liner. The IPTs changed the impact liners with Brock liners and made some (unknown to test personnel) modifications of the pads, and the Soldiers' complaints were noticeably reduced.

4.8 LSDS

The goal was to evaluate the form, fit, and comfort of the LSDS.

The Soldiers preferred the Hidalgo for both the base and FFW wear. It was more comfortable and caused the least amount of interference. This was especially true with the baseline gear. The 1-C caused much irritation when it was worn with the baseline gear.

However, they did not like the straps with the Hidalgo but preferred the straps with the 1-C. The best answer is a combination of both, the slimmer, less irritating Hidalgo with the 1-C straps.

4.9 Conclusion

As mentioned before, there are human factors design issues that need to be addressed and evaluated on all components of the FFW ensemble.

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5. Recommendations

5.1 Uniform

- Use a lighter weight material for the shirt sleeves and trousers. Something similar to the current BDU would be adequate and more comfortable for the Soldiers.
- Replace the zippers on the shirt and trousers, or (at a minimum) have a soft backing on the zippers to reduce the irritation to the skin.
- Reduce the length of the elbow and knee pads and make them more stable to reduce movement of the pads.
- Improve the mechanism of securing the elbow and knee pads to eliminate the possibility of the pads coming loose and moving around while the Soldier is walking.

5.2 Chassis

- Improve the latching system to allow for easier latching and unlatching of the chassis system.
- Provide a means to stow the chassis adjusting cords.
- Eliminate the stock lock system.
- Provide a means to attach the weapon to the chassis in the vicinity of the firing shoulder so that a Soldier can, with one hand, bring his weapon up into his shoulder and achieve a good firing position.
- Ensure that sizing of the chassis takes into consideration height and weight distributions (5th to 95th percentile).

5.3 Ballistic Belt

- The belt needs suspenders as an option.
- Ensure that the sizing of the belt takes into consideration height and weight distributions (5th to 95th percentile).

5.4 Ammunition Accessibility

- Develop a magazine "drop bag" so Soldiers can drop used magazines into an easily accessible bag, as opposed to a tightly fitting magazine pouch.

5.5 Chassis Components

- Determine better locations for hard items (e.g., batteries) other than under the arms.
- Improve the neck-up armor, make it more comfortable, and fix the limitations on head and neck movements.
- Improve the ballistic protection of the chassis, especially in the upper chest, arm pits, lower abdomen, and lower back areas.

5.6 CB Gear

- Reduce the size but not the performance of the PAVS and PAPR.
- Find a way to better secure the PAVS and the PAPR to the back of the chassis or to the waist area.
- Increase the strength and durability of the CB over-garment material.
- Develop reliable hose connectors.

5.7 Design Cycle III Helmets

- Conduct a human factors engineering evaluation on the routing of the wires and connectors between the chassis and helmet.
- Improve the ventilation to the top of the head for all helmets.

5.8 LSDS

- Keep the slimmer Hidalgo LSDS but change the straps to be similar to the straps used on the 1-C system.

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Appendix A. Demographics and Anthropometrics

Table A-1. Demographics.

SAMPLE SIZE = 10

AGE	RANK	MOS	TIME IN SERVICE
Mean = 24	E-3 – 2 E-5 – 2 E-4 – 5 E-6 – 1	11B – 9 91W - 1	Mean = 51 months

GT SCORE	DUTY POSITION	
Mean = 107	Squad Leader - 1 Team Leader – 2 Grenadier - 2	Automatic Rifleman - 2 Rifleman - 2 Medic - 1

1. Do you wear prescription lenses?	3 yes	7 no
2. If yes, which do you wear most often?	2 glasses	1 contacts
3. Which do you wear while firing a weapon?	2 glasses	1 contacts
4. With which hand do you most often write?	9 right	1 left
5. With which hand do you most often fire a weapon?	8 Right	2 left
6. What size BDUs do you wear?	Pants Medium	Short (2) Reg (2) Long (5) XL (1)
	Shirt Medium	Small (1) Reg (3) XLong (1)
	Large	Small (1) Reg (1) Long (1) XL (1)
7. Time in current duty position?	15 months (mean)	
8. Latest APFT score	267 (mean) Out of 300	
9. Have you any experience with the Land Warrior Program?	3 yes 7 no	
10. What is your current assigned personal weapon?	M203 (2) M4 (5) M249 (2) None (1)	
11. What was your most recent weapon qualification score?	37 (mean) out of 40	
12. Have you served in a combat or hostile fire zone?	3 yes 6 no	

13. If so where?	Iraq (3);	Afghanistan (2)
14. When was the last time you participated in chemical/ biological self-defense training?	Jun02 Aug02 Mar03	Apr03 Nov03 May04
15. Have you ever trained/worn full MOPP gear (mask, boots, gloves, and chemical suit)?	9 yes 1 no	
-- If yes, longest time in protective clothing?	4 days (mean)	

16. Self rating of Knowledge, Skills, and Abilities related to Infantry duties:

1 Poor **2** **3** **4 Average** **5** **6** **7 Outstanding**

MEAN RESPONSE	
a. Knowledge of Infantry tactics, techniques, and procedures	4.60
b. Knowledge of rifle marksmanship	5.80
c. Knowledge of room-clearing tactics	5.00
d. Knowledge of mechanics and maintenance procedures for weapon systems and equipment used	4.70
e. Knowledge of reconnaissance, surveillance, and target acquisition procedures	3.80
f. Proficiency in chemical/biological operations	3.50
g. Leadership skills	4.10
h. Knowledge of map reading and orientation in field setting	4.60
i. Knowledge of land navigation	4.56
j. Knowledge relating to communications equipment and communications procedures	4.22
k. Knowledge of MOUT operations	4.56
l. Small unit tactics skills	5.00

17. What load carriage system do you typically use?
9 MOLLE 4 ALICE 1 Other: Aid bag

18. What type of tactical headgear to you typically wear?
0 KEVLAR 9 ACH/MICH 0 CVC 1 Other: Patrol

19. What type of body armor do you typically wear?
9 Interceptor 0 KEVLAR 1 None

20. Military training/instruction received in Infantry operations:

9 Basic training
2 PLDC
0 ANCOC
0 Ranger
0 Sniper
0 Master Gunner
9 Combat Life Saver
2 Advance (Infantry) training
0 BNCOC
0 IOBC/OCS
2 Airborne
0 Bradley Leaders Course
0 ICC
3 Other – EIB, JAVE, Cadre Tng

Table A-2. Anthropometric measurements.

Anthropometric Measurements (Percentile)

Roster	Chest Circumference	Crotch Height	Head Circumference	Head Breadth	Head Length
2	96	43	60	34	65
3	91	12	92	90	80
4	12	43	85	34	90
5	48	2	15	15	19
6	97	2	75	75	65
7	91	2	30	5	19
8	30	55	35	15	19
9	72	72	95	75	85

Roster	Sleeve Length: Spine-Wrist	Waist Circumference (omphalion)	Weight	Stature	Waist Back Length
2	62	77	98	87	10
3	73	92	96	87	38
4	34	20	25	76	10
5	30	65	30	22	2
6	18	92	93	43	23
7	2	95	77	23	10
8	40	38	50	90	10
9	68	72	88	98	48

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Appendix B. Training and Fitting

SAMPLE SIZE = 8

1. Using scale below, please rate your comfort level with donning and doffing and/or using these pieces.

1	2	3	4	5	6	7
Extremely uncomfortable	**Very uncomfortable**	**Uncomfortable**	**Neither comfortable or uncomfortable**	**Comfortable**	**Very comfortable**	**Extremely comfortable**

Item	n	Mean	SD
Combat pants	8	4.63	0.92
Combat shirt	8	4.75	0.89
Armor chassis	8	4.88	0.83
Armored load belt	6	5.17	0.98
FFW ballistic helmet shell	7	5.43	0.98
Headgear suspension and impact liner with integrated eyewear	6	6.00	0.63
On the move 70-oz. hydration system	7	5.86	1.21
IFAK	8	5.38	1.30
Electric components pouch	8	4.50	1.31
Battery pouch	8	4.50	1.31
Pre-configured components	8	4.63	1.30
Soldier radio	7	4.71	1.38
200-round drum pouches	2	4.00	2.83
Grenadier load pack	3	6.33	0.58
Combat lifesaver load pack	5	5.80	1.30
Assault pack	4	6.00	0.82
Wiring harness	6	5.00	1.55
Ammo pouches	6	5.83	1.17
Overall comfort	8	5.38	1.19
WPSM: LSDS	7	4.00	1.73
WPSM: Sleep watch	4	4.25	1.26

2. Were there any pieces of the FFW ensemble that created any safety issues or problems that you are aware of at this time?

0 Yes
8 No

3. Are there any components of the FFW ensemble that you do not understand how to use, wear or carry?

0 Yes
8 No

4. Comments on this phase of the FFW design event.

	No. of Responses
Everyone was very helpful and knew the equipment to help me better understand the purpose	1
I like the idea of custom fitted equipment; it helps with the comfort and it makes things easier to access.	1
The engineers tasked with the fitting and briefing in the equipment were very informative on the uses and setup of the gear.	1

Appendix C. Movement to Contact, Days 2 and 4

Table C-1. Movement to contact, day 2, SME notes.

ID No.	COMMENTS
From AM M-t-C, FTA ID No. 2-5 was wearing the FFW	
1	Knee pads were too long and rubbing his shin. His torso was nice and cool, but arms were too hot.
2	Ballistic belt offers some support to his back but caused too many problems to be used.
3	Grenadier had problems keeping ballistic belt pulled up above his hips. Had to continuously pull it up. He was not wearing suspenders, some were, but it was a request from Soldiers that the IPT did. Had problems with the weight of 40-mm rounds on his leg panels; weighed him down too much and hindered mobility.
4	Had problems with helmet. It caught all the sweat and then at an inopportune time when he moved his head just right, the sweat drained down into his eyes. He thought the zippered vents on the pants were a good idea, but they allowed bugs access to his legs and groin. Weight of the SAW ammunition on the belt pulled it around when he got in prone position. His knee pads were tight when he started but became loose and bothered him. Battery box under right arm caused loss of mobility and a lot of pain. His arm became numb. Did not mind the first aid kit under left arm, because it was soft. Said the suspenders on the ballistic belt helped, but still too much weight on leg panels (SAW ammo).
5	Couldn't unzip ventilation in pants because leg panels prohibited him from reaching the zippers. Didn't like the leg panels; he was wearing them with a regular belt, no ballistic belt small enough to fit him. He did like the extra padding from the leg panels when going through thorn bushes.
From PM M-t-C, FTB ID No. 6-9 was wearing the FFW	
6	Battery under left arm pushes against bicep and changes weapon carry position. Keeps his right arm too high. Ballistic belt must be kept high up to keep from pinching. Ballistic belt would drop down and cause pinching between belt and chassis. Pants and shirt too hot, but air flow under chassis is good.
7	Used suspenders to keep ballistic belt up. It worked for awhile but belt started to fall down. Leg panels with 40-mm rounds too heavy and interfered with his mobility on assault. Right leg strap loosen on assault. Pants and shirt too hot, but air flow under chassis is good.
8	Leg straps falling out of keepers on leg panels. Health hub wire broke off during assault. SAW drum under left arm binds on bicep. Will move SAW drum to leg panel. Liked his helmet better than his ACH. Good fit, stable, straps keep it in place. Liked the chin strap. Lateral strap on right side came loose during assault. Knee pads would not stay in place during movement. Straps holding side panels came loose during movement.
9	Knee pads turn outward. Pinching between belt and chassis. Pants zipper chafes back of thighs and butt. Knee pads would not stay in place during movement. Straps holding side panels came loose during movement.

Table C-2. Subject notes transcribed from video taken on site.

FFW Soldier Video-Taped Comments

Movement to Contact, Day 2

- The weight of the M203 rounds mounted on the leg panels pulled the ballistic protective belts down.
- The SAW gunner used makeshift suspenders to help support the weight of the belt. The use of the suspenders worked well.
- The adjustment strings on the front of the chassis dangle loosely below the chassis and require a method to stow them.
- The Soldiers could not keep the knee pads in place during movement.
- The battery pack and health monitor mounted on the Soldier's side interfered with arm movement and dug into the Soldier's biceps.
- The B-team leader wore a chassis that was too big for him, causing his chest to be exposed.
- The A-team rifleman complained the helmet was hot and caused sweat to build up and drain into his eyes.
- The A-team rifleman complained that when the leg panels were installed, he could not unzip his trousers in the sides to ventilate.
- The B-team SAW gunner's assault pack strap would not stay fastened.
- The B-team SAW gunner claimed the SAW rounds got in the way of his arm movement when they were mounted on the side of the chassis.

Movement to Contact AAR, Day 2

- The heart monitor's straps chafed the Soldiers' necks and sides.
- Soldiers noted that the ballistic belts need suspenders to keep them in place.
- The clips on the leg panels on the B-team SAW gunner got caught on each other, causing him to fall.
- The A-team grenadier's leg panels became loose several tomes during movement.
- The A-team leader had difficulty fastening the chassis with the plastic clip.
- Most of the Soldiers did not like the weapon butt stock stabilizer because they claimed it didn't work.

- All Soldiers stated that the trousers and shirts were hot.
- The A-team leader complained that the gap between the belt and chassis pinched his skin.
- Soldiers liked the ability of the chassis to allow air flow beneath the panels.
- When the Soldiers unzipped the side trouser legs to ventilate, their skin was exposed to insects and briars. They suggested sewing in a mesh material.
- The squad leader said the Velcro[12] on the uniform sleeves snagged on other equipment with Velcro.
- Solders said both variations of the helmet were hot and caused sweat to build up and pour over the face and into the eyes.
- Soldiers said they preferred a helmet that was adjustable up and down as well as around the head's circumference.
- Soldiers liked the weight of both helmets.
- Soldiers liked the way the assault pack attached directly to the chassis.
- Several soldiers said they would prefer to have cargo pockets on the trousers.
- The B-team leader said the zipper on the rear of the trousers chafed him.
- The squad leader said he would like a clip on the chassis to secure his weapon, too.

[12]Velcro is a registered trademark of Velcro USA, Inc., Manchester, NH.

Table C-3. Movement to contact and attack objective, day 2.

SAMPLE SIZE: FFW = 1
BASELINE = 9

1. Using scale below, please rate your ability to complete the tasks shown with the equipment you wore.

1	2	3	4	5	6	7
Extremely hard	**Very hard**	**Hard**	**Neutral**	**Easy**	**Very easy**	**Extremely easy**

TASKS	MEAN RESPONSE									
	FFW									BASE-LINE
Roster No.	1	2	3	4	5	6	7	8	9	
Ease of leg movement	6.00	4.00	2.00	5.00	4.00	1.00	3.00	4.00	7.00	6.22
Ease of assuming prone position	NR	4.00	5.00	6.00	NR	6.00	6.00	5.00	7.00	5.88
Ease of assuming kneeling position	7.00	3.00	5.00	5.00	4.00	3.00	6.00	6.00	7.00	6.22
Ease of arm movement	5.00	5.00	5.00	4.00	5.00	6.00	3.00	6.00	7.00	5.11
Ease of torso movement	5.00	5.00	4.00	3.00	4.00	6.00	6.00	6.00	7.00	5.00
Ease of head movement	7.00	6.00	4.00	5.00	6.00	6.00	7.00	7.00	7.00	6.00
Ability to run	7.00	6.00	2.00	6.00	3.00	1.00	1.00	5.00	7.00	5.78
Use of hand and arm signals	7.00	6.00	5.00	6.00	5.00	6.00	6.00	7.00	7.00	5.56
Move through swampy areas or streams	7.00	5.00	4.00	5.00	NR	4.00	5.00	7.00	7.00	5.67
Move through thick brush Move through brush and vines	7.00	3.00	4.00	3.00	4.00	4.00	5.00	7.00	7.00	5.50
Ability to obtain a good sight picture with your weapon	7.00	6.00	5.00	6.00	4.00	4.00	7.00	7.00	7.00	5.67
Target identification	7.00	6.00	5.00	5.00	5.00	7.00	7.00	7.00	4.00	5.67
Conducting IMT	NR	4.00	3.00	3.00	4.00	2.00	4.00	4.00	4.00	5.00

Comments (by Roster #)

3
The 203 belt needs suspenders.

4
Lot of things on the vest get hung up, especially the gap between the vest and belt.

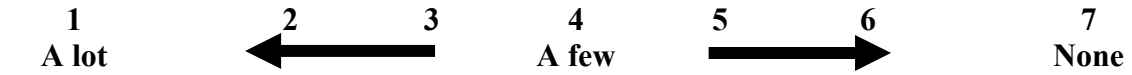
Comments (by Roster #)

7
With the leg panels for the grenadier, it is very heavy on the legs; running and jumping were very difficult, just overall "smoked" the legs.

8
Had a hard time running; clips on thigh mount kept rubbing together. Assault pack kept coming undone. SAW ammo pouch under left arm no good. Need something to catch sweat from entering eyes.

BASELINE
The IBA is much more mobile and the load is distributed better but you should put the pads from the new one in there to create the same space, combine the IBA with the new vest and you guys will have some real good stuff.
We are used to working with the IBA so it's hard to say it's harder or easier.

2. Using the scale below, rate the problem areas encountered with the equipment you wore.



PROBLEM AREAS	MEAN RESPONSE									
	FFW									BASE-LINE
Roster No.	1	2	3	4	5	6	7	8	9	
	SL	ATM	203	SAW	RFL	BTM	203	SAW	RFL	
Pressure points	7.00	6.00	7.00	4.00	5.00	4.00	7.00	4.00	7.00	5.78
Hot spots	7.00	6.00	7.00	7.00	6.00	3.00	3.00	5.00	7.00	4.22
Bruising on your body	7.00	4.00	4.00	7.00	6.00	3.00	4.00	7.00	7.00	5.78
Torso chafing in front	6.00	6.00	3.00	7.00	5.00	3.00	6.00	3.00	7.00	4.22
Torso chafing in back	7.00	6.00	6.00	7.00	5.00	3.00	6.00	5.00	7.00	5.00
Arm/shoulder chafing	7.00	4.00	6.00	7.00	6.00	7.00	6.00	5.00	7.00	5.22
Leg/thigh chafing	5.00	6.00	4.00	7.00	5.00	7.00	4.00	3.00	7.00	6.33
Neck/head chafing	7.00	6.00	7.00	3.00	6.00	7.00	6.00	6.00	7.00	5.11
Equipment snagging	6.00	4.00	4.00	3.00	5.00	7.00	6.00	6.00	7.00	5.44
Equipment hindering movement	5.00	6.00	2.00	4.00	5.00	2.00	4.00	5.00	7.00	5.67
Weight shifting	7.00	4.00	2.00	1.00	6.00	2.00	5.00	6.00	7.00	5.00
Equipment pinching	7.00	6.00	5.00	7.00	1.00	4.00	4.00	3.00	7.00	5.00
Load adjustment	7.00	6.00	6.00	4.00	4.00	4.00	6.00	6.00	7.00	5.78
Access to stowed items	7.00	6.00	6.00	7.00	5.00	6.00	6.00	6.00	7.00	5.22
Ability to breathe	7.00	6.00	6.00	7.00	6.00	5.00	6.00	6.00	7.00	4.78
Overall comfort	5.00	6.00	5.00	4.00	6.00	4.00	4.00	5.00	4.00	4.22

Comments (by Roster #)

1
Torso stayed cool, but arms were hot. Elbow pads felt weird and straps would not stay in place; legs were very hot and knee pads rubbed shins, zipper on the shirt digs into the chest

2
Knee pad shifts out of place often, not used to waist belt. Knee pads need more cushion; vest does not stay fastened.

4
Shirt collar rubbed my neck a little raw; knee pads came loose from time to time; heart monitor was good - you don't realize it's there till you take your stuff off. Kevlar[13] needs some work in the band; it doesn't size right for my head.

6
Pinching between belt and vest; heavy on shoulders after a while; knee pads move too much and don't have the protection of the old ones. Batteries dig into arm; arms and legs are too hot; the zipper digs into the butt while sitting. Also needs front pockets.

7
Torso chafing is the Hidalgo heart monitor, movement and weight shifting is the leg panels, every step I took, the leg panels just move my legs

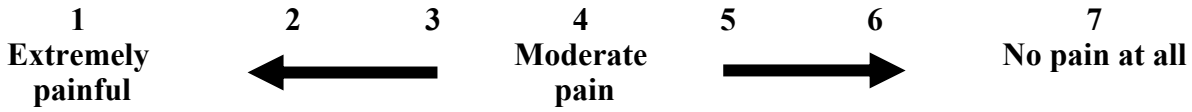
8
Thigh pieces came loose. Kept getting snagged on clips. Blisters or hot spots on feet but nothing you can do to prevent that.

[13]Kevlar is a registered trademark of E.I. DuPont de Nemours & Co., Inc.

9
Chassis was pinching my abdominal area against belt.

BASELINE
IBA causes lower back pain and stiff shoulders and upper back.
IBA needs more padding, mostly in the shoulder area.
IBA puts pressure on your shoulders.
Neck is too high on the IBA and it's too hot and to breath in.
Hidalgo stinks; sticks to the skin and rubbing causing chafing.
The heart monitor with the IBA is not working. It's hard to breathe.
The IBA has no way of allowing air to come in so the heat build-up is extremely high.

3. Using the scale below, what level of pain (if any) did you experience with the equipment you wore?



PAIN	MEAN RESPONSE									
	FFW									BASE-LINE
Roster No.	1	2	3	4	5	6	7	8	9	
Upper back	7.00	4.00	7.00	4.00	5.00	7.00	5.00	6.00	7.00	5.89
Lower back	7.00	7.00	7.00	4.00	5.00	7.00	7.00	3.00	7.00	4.56
Neck	7.00	7.00	4.00	5.00	7.00	7.00	7.00	6.00	7.00	5.44
Head	7.00	7.00	3.00	7.00	7.00	7.00	7.00	6.00	7.00	5.89
Torso front	6.00	7.00	6.00	7.00	7.00	2.00	5.00	6.00	7.00	5.44
Groin	7.00	7.00	6.00	7.00	7.00	7.00	6.00	6.00	7.00	6.78
Legs	6.00	7.00	4.00	2.00	7.00	1.00	6.00	6.00	7.00	6.56
Arms	6.00	5.00	7.00	5.00	7.00	7.00	6.00	6.00	7.00	6.33
Eyes	7.00	7.00	4.00	7.00	7.00	7.00	5.00	6.00	7.00	6.89

Comments (by Roster #)

1
Knee pads rubbed shins; lack of padding and a ridged structure made my shoulders hurt a little. The zipper on the shirt digs into the chest.

2
Shoulder causes pain; arms a little sore.

3
Only the weight of the 203 rounds isn't much, but moving through the terrain we just went through was rough.

4
All that stuff seems to centralize on your hips.

7
Torso pain is from the Hidalgo heart monitor; it rubs all over the side. Legs are painful because the load of the grenadier on the leg panels just makes it so heavy you get "smoked" quickly. Maybe if you could come up with something that attached to the body armor itself. The legs panels are just a bad idea for all those rounds.

8
Sweat in eyes. Leg clips rubbing together cause chafing. Heart monitor piece bothered by back part of IBA.

Comments (by Roster #)

BASELINE
Again the Hidalgo.
IBA has no padding on shoulders; causes the shoulders to start aching. The back plate rides high and bounces off the lower back.
IBA rubs your head and neck raw.
The heart monitor dug into my chest and pushed into my sternum. IBA rubbed neck and weight from it shifted from one shoulder to the other.
The IBA weight is not distributed throughout the body so there is a little lower back pain after a while. With the ACH, heat buildup is extremely high and the padding hurts the head after wearing it for long periods of time. The floating neck pad moves a lot while "on the move" so you constantly have to adjust the ACH, especially when sweating.

4. Did any of the equipment you wore hinder your ability to complete the mission?

Roster No.	FFW									BASELINE
	1	2	3	4	5	6	7	8	9	
No	1	1	0	1	1	1	1	1	1	9
Yes	0	0	1	0	0	0	0	0	0	0

8
Nothing really hindered my ability to complete the mission.

BASELINE-
Didn't hinder my ability to complete the mission but caused more irritation than needed. Heart monitor.

5. Did any of the equipment you wore present an unsafe condition?

Roster No.	FFW									BASELINE
	1	2	3	4	5	6	7	8	9	
No	1	1	1	1	1	1	1	1	1	9
Yes	0	0	0	0	0	0	0	0	0	0

6
Maybe a little looser on the mag pouches so the mags can be stowed faster with another mag already in the pouch.

6. Did you move any of your equipment while moving to the objective to a different location to make your job easier or less irritable?

Roster No.	FFW									BASELINE
	1	2	3	4	5	6	7	8	9	
No	0	0	0	1	1	1	1	1	0	7
Yes	1	1	1	0	0	0	0	0	1	2

Comments (by Roster #)

1
I adjusted the tightening straps for the knee pads to stop the rubbing.

2
Knee pads I moved them back on my knee for support.

3

Adjusted the belt several times.

9
I have not worn it enough to make up my mind.

10
Knee pads shift.

BASELINE
Just the ACH because it keeps coming loose. I just readjusted it back to where I wear it.
Shifting the weight around from shoulder to shoulder and rubbing of the neck.

7. Were you able to reach all your ammunition magazines?

Roster No.	FFW									BASELINE
	1	2	3	4	5	6	7	8	9	
No	0	0	0	0	0	0	0	0	0	0
Yes	1	1	1	1	1	1	1	1	0	8
NR	0	0	0	0	0	0	0	0	1	1

9
Yes because i had a drop bag.

8. Were you able to stow your expended magazines?

Roster No.	FFW									BASELINE
	1	2	3	4	5	6	7	8	9	
No	0	0	0	0	0	0	1	0	0	2
Yes	1	1	1	1	1	1	0	1	0	7
NR	0	0	0	0	0	0	0	0	1	0

Comments (by Roster No.)

8
Didn't use up any of my magazines.

FFW FIRE TEAM ONLY:

9. Did any of the electronic components/wires interfere with your ability to carry combat equipment and/or munitions?

Roster No.	FFW								
	1	2	3	4	5	6	7	8	9
No	1	1	1	1	1	1	1	1	0
Yes	0	0	0	0	0	0	0	0	0
NR	0	0	0	0	0	0	0	0	1

4
Electronics should be moved out of sight and mind (the back or back of the belt would be good).

10. Are there any portions of the chassis that are "fixed in place" that you would move if you could?

Roster No.	FFW								
	1	2	3	4	5	6	7	8	9
No	1	0	1	0	1	0	0	0	0
Yes	0	1	0	1	0	1	1	0	0
NR	0	0	0	0	0	0	0	1	1

2
Butt stock pad, I would take it off.

7
The latch that closes it.

11. In which tactical situations would you consider wearing the following options?

SHOULDER PLATE INSERTS	NUMBER OF RESPONSES FFW								
Roster No.	1	2	3	4	5	6	7	8	9
Movement to contact	0	0	1	0	0	0	0	0	0
Reconnaissance	0	0	1	0	0	0	0	0	0
Attack	0	0	1	0	1	1	1	0	0
Defense	1	1	1	1	0	1	0	1	0
Counter-attack	0	0	1	0	1	0	0	0	0

NECK PROTECTOR INSERTS	NUMBER OF RESPONSES FFW								
Roster No.	1	2	3	4	5	6	7	8	9
Movement to contact	0	0	0	0	0	0	0	0	0
Reconnaissance	0	0	0	0	0	0	0	0	0
Attack	0	0	0	0	0	1	0	0	1
Defense	1	0	0	0	0	1	0	0	0
Counter-attack	0	0	0	0	0	0	0	0	1

BELLY PANEL INSERTS	NUMBER OF RESPONSES FFW								
Roster No.	1	2	3	4	5	6	7	8	9
Movement to contact	0	0	0	0	0	0	0	0	1
Reconnaissance	0	0	0	0	0	0	0	0	1
Attack	0	0	0	0	0	1	1	0	1
Defense	1	0	0	0	0	1	0	0	1
Counter-attack	0	0	0	0	0	0	0	0	1

THIGH INSERTS	NUMBER OF RESPONSES FFW								
Roster No.	1	2	3	4	5	6	7	8	9
Movement to contact	0	0	1	0	1	0	1	1	0
Reconnaissance	0	0	0	0	0	0	1	1	0
Attack	1	0	1	1	1	0	1	1	1
Defense	1	0	0	1	0	0	0	1	1
Counter-attack	0	0	1	0	1	0	0	1	1

Comments (by Roster No.)

1
All of the extra protectors would be most beneficial to a gunner in a HMMWV (.50 cal or MK19 gunner, D Co.).

4
Thigh panels should remain completely optional as they will not help SAW gunners at all.

12. Were you able to reach your individual first aid kit?

Roster No.	FFW									BASELINE
	1	2	3	4	5	6	7	8	9	
No	0	0	0	0	0	0	0	0	0	
Yes	1	1	1	1	1	1	1	1	0	
NR	0	0	0	0	0	0	0	0	1	

13. Did you encounter any difficulty donning the chassis?

Roster No.	FFW									BASELINE
	1	2	3	4	5	6	7	8	9	
No	1	1	1	1	0	0	1	0	0	
Yes	0	0	0	0	1	1	0	0	0	
NR	0	0	0	0	0	0	0	1	1	

6
Locking it in. The hook idea stinks; I would just use clips.

7
When putting on the Velcro, pads come off.

14. Did you encounter any difficulty doffing the chassis?

Roster No.	FFW									BASELINE
	1	2	3	4	5	6	7	8	9	
No	1	1	1	1	0	0	0	0	0	
Yes	0	0	0	0	1	1	1	0	0	
NR	0	0	0	0	0	0	0	1	1	

7
The latch that closes the system.

15. Did you modify any tactics or techniques because of the FFW equipment?

Roster No.	FFW									BASELINE
	1	2	3	4	5	6	7	8	9	
No	1	1	1	1	1	1	1	1	0	
Yes	0	0	0	0	0	0	0	0	0	
NR	0	0	0	0	0	0	0	0	1	

16. How would you change the FFW ensemble you wore if you could?

Comments (by Roster No.)

1
Use a lighter material for the camouflaged part of the uniform and make the knee pads shorter. Find a way to remove the zipper on the shirt or pad it somehow.

4
The pants need mesh so when you unzip them you don't get bugs up your rear and you will definitely need to unzip them; they are hot.

6
Get rid of the little stuff like the disconnector on the side with the wires; the shooting platforms change to something like on a shooting vest.

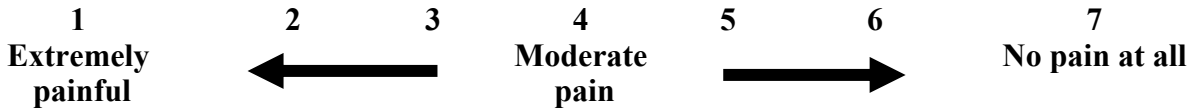
7
The cords that tighten the front and back just dangle, the latch that closes in the front move it to the center some way, and make the camelback bigger.

8
Wearing the leg pieces, can't get to pockets.

9
Make the drop legs lighter and give the belt suspenders.

FFW HELMET ASSEMBLY ONLY:

17. Using the scale below, please address each concern/issue with your level of comfort while wearing the FFW helmet during the exercise?

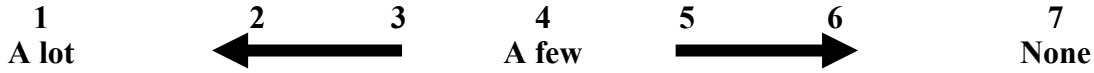


CONCERN/ISSUE	MEAN RESPONSE FFW								
Roster No.	1	2	3	4	5	6	7	8	9
Pressure to the top of head while wearing helmet	7.00	7.00	6.00	7.00	7.00	7.00	6.00	7.00	NR
Pressure to the side of head (along the straps)	7.00	7.00	7.00	2.00	7.00	7.00	6.00	7.00	NR
Comfort level of the FFW helmet with foam liner	7.00	7.00	7.00	4.00	7.00	7.00	6.00	7.00	NR
Comfort level of the FFW helmet with rigid liner	7.00	7.00	7.00	4.00	7.00	7.00	6.00	NR	NR

Comments (by Roster #)

1
I used the ACH/MICH.

18. Using the scale below, please evaluate the level of problems encountered with the following characteristics.



CHARACTERISTICS	MEAN RESPONSE								
	FFW								
Roster No.	1	2	3	4	5	6	7	8	9
Heat buildup with foam liner	7.00	7.00	2.00	7.00	7.00	2.00	5.00	3.00	NR
Heat buildup with rigid liner	7.00	7.00	3.00	2.00	7.00	2.00	5.00	NR	NR
Perspiration buildup with the foam liner	7.00	7.00	1.00	7.00	7.00	2.00	5.00	5.00	NR
Perspiration buildup with the rigid liner	7.00	7.00	1.00	2.00	7.00	2.00	3.00	NR	NR

Comments (by Roster #)

1
I used the ACH/MICH.

7
The FFW is very hot; it allows air to flow through, but I think it is hotter than the IBA while "on the move".

8
Need something to catch sweat from entering eyes.
Sweat a big problem. Irritates the eyes while moving or in motion.

9
Helmets are hot and it is Georgia; there is not much you can do.

Table C-4. Questionnaires categorized, movement to contact, baseline versus FFW, day 2 only.

I categorized the Likert scale means using the following systems:

Preference	Difference
Strong Preference	> .99
Moderate Preference	.25 - .99
No Clear Preference	< .25

Items for which there was a strong preference for the FFW system:

Question	Base	FFW	Diff
Hot spots	3.88	5.50	-1.63
Ability to breathe	4.50	6.13	-1.63
Torso chafing in front	3.88	5.00	-1.13
Neck/head chafing	4.88	6.00	-1.13
Arm/shoulder chafing	5.00	6.00	-1.00

Items for which there was a moderate preference for the FFW system:

Question	Base	FFW	Diff
Torso chafing in back	4.75	5.63	-0.88
Access to stowed items	5.25	6.13	-0.88
Use of hand and arm signals	5.50	6.00	-0.50
Overall comfort	4.25	4.75	-0.50

Items for which there was no clear preference for either system:

Question	Base	FFW	Diff
Ability to obtain a good sight picture with your weapon	5.50	5.75	-0.25
Target identification	5.50	5.75	-0.25
Ease of head movement	5.86	6.00	-0.14
Ease of torso movement	5.00	5.13	-0.13
Ease of arm movement	5.13	5.13	0.00
Equipment snagging	5.25	5.25	0.00
Pressure points	5.63	5.50	0.13
Equipment pinching	4.75	4.63	0.13

Items for which there was a moderate preference for the Baseline system:

Question	Base	FFW	Diff
Ease of assuming prone position	5.88	5.57	0.30
Bruising on your body	5.63	5.25	0.38
Move through swampy areas or streams	5.67	5.29	0.38
Load adjustment	5.88	5.38	0.50
Move through thick brush and vines	5.29	4.63	0.66
Leg/thigh chafing	6.25	5.38	0.88
Weight shifting	5.00	4.13	0.88

Items for which there was a strong preference for the Baseline system:

Question	Base	FFW	Diff
Ease of assuming kneeling position	6.13	4.88	1.25
Equipment hindering movement	5.75	4.38	1.38
Conducting IMT	5.00	3.50	1.50
Ability to run	5.63	3.88	1.75
Ease of leg movement	6.13	3.75	2.38

Table C-5. Movement to contact, what they wore, day 4.

Position	FFW	BASE
Team leader	Chassis with Three ammunition pouches/six magazines front One smoke front IFAK left side One battery left side Camel-back back left Leader's computer back Battery right side Radio right side Display right side Ballistic belt Shoulder armor Belly armor	IPA with First aid kit front Three ammunition pouches with six magazines One smoke front Camel back
M203	Soldier variant helmet w/ drop down Chassis with Four 40-mm rounds right side Four 40-mm rounds on left front Four 40-mm rounds on right front Three ammunition pouches lower front SA display right front CLS left side One battery under left arm Camel back Computer lower back One battery on right rear One radio right side Ballistic belt Belly armor Shoulder armor	IPA with Six 40-mm rounds front Three ammunition pouches with six magazines Four 40-mm rounds left side IFAK back Camel back Two 40-mm rounds right side
SAW	Leader variant helmet w/glasses Chassis with Two 100-rd on belt left and right Display right side CLS left side Battery lower back Health hub beside battery SA box lower right rear Shoulder armor Belly armor Ballistic belt with suspenders	ACH helmet Protective eye ware IPA with First aid pouch upper left front Four 100-rd ammunition lower front Two grenade pouches upper front Camel back
Rifleman	Chassis with Three ammunition pouches front One smoke front IFAK left side Camel back CLS back Butt pack back Health hub back Radio right side Display right side Ballistic belt Belly armor Shoulder armor	IPA with Three ammunition pouches front One smoke front IFAK left side Camel back CLS back

Table C-6. Questionnaire results, day 4, movement to contact and attack objective, day 4.

DUTY POSITIONS/SAMPLE SIZE:

FIRE TEAM LEADER (FTL) = 2
AUTOMATIC RIFLEMAN (AR) = 2
GRENADIER (G) = 2
RIFLEMAN (R) = 2

1. Using scale below, please rate your ability to complete the tasks shown with the equipment you wore.

1	2	3	4	5	6	7
Extremely hard	**Very hard**	**Hard**	**Neutral**	**Easy**	**Very easy**	**Extremely easy**

TASKS	MEAN RESPONSE							
	FFW				BASELINE			
	FTL	AR	G	R	FTL	AR	G	R
Ease of leg movement	6.50	6.00	6.00	7.00	7.00	7.00	7.00	5.00
Ease of assuming prone position	5.00	6.50	6.50	7.00	5.50	6.50	7.00	6.00
Ease of assuming kneeling position	5.50	6.50	6.50	7.00	6.50	6.50	6.50	6.50
Ease of arm movement	5.50	5.50	6.50	6.50	6.50	6.00	6.50	6.00
Ease of torso movement	5.50	5.50	6.50	7.00	6.50	6.00	6.00	5.50
Ease of head movement	6.00	6.50	6.50	7.00	6.50	6.50	6.50	6.50
Ability to run	6.00	6.00	6.00	5.50	7.00	7.00	6.00	6.50
Use of hand and arm signals	7.00	6.50	7.00	6.50	7.00	6.50	6.50	5.50
Move through swampy areas or streams	6.50	7.00	7.00	7.00	7.00	7.00	7.00	5.00
Move through thick brush and vines	6.50	6.50	6.00	6.50	6.50	6.00	6.50	5.50
Ability to obtain a good sight picture with your weapon	6.50	6.50	6.50	7.00	6.00	6.50	7.00	6.00
Target identification	7.00	6.00	6.50	7.00	7.00	6.50	7.00	6.50
Conducting IMT	6.50	6.00	5.50	7.00	6.50	7.00	7.00	6.00

Comments	**No. of Responses**
FFW-G	
Without the leg panels, I had no trouble at all moving through the brush or running.	1
With putting all the gear on the chassis it was a lot easier to move all around.	1

Comments	**No. of Responses**
FFW-R	
The ballistic belt around the outside of my hips restricted me from sprinting.	1
BASELINE-AR	
Try using some fog-resistant Rainex on eye protection to help reduce fogging and sweat buildup.	1

2. Using the scale below, rate the problem areas encountered with the equipment you wore.

1	2	3	4	5	6	7
A lot	←		**A few**		→	**None**

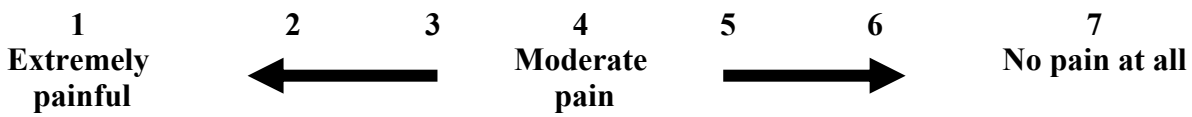
PROBLEM AREAS	MEAN RESPONSE							
	FFW				BASELINE			
	FTL	AR	G	R	FTL	AR	G	R
Pressure points	6.50	6.00	5.50	7.00	6.50	6.50	6.00	5.50
Hot spots	6.50	4.50	5.50	7.00	6.50	6.00	5.00	5.50
Bruising on your body	5.50	4.50	6.00	7.00	6.50	6.50	7.00	6.00
Torso chafing in front	6.50	6.00	4.50	5.50	6.50	5.50	4.00	5.50
Torso chafing in back	6.50	5.00	6.50	7.00	6.50	6.50	6.00	6.50
Arm/shoulder chafing	4.00	4.50	6.50	7.00	5.00	5.50	6.50	6.00
Leg/thigh chafing	5.50	4.50	6.50	6.00	6.50	7.00	6.50	6.50
Neck/head chafing	6.00	4.00	6.50	5.50	6.50	6.00	7.00	5.50
Equipment snagging	6.00	6.00	6.50	7.00	6.50	6.00	7.00	6.50
Equipment hindering movement	6.00	5.50	6.50	7.00	6.50	6.50	7.00	6.50
Weight shifting	4.50	6.00	6.50	7.00	6.50	6.50	5.50	4.50
Equipment pinching	4.50	4.50	4.50	7.00	6.50	7.00	5.50	5.50
Load adjustment	6.00	6.50	6.50	7.00	6.50	7.00	7.00	6.00
Access to stowed items	6.00	6.50	6.50	7.00	5.50	7.00	4.50	6.50
Ability to breathe	6.00	6.50	6.50	7.00	6.50	7.00	5.50	4.50
Overall comfort	5.00	5.50	6.00	6.50	5.50	7.00	4.50	4.00

FFW-FTL
Shoulder and belly panel hold in the heat and don't let air flow. 1

FFW-AR
Left leg knee pad rubbing. Lower back being rubbed by back belt. 1

Comments	No. of Responses
FFW-G	
Four-strap heart monitor scratches the collar bone and side.	1
A few times, the belly armor and the chassis pinched the abdominal area but it was nothing that was too uncomfortable.	1
FFW-R	
I have no complaints.	1
The flat heart monitor band scratches the side of my body under my left arm, back, and it rubbed my neck.	1
BASELINE-AR	
The two-strap heart bra stinks because it eats your neck away.	1
BASELINE-G	
The IBA pulls down on the shoulders.	1

3. Using the scale below, what level of pain (if any) did you experience with the equipment you wore?



PAIN	MEAN RESPONSE							
	FFW				BASELINE			
	FTL	AR	G	R	FTL	AR	G	R
Upper back	6.00	6.50	5.50	7.00	4.00	7.00	4.50	6.00
Lower back	7.00	4.50	4.50	7.00	5.00	6.00	6.50	4.00
Neck	7.00	5.00	6.00	6.50	4.50	5.50	7.00	4.50
Head	7.00	6.50	7.00	7.00	6.00	7.00	7.00	6.00
Torso front	7.00	6.50	4.50	6.50	5.00	5.50	7.00	6.00
Groin	7.00	7.00	7.00	7.00	6.00	7.00	4.50	6.50
Legs	7.00	6.50	6.00	7.00	6.00	7.00	7.00	6.50
Arms	7.00	7.00	6.50	7.00	6.00	7.00	7.00	6.50
Eyes	7.00	7.00	7.00	7.00	6.00	7.00	7.00	6.50

FFW-FTL

Comments	No. of Responses
Pinching between belt and vest.	1

FFW-AR

Comments	No. of Responses
Back being rubbed by belt. Lower leg being rubbed by knee pad.	1

FFW-G

Comments	No. of Responses
Back pain is just from wearing the gear and getting used to how the weight is set up.	1

4. Did any of the equipment you wore hinder your ability to complete the mission?

	NUMBER OF RESPONSES							
	FFW				BASELINE			
	FTL	AR	G	R	FTL	AR	G	R
No	2	2	2	2	2	2	2	2
Yes	0	0	0	0	0	0	0	0

5. Did any of the equipment you wore present an unsafe condition?

	NUMBER OF RESPONSES							
	FFW				BASELINE			
	FTL	AR	G	R	FTL	AR	G	R
No	1	2	2	2	2	2	2	2
Yes	0	0	0	0	0	0	0	0
NR	1	0	0	0	0	0	0	0

6. Did you move any of your equipment while moving to the objective to a different location to make your job easier or less irritable?

	NUMBER OF RESPONSES							
	FFW				BASELINE			
	FTL	AR	G	R	FTL	AR	G	R
No	2	1	2	0	2	1	2	1
Yes	0	0	0	2	0	1	0	1
NR	0	1	0	0	0	0	0	0

FFW-AR
Electronics to the lower back. 1

FFW-R
Ab plate prevented pinching. 1
Move the belt up. My belt didn't have any suspenders. 1

BASELINE-AR
The glasses got too sweaty. I stuck them in the MOLLE on my vest. 1

Comments **No. of Responses**

BASELINE-R
Shifted my IBA around on my shoulders. 1

7. Were you able to reach all your ammunition magazines?

	NUMBER OF RESPONSES							
	FFW				BASELINE			
	FTL	AR	G	R	FTL	AR	G	R
No	1	0	0	0	0	0	0	0
Yes	1	2	2	2	2	2	1	2
NR	0	0	0	0	0	0	1	0

8. Were you able to stow your expended magazines?

	NUMBER OF RESPONSES							
	FFW				BASELINE			
	FTL	AR	G	R	FTL	AR	G	R
No	1	0	0	0	0	0	0	1
Yes	1	2	2	2	2	2	2	1

BASELINE-G
It was hard to stow them. 1

BASELINE-R
I had to put them in my pocket. 1

FIRE TEAM ONLY:

9. Did any of the electronic components/wires interfere with your ability to carry combat equipment and/or munitions?

	NUMBER OF RESPONSES			
	FFW			
	FTL	AR	G	R
No	2	2	2	2
Yes	0	0	0	0

10. Are there any portions of the chassis that are “fixed in place” that you would move if you could?

	NUMBER OF RESPONSES			
	FFW			
	FTL	AR	G	R
No	2	0	2	2
Yes	0	1	0	0
NR	0	1	0	0

11. In which tactical situations would you consider wearing the following options?

SHOULDER PLATE INSERTS	NUMBER OF RESPONSES			
	FFW			
	FTL	AR	G	R
Movement to contact	1	0	1	1
Reconnaissance	0	0	0	0
Attack	0	0	1	1
Defense	1	0	1	1
Counter-attack	1	0	1	1

NECK PROTECTOR INSERTS	NUMBER OF RESPONSES			
	FFW			
	FTL	AR	G	R
Movement to contact	0	0	0	0
Reconnaissance	0	0	0	0
Attack	0	0	0	0
Defense	0	0	1	0
Counter-attack	0	0	0	0

BELLY PANNEL INSERTS	NUMBER OF RESPONSES			
	FFW			
	FTL	AR	G	R
Movement to contact	1	0	1	1
Reconnaissance	0	0	0	0
Attack	1	0	1	1
Defense	1	0	1	1
Counter-attack	1	0	1	1

THIGH INSERTS	NUMBER OF RESPONSES			
	FFW			
	FTL	AR	G	R
Movement to contact	0	0	1	1
Reconnaissance	0	0	0	0
Attack	1	0	1	1
Defense	1	0	1	1
Counter-attack	1	0	1	1

12. Were you able to reach your Individual First Aid Kit?

	NUMBER OF RESPONSES			
	FFW			
	FTL	AR	G	R
No	0	0	0	0
Yes	2	2	2	2

13. Did you encounter any difficulty donning the chassis?

	NUMBER OF RESPONSES			
	FFW			
	FTL	AR	G	R
No	1	2	2	2
Yes	1	0	0	0

Comments	No. of Responses
FFW-FTL	
A little harder with the shoulder pad.	1

14. Did you encounter any difficulty doffing the chassis?

	NUMBER OF RESPONSES			
	FFW			
	FTL	AR	G	R
No	2	2	2	2
Yes	0	0	0	0

15. Did you modify any tactics or techniques because of the FFW equipment?

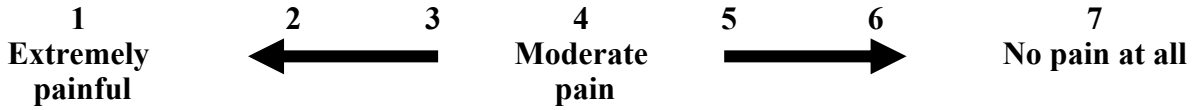
	NUMBER OF RESPONSES			
	FFW			
	FTL	AR	G	R
No	2	2	2	2
Yes	0	0	0	0

16. How would you change the FFW ensemble you wore if you could?

Comments	No. of Responses
FFW-G	
Get rid of the shoulder pads for firing and put some flat rubber or something there.	1

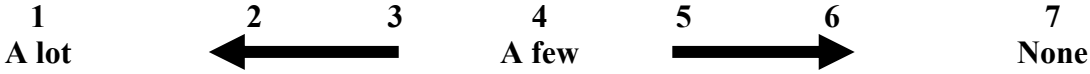
FFW HELMET ASSEMBLY ONLY:

17. Using the scale below, please address each concern/issue with your level of comfort while wearing the FFW helmet during the exercise?



PAIN CONCERNS	MEAN RESPONSE FFW			
	FTL	AR	G	R
Pressure to the top of the head from FFW helmet	7.00	6.00	6.50	7.00
Pressure to the sides of the head from FFW helmet and straps	7.00	6.00	6.50	7.00
Comfort level of the FFW helmet with foam liner	7.00	7.00	6.00	6.50
Comfort level of the FFW helmet with rigid liner	7.00	4.50	6.00	5.00

18. Using the scale below, please evaluate the level of problems encountered with the following characteristics.



HEAT ISSUES	MEAN RESPONSE FFW			
	FTL	AR	G	R
Heat buildup with foam liner	5.50	NR	5.00	6.50
Heat buildup with rigid liner	5.00	5.00	4.00	5.00
Perspiration buildup with the foam liner	5.50	NR	5.00	6.50
Perspiration buildup with the rigid liner	7.00	4.50	3.50	6.00

Table C-7. FFW Soldier video taped comments.

Movement to Contact, Day 4

- The B-team leader's belt was rubbing against the chassis and made noises while patrolling.
- The SAW gunner's belt shifted and was not balanced when he removed rounds from one side to load his weapon.
- The rifleman's neck was chafed by the medical alert harness
- The Soldiers claimed the wool shirt was hotter than the synthetic material

Table C-8. Movement to contact, baseline versus FFW, day 4 only.

I categorized the Likert scale MEANS using the following systems:

Preference	Difference
Strong Preference	> .99
Moderate Preference	.25 - .99
No Clear Preference	< .25

Items for which there was a moderate preference for the FFW system:

Question	Base	FFW	Diff
Access to stowed items	5.88	6.50	-0.63
Ability to breathe	5.88	6.50	-0.63
Move through swampy areas or streams	6.20	6.80	-0.60
Overall comfort	5.25	5.75	-0.50
Use of hand and arm signals	6.38	6.75	-0.38

Items for which there was no strong preference for either system:

Question	Base	FFW	Diff
Move through thick brush and vines	6.13	6.38	-0.25
Ability to obtain a good sight picture with your weapon	6.38	6.63	-0.25
Torso chafing in front	5.38	5.63	-0.25
Weight shifting	5.75	6.00	-0.25
Ease of assuming prone position	6.25	6.43	-0.18
Ease of torso movement	6.00	6.13	-0.13
Pressure points	6.13	6.25	-0.13
Hot spots	5.75	5.88	-0.13
Ease of head movement	6.50	6.50	0.00
Ease of leg movement	6.50	6.38	0.13
Ease of assuming kneeling position	6.50	6.38	0.13
Target identification	6.75	6.63	0.13
Torso chafing in back	6.38	6.25	0.13
Equipment snagging	6.50	6.38	0.13
Load adjustment	6.63	6.50	0.13
Ease of arm movement	6.25	6.00	0.25
Arm/shoulder chafing	5.75	5.50	0.25

Items for which there was a moderate preference for the Baseline system:

Question	Base	FFW	Diff
Equipment hindering movement	6.63	6.25	0.38
Conducting IMT	6.67	6.17	0.50
Ability to run	6.63	5.88	0.75
Bruising on your body	6.50	5.75	0.75
Neck/head chafing	6.25	5.50	0.75

Items for which there was a strong preference for the Baseline system:

Question	Base	FFW	Diff
Leg/thigh chafing	6.63	5.63	1.00
Equipment pinching	6.13	5.13	1.00

Appendix D. MOUT Activities

Table D-1. Room clearing in MOUT, sample size = 8.

A – FFW W/BELT
B – FFW W/UP ARMOR KIT
C - BASELINE

1. Using the scale below, please rate your ability to complete the tasks shown with the equipment you wore.

1	2	3	4	5	6	7
Extremely hard	**Very hard**	**Hard**	**Neutral**	**Easy**	**Very easy**	**Extremely easy**

TASKS	MEAN RESPONSE		
	A	B	C
Ease of leg movement	5.12	5.00	5.88
Ease of assuming prone position	5.33	4.00	6.25
Ease of assuming kneeling position	5.80	5.00	6.33
Ease of arm movement	5.50	5.13	6.00
Ease of torso movement	5.75	5.38	5.50
Ease of head movement	5.75	3.13	5.75
Ability to run	4.75	4.29	6.13
Use of hand and arm signals	6.33	5.17	6.00
Move through doorways	5.75	5.38	5.75
Move through mouse holes	4.50	4.00	5.43
Ability to conduct reflexive shooting	5.63	5.50	6.00
Ability to engage enemy	5.88	5.50	6.25
Conducting IMT	6.00	5.25	6.25
Move through windows	4.00	3.25	6.00
Ability to ascend and descend stairs	6.00	4.50	6.67
Assume the standing/ready or "stacked position"	6.00	5.88	6.13
Ability to crouch (bend and maintain reduced exposure position)	5.71	5.25	5.63

Comments	**No. of Responses**
A-FFW W/BELT	
Can't run with the drop armor on the legs; pants are ridiculously hot. I would rather fight naked but could be good for fall and winter, knee pads bothering me today some chafing in the calves.	1
Leg panels restrict speed, but slow is smooth and smooth is fast.	1
Legs being restrictive when running.	1

Comments	**No. of Responses**
B-FFW W/UP ARMOR KIT	
Dog collar does not allow me to look up. Blocks ventilation and traps heat in more.	1
My situational awareness was decreased due to the addition of the neck collar; it gave me an enclosed feeling.	1
Neck brace prevents me from moving my neck.	1
The neck guard takes away from the mobility of the head but it would be good for a 50 cal. gunner; I didn't like the shoulder or gut plate.	1
Up armor for turrets only.	1

C-BASELINE

Heart monitor too bulky for the IBA.	1
My heart monitor opened my IBA up.	1
The IBA is pretty constraining to mobility.	1

2. Using the scale below, rate the problem areas encountered on this exercise.

1 2 3 4 5 6 7
A lot ← A few → None

PROBLEM AREAS	MEAN RESPONSE		
	A	B	C
Pressure points	6.25	6.25	6.00
Hot spots	5.63	5.50	5.86
Bruising on your body	5.88	5.50	5.43
Torso chafing in front	5.88	5.75	4.50
Torso chafing in back	6.00	5.63	5.29
Arm/shoulder chafing	5.88	4.88	5.71
Leg/thigh chafing	5.63	5.63	5.83
Neck/head chafing	6.38	5.37	5.71
Equipment snagging	6.50	5.00	5.71
Equipment hindering movement	5.63	3.88	6.29
Weight shifting	6.13	6.25	5.29
Equipment pinching	5.38	5.63	5.14
Load adjustment	5.75	6.00	5.71
Access to stowed items	5.88	6.00	5.86
Ability to breathe	5.75	4.88	4.33
Overall comfort	5.25	4.13	4.57
Armor preventing flexing	6.00	5.38	4.86

Comments	**No. of Responses**
A-FFW W/BELT	
Fix the pants; way too hot. But the ventilation in the chassis is the one really good thing you got going.	1
Bottom of shin guard rubbed my shin; it's starting to become sensitive. I had a little rubbing of my neck and thighs; had a slight discomfort by straps.	1
Shoulder straps rubbing collar bone.	1
Vest makes it hard to breathe because it is tight around the upper body.	1
B-FFW W/UP ARMOR KIT	
Dog collar restricts head movement with leader helmet.	1
The neck pro was just too constraining to movement.	2
Torso chafing; once again is Hidalgo heart monitor, and movement is slightly restricted by leg panels.	1
C-BASELINE	
Heart monitor.	1
Heart monitor being pressed against skin by IBA.	2
Medic strap pushes in my chest with the IBA on it. Also hurts me on breathing.	1
The IBA tends to shift from shoulder to shoulder.	1

3. Did any of the equipment you wore hinder your ability to complete the mission?

	A	B	C
No	5	4	8
Yes	2	4	0
NR	1	0	0

A-FFW W/BELT

Comments	No. of Responses
My drop armor slowed my run big time.	1
The stack was way too big moving on the building.	1
I couldn't run as fast as normal because of the drop leg.	1

B-FFW W/UP ARMOR KIT

Comments	No. of Responses
Dog collar stops head movement.	1
Neck movement.	1
Neck pro just took away from situational awareness.	1

4. Did any of the equipment you wore help your ability to complete the mission?

	A	B	C
No	7	8	8
Yes	1	0	0

A-FFW W/BELT

Comments	No. of Responses
Drop mag pouch; reduces mag change time.	1

5. Did any of the equipment you wore present an unsafe condition?

	A	B	C
No	5	7	8
Yes	1	1	0
NR	2	0	0

A-FFW W/BELT

Comments	No. of Responses
Can't run, can't hide.	1

B-FFW W/UP ARMOR KIT

Comments	No. of Responses
Can't look, can't acquire target.	1

6. Did you move any of your equipment while moving to the objective to make your job easier or less irritating?

	A	B	C
No	7	7	8
Yes	0	1	0
NR	1	0	0

B-FFW W/UP-ARMOR KIT

The shoulder pad was nice. 1

7. Were you able to reach all your ammunition magazines?

	A	B	C
No	0	0	0
Yes	8	8	8

8. Were you able to stow your expended magazines?

	A	B	C
No	0	0	1
Yes	7	8	7
NR	1	0	0

Comments **No. of Responses**

A-FFW W/BELT
Drop pouch. 1

B-FFW W/UP-ARMOR KIT
Magazine drop pouch. 1

C-BASELINE
Put them in my cargo pocket. 1

9. Did any of the electronic components/wires interfere with your ability to carry combat equipment?

	A	B	C
No	8	8	NA
Yes	0	0	

10. Are there any items of the chassis that are "fixed in place" that you would move if you could?

	A	B	C
No	3	4	NA
Yes	5	4	

Comments **No. of Responses**

A-FFW W/BELT
All electronics to the back except the little display screen. 1
For guys with bigger upper bodies, I would widen the shoulder part of it. 1
Medical computer. 1
The batteries. 1

B-FFW W/UP ARMOR KIT
Batteries. 1
Medical monitor. 1

11. In which tactical situations would you consider wearing the following options?

	NUMBER OF RESPONSES								
	A				B				C
	a	b	c	d	a	b	c	d	
Movement to contact	4	0	2	6	3	0	3	5	NA
Reconnaissance	0	0	1	4	1	0	1	4	
Attack	5	1	4	6	6	1	4	6	
Defense	4	2	4	5	3	3	4	6	
Counter-attack	4	0	3	6	2	0	3	6	

*a-shoulder plate; b-neck protector; c-Belly panel; d-Thigh inserts

B-FFW W/UP ARMOR KIT

Neck pro would be good for convoy operations. 1

12. Were you able to reach your individual first aid kit?

	A	B	C
No	0	0	NA
Yes	8	8	

13. Did you encounter any difficulty donning the chassis?

	A	B	C
No	8	6	NA
Yes	0	2	

Comments **No. of Responses**

B-FFW W/UP ARMOR KIT

Neck pro was a problem getting adjusted by myself. 1

The dog collar. 1

14. Did you encounter any difficulty doffing the chassis?

	A	B	C
No	8	7	NA
Yes	0	1	

B-FFW W/UP-ARMOR KIT

The latch needs to be filed or just change the whole concept. 1

15. Did you modify any tactics or techniques because of the equipment?

	A	B	C
No	8	8	NA
Yes	0	0	

16. Is there anything you especially liked about the FFW ensemble and the two up-armor kits

(MOUT and Patrolling kits)?

	A	B	C
No	5	4	NA
Yes	0	4	
NR	3	0	

17. How would you change the FFW ensemble you wore if you could?

B-FFW W/UP-ARMOR KIT

I like the shoulder and gut plates.	2
There is more access to gear and equipment.	1
Lose the dog collar. Stack all the electronic equipment in the back that way you have more room to stow other equipment.	1
The neck is not good for dismounted soldiers.	1

FFW HELMET ASSEMBLY ONLY:

18. Using the scale below, please address each concern/issue with your level of comfort while wearing the FFW helmet during the exercise?

1 Extremely painful ← **2 3 4 Moderate pain** → **5 6 7 No pain at all**

CONCERN/ISSUE	MEAN RESPONSE		
	A	B	C
a. Pressure to top of head while wearing helmet	6.63	6.62	NA
b. Pressure to side of head (along the straps)	6.13	6.38	
c. Comfort level of FFW helmet with foam liner	6.50	6.83	
d. Comfort level of FFW helmet with rigid liner	5.83	5.60	

Comments	No. of Responses
A-FFW W/BELT	
I can't completely customize it to my head.	1
If the ear plugs aren't in the right place, it puts a little pressure on the head.	1

19. Using the scale below, please evaluate the level of problems encountered with the following characteristics of the FFW helmet.

1 A lot ← **2 3 4 A few** → **5 6 7 None**

CHARACTERISTICS	MEAN RESPONSE		
	A	B	C
a. Heat buildup with foam liner	5.50	5.83	NA
b. Heat buildup with rigid liner	4.50	5.80	
c. Perspiration buildup with the foam liner	5.50	5.83	
d. Perspiration buildup with the rigid liner	4.83	5.33	

A-FFW W/BELT

The helmet got heated fairly well in the top.	1
Try and change the color from black.	1

B-FFW W/UP ARMOR KIT

I liked the helmet a lot more than the ACH.	1

Table D-2. Room excursion questionnaire results, sample size = 8.

1. Using the scale below, please rate your ability to complete the tasks shown with the equipment you wore.

1	2	3	4	5	6	7
Extremely hard	**Very hard**	**Hard**	**Neutral**	**Easy**	**Very easy**	**Extremely easy**

TASKS	MEAN RESPONSE
Ease of leg movement	6.63
Ease of assuming prone position	6.75
Ease of assuming kneeling position	6.83
Ease of arm movement	6.50
Ease of torso movement	6.50
Ease of head movement	6.50
Ability to run	6.50
Use of hand and arm signals	6.50
Move through doorways	6.75
Move through mouse holes	6.00
Ability to conduct reflexive shooting	6.63
Ability to engage enemy	6.50
Conducting IMT	7.00
Move through windows	6.00
Ability to ascend and descend stairs	6.75
Assume the standing/ready or "stacked position"	6.71
Ability to crouch (bend and maintain reduced exposure position)	6.25

Comments	**No. of Responses**
Everything was extremely comfortable, allowing for smooth mission execution.	1
Movement was great for all in team.	1
The MOUT site could have been more realistic.	1
I got rid of the leg panels and positioned everything on the chassis, I move more freely and a lot faster and smoother.	1

2. Using the scale below, rate the problem areas encountered on this exercise.

1	2	3	4	5	6	7
A lot	←		**A few**		→	**None**

PROBLEM AREAS	MEAN RESPONSE
Pressure points	6.62
Hot spots	6.38
Bruising on your body	6.38
Torso chafing in front	6.25
Torso chafing in back	6.25
Arm/shoulder chafing	5.75
Leg/thigh chafing	6.62
Neck/head chafing	6.38
Equipment snagging	6.25
Equipment hindering movement	6.50
Weight shifting	6.62
Equipment pinching	5.88
Load adjustment	6.50
Access to stowed items	6.50
Ability to breathe	6.25
Overall comfort	6.00
Armor preventing flexing	6.50

Comments	**No. of Responses**
Hot brass went down the back of my FFW and burned me.	1
Moving the battery to the back right of vest was great; wouldn't change it.	1
Shoulder straps rubbing collar bone.	1

3. Did any of the equipment you wore hinder your ability to complete the mission?

No	8
Yes	0

4. Did any of the equipment you wore help your ability to complete the mission?

No	6
Yes	1
NR	1

Got rid of the leg panels and positioned all rounds on front of chassis.	1
The way we were allowed to configure helped 100%.	1

5. Did any of the equipment you wore present an unsafe condition?

No	8
Yes	0

6. Did you move any of your equipment while moving to the objective to make your job easier or less irritating?

No	8
Yes	0

7. Were you able to reach all your ammunition magazines?

No	0
Yes	8

8. Were you able to stow your expended magazines?

No	0
Yes	8

Comments	**No. of Responses**
Drop pouch.	1

9. Did any of the electronic components/wires interfere with your ability to carry combat equipment?

No	8
Yes	0

But wires do get caught.	1

10. Are there any items of the chassis that are "fixed in place" that you would move if you could?

No	8
Yes	0

11. In which tactical situations would you consider wearing the following options?

NUMBER OF RESPONSES				
	a	**b**	**c**	**d**
Movement to contact	4	0	4	5
Reconnaissance	1	0	1	2
Attack	5	1	4	5
Defense	4	2	4	5
Counter-attack	4	0	4	5

*a-shoulder plate; b-neck protector; c-Belly panel; d-Thigh inserts

12. Were you able to reach your individual first aid kit?

No	1
Yes	7

Comments	**No. of Responses**
I placed it on the back of the chassis because it needs rounds before I need first aid.	1

13. Did you encounter any difficulty donning the chassis?

No	8
Yes	0

14. Did you encounter any difficulty doffing the chassis?

No	8
Yes	0

15. Did you modify any tactics or techniques because of the equipment?

No	8
Yes	0

16. Is there anything you especially liked about the FFW ensemble and the two up-armor kits (MOUT and Patrolling kits)?

No	5
Yes	2
NR	1

Comments	**No. of Responses**
Added the shoulder up armor.	1
Moved the electronic from under right arm to the back to ease the comfort.	1
I like all the rounds configured on the chassis. I would get rid of the leg panels.	1
Ventilation.	1

17. How would you change the FFW ensemble you wore if you could?

FFW HELMET ASSEMBLY ONLY:

18. Using the scale below, please address each concern/issue with your level of comfort while wearing the FFW helmet during the exercise?

1 Extremely painful — **2** — **3** — **4 Moderate pain** — **5** — **6** — **7 No pain at all**

CONCERN/ISSUE	MEAN RESPONSE
a. Pressure to top of head while wearing helmet	6.38
b. Pressure to side of head (along the straps)	6.25
c. Comfort level of FFW helmet with foam liner	6.50
d. Comfort level of FFW helmet with rigid liner	6.00

19. Using the scale below, please evaluate the level of problems encountered with the following characteristics of the FFW helmet.

1 A lot — **2** — **3** — **4 A few** — **5** — **6** — **7 None**

CHARACTERISTICS	MEAN RESPONSE
a. Heat buildup with foam liner	6.17
b. Heat buildup with rigid liner	5.17
c. Perspiration buildup with the foam liner	6.17
d. Perspiration buildup with the rigid liner	5.17

Did not even notice it was on. 1

Table D-3. Loft clearing in MOUT questionnaire results, sample size = 8.

A – FFW w/BELT
B – FFW w/UP ARMOR KIT
C - BASELINE

1. Using the scale below, please rate your ability to complete the tasks shown with the equipment you wore.

1	2	3	4	5	6	7
Extremely hard	**Very hard**	**Hard**	**Neutral**	**Easy**	**Very easy**	**Extremely easy**

TASKS	MEAN RESPONSE		
	FFW w/BELT	FFW w/UP ARMOR KIT	BASELINE
Ease of leg movement	4.88	5.50	6.13
Ease of assuming prone position	5.50	4.75	6.33
Ease of assuming kneeling position	5.71	6.00	6.17
Ease of arm movement	5.63	5.63	6.13
Ease of torso movement	5.88	6.00	5.63
Ease of head movement	6.13	4.13	6.13
Ability to run	5.12	4.63	6.00
Use of hand and arm signals	6.17	5.67	5.86
Move through doorways	5.71	5.75	5.88
Move through mouseholes	2.88	3.63	4.50
Ability to conduct reflexive shooting	5.14	6.25	5.88
Ability to engage enemy	5.29	5.17	6.29
Conducting IMT	6.00	5.75	5.83
Move through windows	4.00	3.50	5.75
Ability to ascend and descend stairs	4.29	4.38	5.71
Assume the standing/ready or "stacked position"	6.25	6.13	6.13
Ability to crouch (bend and maintain reduced exposure position)	5.00	5.13	5.75

Comments **No. of Responses**

A-FFW W/BELT
Going through narrow doorways side of chassis a little bulky. 2
Leg straps came undone somewhere along the mission. 1
Got snagged up in the window. 1
In the mousehole of the loft, had problems getting through. Battery kept getting stuck on way out and on way in, sides of chassis got stuck. 1

Comments	No. of Responses
When I went through the mouse hole, the CLS bag caught.	1
The weight makes it harder to maintain a crouched position for an extended period of time.	1

B-FFW W/UP-ARMOR KIT

Neck guard was stopping the head movement.	2

C-BASELINE

Going into the loft with the RFI on was no problem; nothing got snagged like the FFW gear.	1
The gear is in front so movement through small spaces is a lot easier.	1

2. Using the scale below, rate the problem areas encountered on this exercise.

1 A lot ← **2** **3** **4 A few** **5** **6** → **7 None**

PROBLEM AREAS	MEAN RESPONSE		
	A	B	C
Pressure points	5.00	5.88	6.29
Hot spots	5.75	6.13	6.29
Bruising on your body	6.25	5.25	5.71
Torso chafing in front	5.71	5.75	5.29
Torso chafing in back	5.75	5.75	6.00
Arm/shoulder chafing	6.00	4.88	5.57
Leg/thigh chafing	4.88	5.37	6.29
Neck/head chafing	5.38	4.75	5.29
Equipment snagging	5.63	4.25	5.29
Equipment hindering movement	3.75	4.00	4.86
Weight shifting	3.88	6.00	5.57
Equipment pinching	6.25	5.38	6.00
Load adjustment	5.25	6.13	6.00
Access to stowed items	6.25	6.00	6.33
Ability to breathe	6.25	5.00	4.00
Overall comfort	6.13	5.00	5.00
Armor preventing flexing	4.75	5.75	5.14

Comments	No. of Responses

A-FFW W/BELT

Went fairly smooth	
Cannot breathe good.	1
Chafing is due to Hidalgo heart monitor.	1
Shoulder straps starting to be irritating to shoulders.	1
Equipment snagging in little cubby doorways.	2

B-FFW W/UP-ARMOR KIT

Chafing is from Hidalgo heart monitor.	1
Leg panels snagged through the loft.	1
Medical computer needs to be moved.	1
Neck pro got in the way.	1
We get caught going through the mousehole because of our size.	1

C-BASELINE

Heart monitor stinks when wearing IBA; too much rubbing.	1
Medic belt pushes in on chest; hard to get through hole with IBA.	1

3. Did any of the equipment you wore hinder your ability to complete the mission?

	A	B	C
No	4	5	7
Yes	4	2	1

A-FFW W/BELT

Going through the loft entry.	1
Got stuck in the hole.	1
Vest too wide for small openings.	1
Leg restriction.	1

B-FFW W/UP ARMOR KIT

Dog collar.	1
Neck guard and CLS bag snagged going through the hole neck guard gives limited range of head.	1
Neck movement.	1

Comments	No. of Responses

C-BASELINE

My butt pack snagged when I climbed the stairs to get through the mouse hole.	1

4. Did any of the equipment you wore help your ability to complete the mission?

	A	B	C
No	8	8	7
Yes	0	0	1

A-FFW W/BELT

Having round ready available on chassis.	1

C-BASELINE

Could get into the loft a lot faster and easier without any snags.	1

5. Did any of the equipment you wore present an unsafe condition?

	A	B	C
No	6	7	7
Yes	1	1	0
NR	1	0	1

A-FFW W/BELT

Being stuck in small openings makes you a stationary target.	1

6. Did you move any of your equipment while moving to the objective to make your job easier or less irritating?

	A	B	C
No	7	6	8
Yes	1	0	0
NR	0	2	0

A-FFW W/BELT
The "breath-ability" of the vest. 1

7. Were you able to reach all your ammunition magazines?

	A	B	C
No	0	0	0
Yes	8	8	7
NR	0	0	1

8. Were you able to stow your expended magazines?

	A	B	C
No	1	0	1
Yes	7	8	7
NR	1	0	

Comments **No. of Responses**

A-FFW W/BELT
Drop pouch on leg armor. 1

B-FFW W/UP-ARMOR KIT
Drop pouch on leg for my expended magazines. 1

C-BASELINE
Place on my cargo pocket. 1

9. Did any of the electronic components/wires interfere with your ability to carry combat equipment?

	A	B	C
No	8	0	NA
Yes	0	7	
NR	0	1	

10. Are there any items of the chassis that are "fixed in place" that you would move if you could?

	A	B	C
No	2	3	NA
Yes	6	4	
NR	0	1	

Comments **No. of Responses**

A-FFW W/BELT
Batteries. 3
Electronics to back. 1
I would not wear the leg inserts or the waist belt. 1
The medical diagnostic computer under right arm. Would move it to the back. 1

B-FFW W/UP-ARMOR KIT
I would not wear the up armor in mount. 1
The latch that closes the chassis; try to work something in the middle or a zipper. 1

11. In which tactical situations would you consider wearing the following options?

	NUMBER OF RESPONSES								
	A				B				C
	a	b	c	d	a	b	c	d	
Movement to contact	2	0	0	4	3	0	5	5	NA
Reconnaissance	1	0	0	2	0	0	1	4	
Attack	4	1	1	5	6	1	5	6	
Defense	3	4	1	4	5	3	6	6	
Counter-attack	1	0	0	2	4	0	5	6	

*a-shoulder plate; b-neck protector; c-Belly panel; d-Thigh inserts

12. Were you able to reach your individual first aid kit?

	A	B	C
No	0	0	NA
Yes	8	8	

13. Did you encounter any difficulty donning the chassis?

	A	B	C
No	7	6	NA
Yes	1	2	

A-FFW W/BELT

Comments	No. of Responses
Hooking the latch; get rid of it.	1

B-FFW W/UP-ARMOR KIT

Neck pro was in the way.	1
Shoulder pad.	1

14. Did you encounter any difficulty doffing the chassis?

	A	B	C
No	7	8	NA
Yes	1	0	

A-FFW W/BELT

The latch; had someone to pull it to get it off.	1

15. Did you modify any tactics or techniques because of the equipment?

	A	B	C
No	7	7	NA
Yes	1	0	
NR	0	1	

A-FFW W/BELT

Climbing the ladder.	1

16. Is there anything you especially liked about the FFW ensemble and the two up-armor kits (MOUT and Patrolling kits)?

	A	B	C
No	5	4	NA
Yes	2	3	
NR	1	1	

A-FFW W/BELT

The layout of the FFW is great, but I would fix the latch that closes it.	1
Yes, because it breathes; and no, on the neck guard.	1

Comments	**No. of Responses**

B-FFW W/UP-ARMOR KIT

Access to equipment.	1
Move the medical information piece to the rear.	1
The shoulder and gut guard, I didn't feel them and it's more protection.	1

17. How would you change the FFW ensemble you wore if you could?

FFW HELMET ASSEMBLY ONLY:

18. Using the scale below, please address each concern/issue with your level of comfort while wearing the FFW helmet during the exercise?

1 Extremely painful — **2** — **3** — **4 Moderate pain** — **5** — **6** — **7 No pain at all**

CONCERN/ISSUE	MEAN RESPONSE		
	A	B	C
a. Pressure to top of head while wearing helmet	6.67	6.25	NA
b. Pressure to side of head (along the straps)	6.43	6.13	
c. Comfort level of FFW helmet with foam liner	6.60	6.33	
d. Comfort level of FFW helmet with rigid liner	6.17	6.00	

Comments	**No. of Responses**

A-FFW W/BELT

Did notice that on the Soldier version of the FFW helmet that when you pull down the goggles it is on the top of the ears.	1

B-FFW W/UP-ARMOR KIT

Works well helmet stays in place even when hitting your head.	1

19. Using the scale below, please evaluate the level of problems encountered with the following characteristics of the FFW helmet.

1 A lot — **2** — **3** — **4 A few** — **5** — **6** — **7 None**

CHARACTERISTICS	MEAN RESPONSE		
	A	B	C
a. Heat build-up with foam liner	5.17	5.17	NA
b. Heat build-up with rigid liner	4.67	4.83	
c. Perspiration build-up with the foam liner	5.33	5.83	
d. Perspiration build-up with the rigid liner	5.00	5.17	

Comments **No. of Responses**

A-FFW W/BELT
Helmet was much more user friendly with the foam liner. 1

Table D-4. Run matrix.

MOUT Operations Day 3													
Iteration		**1**			**2**			**3**			**Excursion**		
Fire Team	**Time of Day**	**Obj**	**Config**	**Time**	**Obj**	**Config**	**Time**	**Obj**	**Config**	**Time**	**Obj**	**Config**	**Time**
FTB	0850	Loft	Belt	1:07:24									
FTA	0904	Room	Base										
FTB	0925				Room	Up Arm							
FTA	0940				Loft	Base	1:07:78						
FTB	0950							Loft	Up Arm	1:00:06			
FTB	1015							Room	Belt				
FTB											Room	Self	
FTA	1330	Room	Belt										
FTB	1345	Room	Base										
FTA	1355				Loft	Belt	1:14:21						
FTB	1415				Loft	Base	1:08:93						
FTA	1435							Room	Up Arm				
FTA	1457							Loft	Up Arm	1:24:72			
FTA											Room	Self	

Table D-5. Times for entering hole in wall and loft times.

Day 3							
	Fire Team	**Mission**	**Configuration**	**Door**	**Time to Enter Seconds**	**Loft Time In**	**Loft Time out**
1	A	Room	FFW w/belt	A	6.03		
2	B	Room	Base	B	7.21		
3	A	Loft	Up-Armor	C	6.75	1:24:72	1:36:50
4	B	Loft	FFW w/belt	A	5.06	1:07:24	1:35:50
5	A	Room	Base	B	6.50		
6	B	Room	Up-Armor	C	7.50		
7	A	Loft	FFW w/belt	A	5.89	1:14:21	1:52:69
8	B	Loft	Up-Armor	B	8.01	1:00:06	1:42:56
9	A	Room	Up-Armor	C	8.28		
10	B	Room	FFW w/belt	A	5.24		
11	A	Loft	Base	B	6.50	1:07:78	1:42:56
12	B	Loft	Base	C	7.52	1:08:93	1:15:84
X	B	Xtra Run Room	Whatever	C	6.31		
X	A	Xtra Run Room	Whatever	B	6.50		

Table D-6. What the Soldiers wore on the excursion.

M203 B	No. 7 Did not wear neck protection or leg panels Why: Neck protection is hot and covers mouth when in a crouching position. Hampers breathing and interferes with air flow (hot). Leg panels slow my movement. Would only wear if there was no place else to store equipment. How Configured: Move 40-mm rounds to the sides and front of vest. Move magazines to middle front of vest. Move PDA panel to chest protector.	M203 A	No. 3 Did not wear neck protection and leg panels. Why: Neck protection restricts my head movement too much. Leg panels are neat to carry ammunition, but they restrict my movement too much, especially while running. How Configured: Move 40-mm rounds to side and front of vest and some on belt. Put three magazines in front on vest.
SAW B	No. 8 No Up-Armor at all Why: Interfered with head movement and too hot How Configured: Chassis with belt and suspenders SAW ammo pouches on belt First Aid Move electronics to back Smoke and frags on front of vest Open all zippers for ventilation	SAW A	No. 4 No neck protection Why: Too hot, restricts movement How configured: Chassis Shoulder Pad Leg Panels – drum pouches on each First aid kit on left leg panel Move electronics from under arm to back Would add more drums to belt for more ammunition Smoke on vest
Rifleman	No. 9 No Up-Armor Why: Too hot, restricts movement How Configured: Remove left leg panel Remove Ballistic belt Move CLS bag to upper rear Keep right leg panel	Rifleman	No. 5 No Neck protection Why: Too hot How Configured: Liked everything except the neck collar Did not move any pouches Wanted suspenders for the ballistic belt
BTL	No. 6 Did not like the location of the battery; it irritated his bicep and his movement. He would move it to the back of the chassis or reshape the batteries so they would not be as bulky Would wear all up armor in MOUT except the Neck Armor Would never wear neck armor, restricts head movement, retains heat, breath comes back into face and fogs goggles. For one room clearing known situation would wear chassis only, trade speed, flexibility and coolness for protection.	ATL	No. 2 In urban environment would use chassis only because belt so uncomfortable and he never used his leg panels to carry equipment or ammunition Leader's radio (left side) interferes with movement Wanted more ammunition Move radio to right front of chassis Add more ammunition on front of chassis Move IFAK to right rear of chassis

Table D-7. Soldier comments by iteration.

Test Directorate Recorded Soldier Comments			
Task	**ID No.**	**Configu-ration**	**Comment**
1A – Room FTA	4, 5	FFW w/belt	Bottom of shin guard rubbing
	2		Shoulders starting to hurt
2B – Room FTB	All	Base	IBA pushes on heart monitor
3C – Loft FTA	3, 4	FFW Up Armor	Had hard time looking up due to neck armor Shoulder pad got caught in mouse hole
	3		Felt claustrophobic wearing up armor
4A – Loft FTB	6, 8	FFW w/belt	Leg straps on leg panel came undone
	6		Too bulky, had to take chassis off to get through hole to come out
5B – Room FTA	3,4	Base	IBA presses hard on the heart monitor and hurts
6C – Room FTB	6, 8	FFW Up Armor	Neck armor restricts looking up while wearing the leader variant helmet. Holds too much heat in
	6		Equipment caught on entrance door # C
7A – Loft FTA	3	FFW w/belt	Had difficulty getting through mouse hole with leg panels (ammo and first aid pouch on leg panel)
	4		Knee pads still causing problems with rubbing
	5		CLS bag on leg panel got caught on mouse hole
	2		Leg pads got in way, he wasn't carrying anything on them; so he would not wear them in this type of operation
8B – Loft FTB	6, 8, 9	FFW Up Armor	Looking up with helmet is lifting neck armor, had to push it back down into place, but could do it with the helmet as the armor is flexible
9C – Room FTA	3, 4, 5	FFW Up Armor	Neck armor uncomfortable and restrictive
			Several mentioned that the shoulder pad and belly pad were not noticeable
10A – Room FTB	6	FFW w/belt	Armor belt would not stay up in place caused problems (he had no suspenders)
11B – Loft FTA	All	Base	All had problems with the heart monitor being pressed into their chest by IBA
12C – Loft FTB	All	Base	No comments
General Comments			
Morning, FTB (No.6-9) was FFW			No. 6 had to drop his chassis from the loft to the ground to egress back out of the mouse hole No. 6 did not like the location of the battery; it irritated his bicep and his movement. He would move it to the back of the chassis or reshape the batteries so they would not be as bulky No. 6 Would wear all up armor in MOUT except the Neck Armor Would never wear neck armor, restricts head movement, retains heat, breath comes back into face and fogs goggles. For one room clearing known situation would wear chassis only, trade speed, flexibility and coolness for protection.
Afternoon, FTA) No. 2-5) was FFW			No. 2 ballistic belt was uncomfortable In urban environment would use Chassis only because belt so uncomfortable and he never used his leg panels to carry equipment or ammo Leader's radio (left side) interferes with movement Wanted more ammo Move radio to right front of chassis Add more ammo on front of chassis Move IFAK to right rear of chassis

Table D-8. FFW Soldier video taped comments.

MOUT DAY 3
• Soldier had to remove the chassis in order to fit through the loft when exiting
• Soldiers did not like the neck protectors because they restricted neck movement and did not allow a flow of air around the face.
• Soldier's equipment mounted on the leg panels got caught on entry and exit of the loft
• The knee pads on the B-team rifleman made abrasions on his shin
• Soldiers complained of trousers being too hot
• Leg panels restricted mobility. When given the option, Soldiers removed leg panels and mounted equipment on chassis.
• All Soldiers wore suspenders for waist belt and clawed it helped keep the belt in place.
• The medical monitor straps chafed the Soldiers' necks and sides.

Table D-9. Summary of Soldiers' comments about specific gear: room/loft clearing.

Questionnaires include:

- Room Clearing Excursion
- Loft Clearing
- Room Clearing

Leg panels	I got rid of the leg panels and positioned everything on the chassis; I move more freely and a lot faster and smoother
	I would get rid of the leg panels
	Leg straps came undone somewhere along the mission
	Leg panels snagged through the loft
	Leg panels were restrictive when running (6)
	Lose the pouch on leg armor (2)
	I would not wear the leg inserts
	Leg panels restrict speed, but slow is smooth and smooth is fast
Up-armor kit	We get caught going through the mousehole because of our size
	I would not wear the up-armor kit in mount
	It breathes
	I liked the access to equipment (2)
	Up-armor kit might work well for turret gunners but not for dismounted Infantry
CLS Bag	When I went through the mouse hole the CLS bag caught (2)
Chassis	
	Shoulder straps rub the collar bone (2)
	I got rid of the leg panels and positioned all rounds on front of chassis
	Going through narrow doorways, the side of the chassis was a little bulky (loft clearing)
	In the mousehole of the loft I had problems getting through; the battery kept getting stuck on way out and on way in sides of chassis got stuck (2)

Chassis	Shoulder straps starting to be irritating to shoulders
	I like having rounds readily available on the chassis (2)
	The chassis makes it hard to breathe because it is tight around the upper body (2)
	The latch that closes the chassis needs to be re-positioned; try to work something in the middle or a zipper (4)
	Needed help with the latch to doff the chassis
	The ventilation in the chassis is the one really good thing about it
	For guys with bigger upper bodies I would widen out the shoulder part of it
Electronics	The wires get caught
	Move all electronics to the back except the little display screen (4)
IFAK	I placed it on the back of the chassis, because I need rounds before I need first aid
FFW general	The gear got snagged up in the window
	FFW with belt is too bulky
	Equipment (FFW with belt) just snagged on mousehole to loft (2)
	Equipment (FFW with belt) snagging in little cubby doorways
	FFW with belt went fairly smooth in loft clearing
	Difficult to climb the ladder with the FFW with belt gear
	The layout of the FFW is great
	The drop magazine pouch reduces mag change time (FFW with belt)
	Can't run, can't hide
	I would put the interior pads in the IBA to create ventilation, and ditch the rest

Neck protection	Neck guard was stopping the head movement
	Neck protection got in the way (6)
	Neck guard snagged going through the mousehole; neck guard gives limited range of head movement
	Don't like the neck guard (2)
	Dog collar does not allow me to look up. It blocks ventilation and traps heat in more
	My situational awareness was decreased due to the addition of the neck collar; it gave me an enclosed feeling (2)
	The neck guard takes away from the mobility of the head, but it would be good for a 50 cal. gunner
	Neck protection would be good for convoy ops
	Difficult to don (2)
	Dog collar restricts head movement with leader helmet
LSDS	Chafing is due to Hidalgo heart monitor (3)
	Medical computer needs to be moved to the rear (5)
Baseline general	My butt pack snagged when I climbed the stairs to get through the mousehole
	I could get into the loft a lot faster and easier, without any snags, with the Baseline gear
	Going into the loft with the Baseline gear on was no problem, nothing got snagged like the FFW gear
	The IBA is pretty constraining to mobility
	The IBA tends to shift from shoulder to shoulder
Batteries	Batteries need to be re-positioned (5)
	Moving the battery to the back right of vest was great; I wouldn't change it
Ballistic belt	I would not wear the waist belt
	Hooking the latch is difficult; get rid of it

Shoulder pad	Don't like shoulder pad (2)
	I like the shoulder pad; I didn't feel it and it's more protection
	The shoulder pad was nice (2)
Belly panel	I like the gut guard; I didn't feel it and it's more protection (2)
	I didn't like the gut plate
Helmet, Soldier variation	When you pull down the goggles it is on the top of the ears
	Try and change the color from black
Helmet, unspecified variation	Works well; helmet stays in place even when hitting your head
	Helmet was much more user friendly with the foam liner
	I can't completely customize it to my head
	If the ear plugs aren't in the right place it puts a little pressure on the head
	The helmet got heated fairly well in the top
	I liked the helmet a lot more than the ACH
Trousers	Pants are ridiculously hot. I would rather fight naked. Maybe the pants are good for fall and winter. The knee pads are bothering me today; some chafing in the calves
	Bottom of shin guard rubbed my shin; it's starting to become sensitive.
	Fix the pants; they are way too hot.
	I would ditch the pants, which get more and more uncomfortable by the day

Table D-10. Likert ratings, loft clearing, FFW with belt versus up-armor kit.

Strong preference for up-armor kit:

Question	Belt	Up Armor	Diff
Ability to conduct reflexive shooting	5.14	6.25	-1.11

Moderate preference for up-armor kit:

Question	Belt	Up Armor	Diff
Move through mouse holes	2.88	3.63	-0.75
Ease of leg movement	4.88	5.50	-0.63
Equipment snagging	3.75	4.25	-0.50
Ease of assuming kneeling position	5.71	6.00	-0.29
Overall comfort	4.75	5.00	-0.25

No clear preference:

Question	Belt	Up Armor	Diff
Ease of torso movement	5.88	6.00	-0.13
Ability to crouch (bend and maintain reduced exposure position	5.00	5.13	-0.13
Pressure points	5.75	5.88	-0.13
Equipment hindering movement	3.88	4.00	-0.13
Equipment pinching	5.25	5.38	-0.13
Ability to ascend and descend stairs	4.29	4.38	-0.09
Move through doorways	5.71	5.75	-0.04
Ease of arm movement	5.63	5.63	0.00
Torso chafing in front	5.75	5.75	0.00
Arm/shoulder chafing	4.88	4.88	0.00
Leg/thigh chafing	5.38	5.38	0.00
Ability to engage enemy	5.29	5.17	0.12
Assume the standing/ready or “stacked position”	6.25	6.13	0.13
Hot spots	6.25	6.13	0.13
Load adjustment	6.25	6.13	0.13

Moderate preference for FFW with Belt:

Question	Belt	Up Armor	Diff
Conducting IMT	6.00	5.75	0.25
Torso chafing in back	6.00	5.75	0.25
Weight shifting	6.25	6.00	0.25
Access to stowed items	6.25	6.00	0.25
Armor preventing flexing	6.13	5.75	0.38
Bruising on your body	5.71	5.25	0.46
Ability to run	5.13	4.63	0.50
Use of hand and arm signals	6.17	5.67	0.50
Move through windows	4.00	3.50	0.50
Ease of assuming prone position	5.50	4.75	0.75
Neck/head chafing	5.63	4.75	0.88

Strong preference for FFW with Belt:

Question	Belt	Up Armor	Diff
Ability to breathe	6.13	5.00	1.13
Ease of head movement	6.13	4.13	2.00

BASELINE VERSUS FFW WITH BELT

Strong preference for FFW with Belt:

Question	Base	Belt	Diff
Ability to breathe	4.00	6.13	-2.13

Moderate preference for FFW with Belt:

Question	Base	Belt	Diff
Armor preventing flexing	5.14	6.13	-0.98
Weight shifting	5.57	6.25	-0.68
Torso chafing in front	5.29	5.75	-0.46
Neck/head chafing	5.29	5.63	-0.34
Use of hand and arm signals	5.86	6.17	-0.31
Ease of torso movement	5.63	5.88	-0.25
Load adjustment	6.00	6.25	-0.25

No clear preference:

Question	Base	Belt	Diff
Conducting IMT	5.83	6.00	-0.17
Assume the standing/ready or “stacked position”	6.13	6.25	-0.13
Torso chafing in back	6.00	6.00	0.00
Bruising on your body	5.71	5.71	0.00
Ease of head movement	6.13	6.13	0.00
Hot spots	6.29	6.25	0.04
Access to stowed items	6.33	6.25	0.08
Move through doorways	5.88	5.71	0.16

Moderate preference for Baseline:

Question	Base	Belt	Diff
Overall comfort	5.00	4.75	0.25
Ease of assuming kneeling position	6.17	5.71	0.45
Ease of arm movement	6.13	5.63	0.50
Pressure points	6.29	5.75	0.54
Arm/shoulder chafing	5.57	4.88	0.70
Ability to conduct reflexive shooting	5.88	5.14	0.73
Ability to crouch (bend and maintain reduced exposure position	5.75	5.00	0.75
Equipment pinching	6.00	5.25	0.75
Ease of assuming prone position	6.33	5.50	0.83
Ability to run	6.00	5.13	0.88
Leg/thigh chafing	6.29	5.38	0.91
Equipment hindering movement	4.86	3.88	0.98

Strong preference for Baseline:

Question	Base	Belt	Diff
Ability to engage enemy	6.29	5.29	1.00
Ease of leg movement	6.13	4.88	1.25
Ability to ascend and descend stairs	5.71	4.29	1.43
Equipment snagging	5.29	3.75	1.54
Move through mouseholes	4.50	2.88	1.63
Move through windows	5.75	4.00	1.75

Table D-11. Room clearing, Likert ratings, baseline versus FFW with belt.

Strong preference for FFW with Belt:

Question	Base	Belt	Diff
Ability to breathe	4.33	5.75	-1.42
Torso chafing in front	4.50	5.88	-1.38
Armor preventing flexing	4.86	6.00	-1.14

Moderate preference for FFW with Belt:

Question	Base	Belt	Diff
Weight shifting	5.29	6.13	-0.84
Equipment snagging	5.71	6.50	-0.79
Torso chafing in back	5.29	6.00	-0.71
Overall comfort	4.57	5.25	-0.68
Neck/head chafing	5.71	6.38	-0.66
Bruising on your body	5.43	5.88	-0.45
Use of hand and arm signals	6.00	6.33	-0.33

No clear preference:

Question	Base	Belt	Diff
Pressure points	6.00	6.25	-0.25
Ease of torso movement	5.50	5.75	-0.25
Equipment pinching	5.14	5.38	-0.23
Arm/shoulder chafing	5.71	5.88	-0.16
Ability to crouch (bend and maintain reduced exposure position	5.63	5.71	-0.09
Load adjustment	5.71	5.75	-0.04
Access to stowed items	5.86	5.88	-0.02
Move through doorways	5.75	5.75	0.00
Ease of head movement	5.75	5.75	0.00
Assume the standing/ready or “stacked position”	6.13	6.00	0.13
Leg/thigh chafing	5.83	5.63	0.21
Hot spots	5.86	5.63	0.23
Conducting IMT	6.25	6.00	0.25

Moderate preference for Baseline:

Question	Base	Belt	Diff
Ability to conduct reflexive shooting	6.00	5.63	0.38
Ability to engage enemy	6.25	5.88	0.38
Ease of arm movement	6.00	5.50	0.50
Ease of assuming kneeling position	6.33	5.80	0.53
Equipment hindering movement	6.29	5.63	0.66
Ability to ascend and descend stairs	6.67	6.00	0.67
Ease of leg movement	5.88	5.13	0.75
Ease of assuming prone position	6.25	5.33	0.92
Move through mouse holes	5.43	4.50	0.93

Strong preference for Baseline:

Question	Base	Belt	Diff
Ability to run	6.13	4.75	1.38
Move through windows	6.00	4.00	2.00

Table D-12. Room clearing, Likert ratings, FFW with belt versus FFW up-armor kit.

There is a pretty clear trend for the FFW with Belt configuration to be preferred to the FFW up-armor kit.

Moderate preference for up-armor kit:

Question	Belt	Up Armor	Diff
Equipment pinching	5.38	5.63	-0.25
Load adjustment	5.75	6.00	-0.25

No clear preference:

Question	Belt	Up Armor	Diff
Access to stowed items	5.88	6.00	-0.13
Weight shifting	6.13	6.25	-0.13
Leg/thigh chafing	5.63	5.63	0.00
Pressure points	6.25	6.25	0.00
Ability to conduct reflexive shooting	5.63	5.50	0.13
Assume the standing/ready or “stacked position”	6.00	5.88	0.13
Ease of leg movement	5.13	5.00	0.13
Hot spots	5.63	5.50	0.13
Torso chafing in front	5.88	5.75	0.13

Moderate preference for FFW with Belt:

Question	Belt	Up Armor	Diff
Ability to engage enemy	5.88	5.50	0.38
Bruising on your body	5.88	5.50	0.38
Ease of arm movement	5.50	5.13	0.38

Ease of torso movement	5.75	5.38	0.38
Move through doorways	5.75	5.38	0.38
Torso chafing in back	6.00	5.63	0.38
Ability to crouch (bend and maintain reduced exposure position	5.71	5.25	0.46
Ability to run	4.75	4.29	0.46
Move through mouse holes	4.50	4.00	0.50
Armor preventing flexing	6.00	5.38	0.63
Conducting IMT	6.00	5.25	0.75
Move through windows	4.00	3.25	0.75
Ease of assuming kneeling position	5.80	5.00	0.80
Ability to breathe	5.75	4.88	0.88

Strong preference for FFW with Belt:

Question	Belt	Up Armor	Diff
Arm/shoulder chafing	5.88	4.88	1.00
Neck/head chafing	6.38	5.38	1.00
Overall comfort	5.25	4.13	1.13
Use of hand and arm signals	6.33	5.17	1.17
Ease of assuming prone position	5.33	4.00	1.33
Ability to ascend and descend stairs	6.00	4.50	1.50
Equipment snagging	6.50	5.00	1.50
Equipment hindering movement	5.63	3.88	1.75
Ease of head movement	5.75	3.13	2.63

Appendix E. Individual Movement Technique Course and CB

Table E-1. Woodland IMT course with CB gear.

Results of Soldier Questionnaires
EQUIPMENT/SAMPLE SIZE:

A	**FFW, CB AND MASK**	**MEDIUM-1; LARGE-2**
B	**FFW, CB, MASK AND BELT MOUNT**	**MEDIUM-2; LARGE-1**
C	**FFW, CB, MASK AND LEG MOUNT**	**MEDIUM-1; LARGE-1**

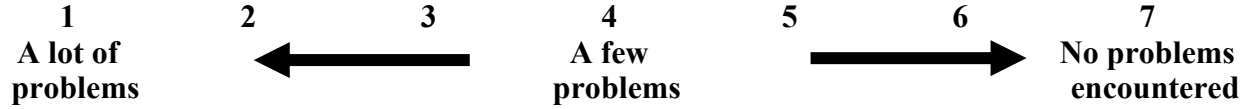
1. Using the scale below, please rate your ability to complete the tasks on the obstacles shown with the equipment you wore.

1	2	3	4	5	6	7
Extremely hard	**Very hard**	**Hard**	**Neutral**	**Easy**	**Very easy**	**Extremely easy**

TASKS	MEAN RESPONSE					
	MEDIUM			LARGE		
	A	B	C	A	B	C
PIPE CRAWL						
Running/dashing	4.00	6.00	5.00	6.50	7.00	6.00
Negotiating pipe crawl	6.00	4.50	6.00	6.50	7.00	5.00
Leg movement	3.00	4.50	5.00	6.50	7.00	4.00
Arm movement	3.00	5.50	7.00	6.50	7.00	5.00
Torso movement	6.00	5.00	7.00	6.50	7.00	5.00
Head movement	1.00	3.50	7.00	6.50	7.00	4.00
Crawling	6.00	4.50	3.00	6.50	7.00	5.00
ZIG-ZIG, TWO-FOOT JUMP, MOUND						
Negotiating the zigzag	6.00	5.50	6.00	6.50	7.00	6.00
Negotiating the 2-ft Jump	6.00	6.00	7.00	6.50	7.00	6.00
Negotiating the hill	5.00	5.50	7.00	6.50	7.00	6.00
Head movement	1.00	3.50	7.00	6.50	7.00	5.00
Running	6.00	6.00	5.00	6.50	7.00	5.00
Seeing/scanning left and right	5.00	4.50	6.00	6.50	7.00	3.00
Seeing/scanning up and down	1.00	5.00	7.00	5.00	7.00	4.00
FOXHOLE AND FIRING POSITION						
Getting into the foxhole	7.00	7.00	7.00	6.50	7.00	6.00
Assuming good foxhole firing position	4.00	6.50	7.00	6.50	7.00	6.00
Retrieving magazines from ammunition pouches while in foxhole firing position	6.00	6.00	7.00	6.50	3.00	4.00
Replacing empty magazines in ammunition pouches while in foxhole firing position	1.00	4.50	7.00	6.50	3.00	2.00
Arm movement	5.00	6.00	7.00	6.50	7.00	5.00
Acquiring targets from foxhole firing position	4.00	6.00	7.00	6.50	4.00	5.00
Seeing/scanning left and right	6.00	4.00	6.00	6.50	7.00	3.00
Seeing/scanning up and down	6.00	4.00	7.00	6.50	7.00	3.00
Getting out of foxhole	5.00	5.00	5.00	6.50	7.00	5.00

COMBAT ROLL, PRONE FIRING POSITION						
Executing combat rolls left and right	6.00	6.00	3.00	6.50	7.00	2.00
Assuming a good prone firing position	5.00	5.00	7.00	6.50	7.00	5.00
Acquiring targets	6.00	5.50	7.00	6.50	7.00	5.00
Retrieving magazines from ammunition pouches while in the prone firing position	6.00	6.50	7.00	5.00	3.00	3.00
Replacing empty magazines back into ammunition pouches while in the prone firing position	1.00	3.00	6.00	3.50	3.00	1.00
Seeing/scanning left and right	5.00	4.00	6.00	6.50	7.00	2.00
Seeing/scanning up and down	1.00	5.00	7.00	6.50	7.00	3.00
HIGH CRAWL						
Negotiating the high crawl obstacle	5.00	6.00	3.00	6.00	7.00	5.00
Leg Movement	5.00	4.50	7.00	6.00	7.00	3.00
Arm Movement	5.00	5.50	7.00	6.00	7.00	6.00
Torso Movement	6.00	5.00	7.00	6.00	7.00	6.00
Head Movement	3.00	5.00	6.00	6.00	7.00	6.00
Seeing/scanning up and down	1.00	4.00	6.00	6.00	7.00	6.00
Seeing/scanning left and right	6.00	4.50	6.00	6.00	7.00	3.00
KNEELING FIRING POSITION						
Assuming a good kneeling firing position	6.00	6.00	7.00	6.50	7.00	5.00
Leg movement	5.00	4.50	7.00	6.50	7.00	5.00
Arm movement	6.00	5.00	7.00	6.50	7.00	5.00
Torso movement	5.00	5.00	7.00	6.50	7.00	5.00
Acquiring targets from the kneeling firing position	6.00	5.00	7.00	6.50	7.00	5.00
Retrieve magazines from ammunition pouches from the kneeling position	6.00	6.50	7.00	5.00	4.00	4.00
Replace empty magazines back into the ammunition pouches in the kneeling position	1.00	4.50	7.00	5.00	4.00	2.00
Seeing/scanning left and right	7.00	4.50	6.00	6.50	7.00	4.00
Seeing/scanning up and down	1.00	5.00	7.00	6.50	7.00	6.00
HIGH WALL AND PRONE FIRING POSITION						
Negotiating the high wall obstacle	5.00	5.50	4.00	6.50	7.00	5.00
Assuming the prone firing position	3.00	5.50	7.00	6.50	7.00	5.00
Leg movement	4.00	4.50	6.00	6.50	7.00	4.00
Arm movement	6.00	5.50	7.00	6.50	7.00	6.00
Torso movement	6.00	5.50	7.00	6.50	7.00	5.00
Acquiring targets from the prone firing position	4.00	5.00	7.00	6.50	7.00	6.00
Retrieve magazines from ammo pouches from the prone position	6.00	5.50	7.00	5.00	1.00	2.00
Replace empty magazines back into the ammunition pouches in the prone position	1.00	3.00	6.00	5.00	1.00	2.00
Seeing/scanning left and right	6.00	4.50	6.00	6.50	7.00	4.00
Seeing/scanning up and down	1.00	5.00	7.00	6.50	7.00	6.00

2. Using the scale below, please rate the problem areas encountered on this exercise.



PROBLEM AREAS	MEAN RESPONSE					
	MEDIUM			LARGE		
	A	B	C	A	B	C
Pressure Points	7.00	7.00	7.00	6.50	7.00	5.00
Hot Spots	1.00	4.00	7.00	6.50	7.00	5.00
Bruising on your body	6.00	7.00	7.00	6.50	7.00	5.00
Torso chafing in front	7.00	7.00	7.00	6.50	7.00	5.00
Torso chafing in back	7.00	6.50	7.00	6.50	7.00	5.00
Arm/Shoulder chafing	6.00	6.50	7.00	6.50	7.00	5.00
Leg/Thigh chafing	7.00	6.50	7.00	6.50	7.00	5.00
Neck/Head chafing	7.00	6.50	7.00	6.50	7.00	5.00
Equipment catching	7.00	4.50	6.00	6.50	7.00	5.00
Equipment hindering movement	3.00	5.50	4.00	6.50	7.00	2.00
Weight shifting	7.00	5.00	7.00	6.50	7.00	5.00
Equipment pinching	6.00	5.50	7.00	6.50	7.00	5.00
Armor preventing flexing	5.00	6.00	7.00	6.50	7.00	5.00
Hoses restricting movement (too short)	NA	5.00	7.00	NA	7.00	5.00
Hoses snagging (too long)	NA	7.00	7.00	NA	7.00	5.00
Control knobs on PAVS and PAPR with gloved hands	NA	4.50	5.00	NA	7.00	5.00
Connecting/disconnecting PAVS hose to/from manifold assembly	NA	4.50	5.00	NA	7.00	5.00
Exchange battery in PAVS	NA	7.00	7.00	NA	7.00	5.00
Overall comfort	4.00	5.00	7.00	6.00	6.00	5.00

3. During this exercise, did any of the equipment you wore hinder your ability to complete the mission?

	MEDIUM			LARGE		
	A	B	C	A	B	C
No	1	2	0	1	1	0
Yes	0	0	1	1	0	1

Comments **No. of Responses**

A-LARGE

Heat buildup. 1

Comments **No. of Responses**

C-MEDIUM
The blower on the outside of my leg rolled to the inside while I was high crawling and slowed me down. 1

C-LARGE
The leg mounts shifted during the high crawl. 1

4. During this exercise, did any of the equipment you wore present an unsafe condition?

	MEDIUM			LARGE		
	A	**B**	**C**	**A**	**B**	**C**
No	1	2	1	1	1	1
Yes	0	0	0	1	0	0

A-LARGE
Heat buildup. 1

5. Would you move or adjust any of your equipment to a different location to make your job easier or more comfortable?

	MEDIUM			LARGE		
	A	**B**	**C**	**A**	**B**	**C**
No	1	2	0	1	1	0
Yes	0	0	1	1	0	1

A-LARGE
Placement of the magazine or adding a magazine drop pouch. 1

B-LARGE
The magazines are hard to see with the gear on. I would add a drop pouch for expended magazines. 1

C-MEDIUM
The blowers can't go on your legs. 1

C-LARGE
Get the blowers off the legs; it makes movement too slow and sluggish. 1

6. Did you encounter any difficulty donning the CB garment with the FFW gear?

	MEDIUM			LARGE		
	A	**B**	**C**	**A**	**B**	**C**
No	1	2	1	2	1	1
Yes	0	0	0	0	0	0

7. Did you encounter any difficulty doffing the CB garment with the FFW gear?

	MEDIUM			LARGE		
	A	**B**	**C**	**A**	**B**	**C**
No	1	2	1	2	1	`
Yes	0	0	0	0	0	0

8. Using the scale below, please rate the airflow to the different areas of your body while wearing the CB Garment and positive air ventilation systems.

1	2	3	4	5	6	7
No Airflow	Very bad airflow	Bad airflow	Neither good nor bad airflow	Good airflow	Very good airflow	Ideal Airflow

AIRFLOW	MEAN RESPONSE					
	MEDIUM			LARGE		
	A	B	C	A	B	C
Face	4.00	5.50	7.00	4.50	4.00	6.00
Right arm	2.00	4.00	6.00	4.00	1.00	6.00
Left arm	2.00	4.00	6.00	4.00	1.00	6.00
Torso/trunk front	3.00	4.50	7.00	4.00	6.00	6.00
Torso/trunk back	3.00	4.50	7.00	4.00	4.00	6.00
Right leg	2.00	4.50	5.00	4.00	1.00	6.00
Left leg	2.00	4.50	5.00	4.00	1.00	6.00

9. How would you rate the overall comfort of this CB system?

1	2	3	4	5	6	7
Extremely bad	Very bad	Bad	Neutral	Good	Very good	Extremely good

MEAN RESPONSE					
MEDIUM			LARGE		
A	B	C	A	B	C
4.00	4.50	7.00	5.50	7.00	NR

10. Now that you have worn both the PAVS and PAPR air ventilation systems, please answer the following questions using the scale below.

1	2	3	4	5	6	7
Totally disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Totally agree

	MEAN RESPONSE					
	MEDIUM			LARGE		
	A	B	C	A	B	C
The performance of the PAVS is worth carrying the extra weight	NA	4.50	7.00	NA	5.00	6.00
The best place to carry the PAVS is on the belt	NA	4.00	7.00	NA	5.00	6.00
The best place to carry the PAVS is on the hip	NA	4.00	2.00	NA	6.00	NR
I would accept less performance of the PAVS in order to reduce the size and weight	NA	2.50	4.00	NA	3.00	NR
The performance of the PAPR is worth carrying the extra weight	NA	4.50	7.00	NA	5.00	6.00
The best place to carry the PAPR is on the belt	NA	4.00	7.00	NA	6.00	6.00
The best place to carry the PAPR is on the hip	NA	4.00	2.00	NA	3.00	NR
I would accept less performance of the PAPR in order to reduce the size and weight	NA	2.50	4.00	NA	1.00	NR

11. Please rate the concept of an air ventilation system for a CB over-garment and mask.

1	2	3	4	5	6	7
Extremely bad	**Very bad**	**Bad**	**Neutral**	**Good**	**Very good**	**Extremely good**

MEAN RESPONSE					
MEDIUM			**LARGE**		
A	**B**	**C**	**A**	**B**	**C**
7.00	7.00	7.00	7.00	7.00	7.00

IMT Course

Size	**Roster**	**Iteration**		
		1	**2**	**3**
Medium PAV Hip Inlet	9	A	B	
	4	FFW	A	
Large PAV Belly Inlet	5	B	A	
	8	A	FFW	

FFW – Chassis w/Belt
A – CB Equipment w/PAPR Belt Mount
B – CB Equipment w/PAPR Leg Mount

Table E-2. Woodland IMT questionnaire, Soldiers' video comments.

FFW + CB + Mask	Heat buildup (2)
	Change the placement of the magazine or add a magazine drop pouch
FFW + CB + Mask + Belt Mount	The magazines are hard to see with the gear on. I would add a drop pouch for expended magazines.
FFW + CB + Mask + Leg Mount	The blower on the outside of my leg rolled to the inside while I was high crawling and slowed me down.
	The leg mounts shifted during the high crawl
	The blowers can't go on your legs
	Get the blowers off the legs; it makes movement too slow and sluggish.

Table E-3. IMT observations.

Observations from Future Force Warrior Design Evaluation (EDE) #4, Friday 13 May Sent 25 May 2005 by Stewardson, Cheryl RDECOM (PKI) [Cheryl.Stewardson@us.army.mil] 1. PAVS hose became disconnected while some of the test subjects were on the IMT course. Disconnects occurred at both the blower and manifold locations. Test subjects suggested including a quick connect/disconnect to allow for ease of donning/doffing the PAVS. 2. Switch on the PAVS was difficult for the test subjects to activate. This may have been due to the mounting location of the PAVS on the body, limited field of view caused by mask, carrier design (switch accessed by un-snapping cover), size of switch, or all/some of the above. 3. OEM filters were not used on the PAPR during the evaluation because they were unavailable; PAVS (C2 canisters) were used instead. The OEM filters are approximately ¾ inch deeper (i.e., larger) and heavier than the C2 canisters. It is unclear if this resulted in a positive or negative impact on the air flow rate and/or physical integration of the PAPR with the FFW ensemble. 4. BB2800 batteries were used to power the PAVS. In general, these batteries performed well. However, high failure rates noted prior to the evaluation and continuing difficulties attaining a 100% charge may warrant examining alternative power sources. It should be noted that these batteries were only used for approximately 20 minutes at any one time during the evaluation, and then were placed into the battery charger.

Table E-4. SME comments, times, and medical notes.

IMT Course - Day 5											
1st Iteration											
Itera-tion	**ID No.**	**Config**	**Temp**	**Heart Rate**	**Respir-ation**	**Time to Compete**	**FP No.1**	**FP No.2**	**FP No.3**	**FP No.4**	**Notes**
Pre 1st	5	A	na	60	20	07:43.0	01:03.9	00:51.1	01:09.0	01:33.3	Struggled replacing magazines into pouches
	9	B	na	84	20	04:43.0	00:34.9	00:27.5	00:30.8	01:04.5	Had difficulty replacing magazines and caused extra time at firing points
Post 1st	5	A	95.4	116	36						
	9	B	na	152	56						
Pre 1st	4	FFW		84	16	06:48.0	00:59.1	00:42.5	01:07.9	00:33.9	Chassis came open and he could not re-connect, had to be reconnected by test personnel. Reconnected at Foxhole FP.
	8	A		76	16	05:53.0	00:47.2	00:44.4	00:44.2	00:59.3	PAVS hose came off had to be reconnected after high crawl.
Post 1st	4	FFW	98.3	136	32						
	8	A	98.1	128	48						
2nd Iteration											
Pre 2nd	5	B	98.1	94	16	06:13.0	00:51.6	00:53.5	01:01.8	00:51.7	
	9	A	87.8	88	20	05:09.0	00:45.8	00:43.1	00:29.9	00:39.7	Blank adapter was loose, caused misfire at FP#1. Did not return used magazines to ammo pouches at FP #2 and 4
Post 2nd	5	B	99.2	144	44						
	9	A	99.1	152	56						
Pre 2nd	4	A	97.3	88	24	05:19.0	00:37.6	00:52.0	00:34.3	00:53.0	PAPR hose came off in foxhole, Soldier tried to fix it himself. Both PAPR and PAVS came off on high crawl, stopped Soldier reconnected.
	8	FFW	98.2	80	24	05:28.0	00:33.2	00:53.0	00:40.6	00:48.6	
Post	4		99.6	200	36						
	8		98.3	184	48						

Appendix F. Soldier and Equipment Weights

Table F-1. Day 2, AM weights, movement to contact.

Soldier Weights				
10 May 05 - Day 2 - Morning				
ID	**Pos**	**Load Types**	**Weight**	**Notes**
1	SL	**RFI (Baseline) and FFW Mix**		**All Soldiers wearing a version of the LSDS.**
		Approach Load	N/A	
		FFW Uniform with RFI (Baseline) Vest and Wpn	198	No Ballistic Belt. SL not weighed with ICOM radio.
		Uniform Only with Helmet (No Wpn)	173	
2	A-TL	**FFW**		
		Approach Load	N/A	
		Fighting Load	288	No Ballistic Belt
		Uniform Only with Helmet (No Wpn)	240	FFW Leader Variant Helmet
		BDU no boots	**230**	
3	G	**FFW**		
		Approach Load	N/A	
		Fighting Load	282.5	No Ballistic Belt. Not weighed with personal GPS.
		Uniform Only with Helmet (No Wpn)	233	FFW Soldier Variant Helmet
		BDU no boots	**220**	
4	AR	**FFW**		
		Approach Load	N/A	
		Fighting Load	221	With Ballistic Belt
		Uniform Only with Helmet (No Wpn)	164.25	FFW Soldier Variant Helmet
		BDU no boots	**156**	
5	R	**FFW**		
		Approach Load	N/A	
		Fighting Load	219	# 5 had traditional belt with equip pouches strapped on legs.
		Uniform Only with Helmet (No Wpn)	164.25	FFW Soldier Variant Helmet
		BDU no boots	**160**	
6	B-TL	**RFI (Baseline)**		
		Approach Load	N/A	No Assault Pack
		Fighting Load	249	
		Uniform with Helmet (No Wpn)	231	
		BDU no boots	**214.5**	

Soldier Weights				
10 May 05 - Day 2 - Morning				
7	G	**RFI (Baseline)**		
		Approach Load	N/A	No Assault Pack
		Fighting Load	234	
		Uniform with Helmet (No Wpn)	194.25	
		BDU no boots	**189**	
8	AR	**RFI (Baseline)**		
		Approach Load	235	
		Fighting Load	218.5	
		Uniform Only with Helmet (No Wpn)	181	
		BDU no boots	**171**	
9	R	**RFI (Baseline)**		
		Approach Load	N/A	No Assault Pack
		Fighting Load	238	
		Uniform Only with Helmet (No Wpn)	214.5	
		BDU no boots	**201**	
10	Medic	**FFW**		
		Approach Load	N/A	
		FFW Undergarmet Shirt, Medics Bag, Soft Cap, and No Wpn	236	No Ballistic Belt
		Uniform Only (No Medics Bag, No Helmet, No Wpn)	206.5	
		BDU no boots		

Table F-2. Day 2, PM weights, movement to contact.

Soldier Weights				
10 May 05 - Day 2 - Afternoon				
ID	**Pos**	**Load Types**	**Weight**	**Notes**
1	SL	**All RFI (Baseline)**		
		Approach Load	N/A	No Assault Pack
		FFW Uniform with RFI (Baseline) Vest and Wpn	197.75	
		Uniform Only with Helmet (No Wpn)	171.5	
2	A-TL	**RFI (Baseline)**		
		Approach Load	N/A	No Assault Pack. Wearing Sleep Watch
		Fighting Load	279	
		Uniform with Helmet (No Wpn)	239.5	
3	G	**RFI (Baseline)**		
		Approach Load	N/A	No Assault Pack
		Fighting Load	268	
		Uniform Only with Helmet (No Wpn)	230	
4	AR	**RFI (Baseline)**		
		Approach Load	N/A	No Assault Pack. Wearing Sleep Watch
		Fighting Load	211	
		Uniform Only with Helmet (No Wpn)	168.5	
5	R	**RFI (Baseline)**		All Soldiers wearing a version of LSDS.
		Approach Load	N/A	No Assault Pack. Wearing Sleep Watch
		Fighting Load	199.5	
		Uniform with Helmet (No Wpn)	167	
6	B-TL	**FFW**		
		Approach Load	N/A	No Assault Pack
		Fighting Load	272	With Ballistic Belt
		Uniform Only with Helmet (No Wpn)	224	
7	G			
		Approach Load	N/A	No Assault Pack
		Fighting Load	262.5	With Ballistic Belt. With Grenades
		Uniform Only with Helmet (No Wpn)	195.25	
8	AR	Approach Load	N/A	No Assault Pack
		Fighting Load	244	With Ballistic Belt. Wearing Sleep Watch
		Uniform Only with Helmet (No Wpn)	183	
9	R	**FFW**		
		Approach Load	N/A	No Assault Pack
		Fighting Load	259.25	With Ballistic Belt. Wearing Sleep Watch.
		Uniform Only with Helmet (No Wpn)	209.5	
		FFW		
10	Medic	Approach Load	N/A	
		FFW Under garmet Shirt, Medics Bag, Soft Cap, and No Wpn	236	No Ballistic Belt
		Uniform Only (No Medics Bag, No Helmet, No Wpn)	206.5	

Table F-3. Day 3, AM weights, MOUT.

Soldier Weights				
11 May 05 - Day 3 - Morning				
ID	**Pos**	**Load Types**	**Weight**	**Notes**
6	B-TL	**FFW**		
		Approach Load	N/A	
		Fighting Load	270.25	Six 5.56 Mags on Body. 1 in Weapon.
		Uniform Only with Helmet (No Wpn)	223	FFW Leader Variant Helmet
2	A-TL	**RFI (Baseline)**		
		Approach Load	N/A	
		Fighting Load	277	Six 5.56 Mags on Body. 1 in Weapon.
		Uniform with Helmet (No Wpn)	240	
7	G	**FFW**		
		Approach Load	N/A	
		Fighting Load	252	12 40mm HE Grenades on Body. Six 5.56 Mags on Body. 1 in Weapon
		Uniform Only with Helmet (No Wpn)	194.25	FFW Leader Variant Helmet
3	G	**RFI (Baseline)**		
		Approach Load	N/A	
		Fighting Load	272	12 40mm HE Grenades on Body. Six 5.56 Mags on Body. 1 in Weapon
		Uniform Only with Helmet (No Wpn)	231	
End				
8	AR	**FFW**		All Soldiers Wearing Some LSDS Version.
		Approach Load	N/A	
		Fighting Load	233	200 Rounds Carried. 100 Rounds in Weapon.
		Uniform with Helmet (No Wpn)	183	FFW Soldier Variant Helmet
4	AR	**RFI (Baseline)**		
		Approach Load	N/A	
		Fighting Load	208	200 Rounds Carried. 100 Rounds in Weapon.
9	R	Uniform Only with Helmet (No Wpn) **FFW** Approach Load Fighting Load Uniform Only with Helmet (No Wpn)	164 N/A 252 207	 With Combat Lifesavers Bag. Six 5.56 Mags on Body. 1 in Weapon. FFW Soldier Variant Helmet
5	R	**RFI (Baseline)** Approach Load FFW Uniform with RFI (Baseline) Vest and Wpn Uniform Only with Helmet (No Wpn)	 N/A 202 166.75	 Six 5.56 Mags on Body. 1 in Weapon.
1	SL	**RFI (Baseline)** Approach Load Fighting Load Uniform Only with Helmet (No Wpn)	 N/A 201.75 170.25	

Table F-4. Day 3, AM weights, MOUT, up armor.

Soldier Weights				
11 May 05 - Day 3 - Morning (FFW Up-Armor)				
ID	**Pos**	**Load Types**	**Weight**	**Notes**
6	B-TL	**FFW (With Up-Armor)**		
		Approach Load	N/A	
		Fighting Load with Up-Armor	274.5	
7	G	**FFW (With Up-Armor)**		
		Approach Load	N/A	
		Fighting Load with Up-Armor	256.25	
8	AR	**FFW (With Up-Armor)**		All Soldiers Wearing Some LSDS Version.
		Approach Load	N/A	
		Fighting Load with Up-Armor	236.25	
9	R	**FFW (With Up-Armor)**		
		Approach Load	N/A	
		Fighting Load with Up-Armor	255.75	
End				

Table F-5. Day 3, PM weights, MOUT.

Soldier Weights				
11 May 05 - Day 3 - Afternoon				
ID	**Pos**	**Load Types**	**Weight**	**Notes**
2	A-TL	**FFW**		
		Approach Load	N/A	
		Fighting Load	288.5	Six 5.56 Mags on Body. 1 in Weapon.
		Uniform Only with Helmet (No Wpn)	241.75	FFW Leader Variant Helmet
6	B-TL	**RFI (Baseline)**		
		Approach Load	N/A	
		Fighting Load	256	Six 5.56 Mags on Body. 1 in Weapon.
		Uniform with Helmet (No Wpn)	221.75	
3	G	**FFW**		
		Approach Load	N/A	
		Fighting Load	291	12 40mm HE Grenades on Body. Six 5.56 Mags on Body. 1 in Weapon
		Uniform Only with Helmet (No Wpn)	234.25	FFW Leader Variant Helmet
7	G	**RFI (Baseline)**		
		Approach Load	N/A	
		Fighting Load	238	12 40mm HE Grenades on Body. Six 5.56 Mags on Body. 1 in Weapon
		Uniform Only with Helmet (No Wpn)	193.75	
4	AR	**FFW**		All Soldiers Wearing Some LSDS Version.
		Approach Load	N/A	
		Fighting Load	214	200 Rounds Carried. 100 Rounds in Weapon.
		Uniform with Helmet (No Wpn)	166	FFW Soldier Variant Helmet
8	AR	**RFI (Baseline)**		
		Approach Load	N/A	
		Fighting Load	227	200 Rounds Carried. 100 Rounds in Weapon.
		Uniform Only with Helmet (No Wpn)	183	
5	R	**FFW**		
		Approach Load	N/A	
		Fighting Load	211.75	Six 5.56 Mags on Body. 1 in Weapon.
		Uniform Only with Helmet (No Wpn)	168	FFW Soldier Variant Helmet
9	R	**RFI (Baseline)**		
		Approach Load	N/A	
		FFW Uniform with RFI (Baseline) Vest and Wpn	252	Six 5.56 Mags on Body. 1 in Weapon.

Table F-6. Day 3, PM weights, MOUT, up armor.

4 Soldier Weights				
11 May 05 - Day 3 - Afternoon (FFW Up-Armor)				
ID	**Pos**	**Load Types**	**Weight**	**Notes**
2	A-TL	**FFW (With Up-Armor)**		
		Approach Load	N/A	
		Fighting Load with Up-Armor	293.25	
3	G	**FFW (With Up-Armor)**		
		Approach Load	N/A	
		Fighting Load with Up-Armor	294.5	
4	AR	**FFW (With Up-Armor)**		All Soldiers Wearing Some LSDS Version.
		Approach Load	N/A	
		Fighting Load with Up-Armor	218	200 Rounds Carried. 100 Rounds in Weapon.
5	R	**FFW (With Up-Armor)**		
		Approach Load	N/A	
		Fighting Load with Up-Armor	215.5	
End				

Table F-7. Day 4, weights, movement to contact.

Soldier Weights				
12 May 05 - Day 4 - 2nd Iteration of Movement to Contact				
ID	**Pos**	**Load Types**	**Weight**	**Notes**
2	A-TL	**FFW**		
		Approach Load	N/A	
		Fighting Load	294.75	
			230	Delta 64.75 lb
6	B-TL	**RFI (Baseline)**		
		Approach Load	N/A	
		Fighting Load	261.5	
			214.5	Delta 47 lb
3	G	**FFW**		
		Approach Load	N/A	
		Fighting Load	293.75	
			220	Delta 73.75 lb
7	G	**RFI (Baseline)**		
		Approach Load	N/A	
		Fighting Load	245.75	
			189	Delta 56.75 lb
4	AR	**FFW**		All Soldiers Wearing Some LSDS Version.
		Approach Load	N/A	
		Fighting Load	218.25	200 Rounds Carried. 200 Rounds in SAW.
			156	Delta 62.25 lb
8	AR	**RFI (Baseline)**		
		Approach Load	N/A	
		Fighting Load	229	200 Rounds Carried. 200 Rounds in SAW.
			171	Delta 58 lb
5	R	**FFW**		
		Approach Load	N/A	
		Fighting Load	214.75	
			160	Delta 54.75
9	R	**RFI (Baseline)**		
		Approach Load	N/A	
		FFW Uniform with RFI (Baseline) Vest and Wpn	251.5	
			201	Delta 50.5 lb

Table F-8. Day 5, weights, CB IMT course.

FFW EDE No. 4 Soldier Weights				
12 May 05 - Day 4 - 2nd Iteration of Movement to Contact				
ID	**Uniform**	**Load Types**	**Weight**	**Notes**
		1st Iteration		
9	A	Med, Hip Inlet, Belt Mount	**261**	
5	B	Lg, Belly Inlet, Leg Mount	**252**	
4	Base	FFW with Base CB Suit	**209**	
8	A	Lg, Belly Inlet, Leg Mount	**224**	
		2nd Iteration		
9	Base	FFW with Base CB Suit	**221**	
5	B	Lg, Belly Inlet, Leg Mount	**222**	
4	A	Med, Belly Inlet, Leg Mount	**218**	
8	Base	FFW with Base CB Suit	**233**	

Table F-9. Typical weight differences FFW versus RFI.

ID	Pos	Load Types	Weight		ID	Pos	Load Types	Weight
2	A-TL	FFW Fighting Load	294.75		6	B-TL	RFI (Baseline) Fighting Load	261.5
		Body Weight w/BDU	230				Body Weight w/BDU	214.5
		Delta	64.75				Delta	47
3	G	FFW Fighting Load	293.75		7	G	RFI (Baseline) Fighting Load	245.75
		Body Weight w/BDU	220				Body Weight w/BDU	189
		Delta	73.75				Delta	56.75
4	AR	FFW Fighting Load	218.25		8	AR	RFI (Baseline) Fighting Load	229
		Body Weight w/BDU	156				Body Weight w/BDU	171
		Delta	62.25				Delta	58
5	R	FFW Fighting Load	214.75		9	R	RFI (Baseline) Fighting Load	251.5
		Body Weight w/BDU	160				Body Weight w/BDU	201
		Delta	54.75				Delta	50.5

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Appendix G. Miscellaneous

Table G-1. Observations from IPT observers.

Observations from Future Force Warrior Design Evaluation (EDE) 4, Friday 13 May Sent 25 May 2005 by Stewardson, Cheryl RDECOM (PKI) [Cheryl.Stewardson@us.army.mil] 1. PAVS hose became disconnected while some of the test subjects were on the IMT course. Disconnects occurred at both the blower and manifold locations. Test subjects suggested including a quick connect/disconnect to allow for ease of donning/doffing the PAVS. 2. Switch on the PAVS was difficult for the test subjects to activate. This may have been due to the mounting location of the PAVS on the body, limited field of view caused by mask, carrier design (switch accessed by un-snapping cover), size of switch, or all/some of the above. 3. OEM filters were not used on the PAPR during the evaluation because they were unavailable; PAVS (C2 canisters) were used instead. The OEM filters are approximately ¾" deeper (i.e. larger) and heavier than the C2 canisters. It is unclear if this resulted in a positive or negative impact on the air flow rate and/or physical integration of the PAPR with the FFW ensemble. 4. BB2800 batteries were used to power the PAVS. In general these batteries performed well. However, high failure rates noted prior to the evaluation and continuing difficulties attaining a 100% charge may warrant examining alternative power sources. It should be noted that these batteries were only used for approximately 20 minutes at any one time during the evaluation, and then were placed into the battery charger.

Data Submitted by Adam Malhoit, BDST/MRMC for FFW

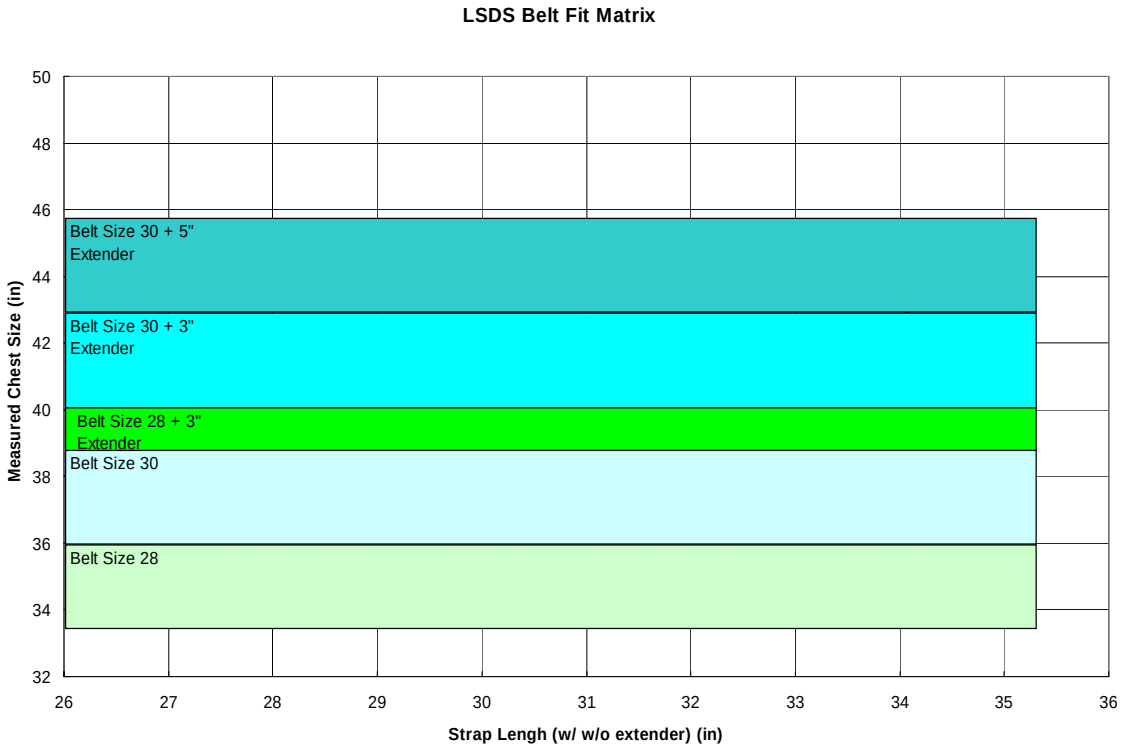
The following are notes and tables containing data acquired from 9-12MAY05 @ Ft. Benning during the FFW evaluation. These data will be submitted by data type, then chronologically.

I. LSDS Fitting

A. Process:

The LSDS fit was attained by following the tables, unless fit was achievable in a comfortable fashion, with fewer or no extension straps.

LSDS 1-C



Hidalgo LSDS

Strap #	Chest Size range		3" extender	5" extender	Both 3" & 5"	Two 5"
	min	max	Max chest	Max Chest	Max Chest	Max Chest
M1*	30.5	35.0	38.0	40.0	43.0	45.0
M2	31.0	34.0	37.0	39.0	42.0	44.0
M3	31.0	34.5	37.5	39.5	42.5	44.5
M4	30.5	33.8	36.8	38.8	41.8	43.8

* chest strap is of a smaller diameter

Actual Fit Results

10, 11MAY2005; Kunzig Range & Eiler Hall

Soldier Number	Chest Size (in.)	LSDS Style	Strap Label	Strap Size (in.)	1st Extension Required	2nd Extension Required
9	37.50	HIDALGO	M3	unknown	3"	
4	33.88	1-C	#05	27.50		
8	34.00	HIDALGO	M1	unknown		
5	34.75	1-C	#01	28.00	3"	
2	41.00	1-C	#04	30.00	5"	3"
3	40.25	1-C	#02	30.00	5"	
7	40.50	HIDALGO	M4	unknown	5"	
6	42.25	HIDALGO	M2	unknown		

12, 13 MAY2005; Kunzig Range & McKenna MOUT IMT Course

Soldier Number	Chest Size (in.)	LSDS Style	Strap Label	Strap Size (in.)	1st Extension Required	2nd Extension Required
9	37.50	1-C	#06	30.00		
4	33.88	HIDALGO	M4	unknown		
8	34.00	1-C	#01	28.00		
5	34.75	HIDALGO	M2	unknown		
2	41.00	HIDALGO	M1	unknown		
3	40.25	HIDALGO	M3	unknown	5"	
7	40.50	1-C	#04	30.00		
6	42.25	1-C	#03	30.00	5"	

Pictures of two styles

LSDS 1-C

Hidalgo strap

Medical Load Carriage Configurations

10 May 05, Kunzig Range

Soldier Number	Uniform Configuration	Kit Type	Original MOLLE-Mounted location	Timeframe
4	FFW	IFAK-Crye*	soft armor under LEFT arm	Morning
3	FFW	IFAK-Crye*	RIGHT leg MOLLE drop-down panel	Morning
2	FFW	IFAK-Crye*	soft armor under LEFT arm	Morning
5	FFW	IFAK-Crye*	LEFT leg MOLLE drop-down panel (above CLS Kit)	Morning
5	FFW	CLS-Crye*	LEFT leg MOLLE drop-down panel (below IFAK)	Morning
6	IBA	IFAK-ARMY**	over RIGHT kidney (lower right back)	Morning
7	IBA	IFAK-ARMY**	front RIGHT abdomen	Morning
9	IBA	IFAK-ARMY**	front RIGHT abdomen	Morning
8	IBA	IFAK-ARMY**	over LEFT kidney (lower left back)	Morning
2	IBA	IFAK-ARMY**	upper front RIGHT chest	Afternoon
4	IBA	IFAK-ARMY**	upper front LEFT chest	Afternoon
5	IBA	IFAK-ARMY**	soft armor under LEFT arm	Afternoon
3	IBA	IFAK-ARMY**	over LEFT kidney (lower left back)	Afternoon
7	FFW	IFAK-Crye	RIGHT leg MOLLE drop-down panel	Afternoon
9	FFW	IFAK-Crye	soft armor under LEFT arm	Afternoon
8	FFW	IFAK-Crye	LEFT leg MOLLE drop-down panel	Afternoon
6	FFW	IFAK-Crye	soft armor under RIGHT arm	Afternoon
9	FFW	CLS-Crye	LEFT leg MOLLE drop-down panel	Afternoon
9	FFW	Drop Pouch***	Lower back panel	N/A

*Crye Associates' new design for FFW ensemble
**AMEDD recommended IFAK solution for current Army with insert
***Used to hold one 500-mL bag of saline intravenous fluid

11 May 05, Eiler Hall

Soldier Number	Uniform Configuration	Kit Type	MOLLE-Mounted location
2	IBA	IFAK-ARMY*	upper front RIGHT chest
2	FFW	IFAK-Crye	soft armor under RIGHT arm
3	IBA	IFAK-ARMY*	over LEFT kidney (lower left back)
3	FFW	IFAK-Crye	LEFT leg MOLLE drop-down panel
4	IBA	IFAK-ARMY*	upper front LEFT chest
4	FFW	IFAK-Crye	soft armor under LEFT arm
5	IBA	IFAK-ARMY*	soft armor under LEFT arm
5	IBA	CLS-ARMY	back mid-plate[2]
5	FFW	IFAK-Crye	soft armor under LEFT arm
5	FFW	CLS-Crye	RIGHT leg MOLLE drop-down panel[3]
6	FFW	IFAK-Crye	soft armor under RIGHT arm
6	IBA	IFAK-ARMY*	front RIGHT abdomen
7	FFW	IFAK-Crye	RIGHT leg MOLLE drop-down panel
7	IBA	IFAK-ARMY*	Upper left back
8	FFW	IFAK-Crye	LEFT leg MOLLE drop-down panel
8	IBA	IFAK-ARMY*	upper right front chest
9	FFW	IFAK-Crye	soft armor under LEFT arm
9	FFW	CLS-Crye	Upper Back plate
9	FFW	Drop Pouch**	Lower back plate
9	IBA	IFAK-ARMY*	front RIGHT abdomen
9	IBA	CLS-ARMY	back mid-plate[2]

12 May 05, Kunzig Range

Soldier Number	Uniform Configuration	Kit Type	Molle-Mounted location
2	FFW	IFAK-Crye	soft armor under LEFT arm[1]
2	IBA	IFAK-ARMY*	upper front RIGHT chest
3	FFW	IFAK-Crye	soft armor under LEFT arm[1]
3	IBA	IFAK-ARMY*	over LEFT kidney (lower left back)
4	FFW	IFAK-Crye	soft armor under LEFT arm[1]
4	IBA	IFAK-ARMY*	upper front LEFT chest
5	FFW	IFAK-Crye	soft armor under LEFT arm[1]
5	FFW	CLS-Crye	Upper Back plate[3]
5	IBA	IFAK-ARMY*	soft armor under LEFT arm
5	IBA	CLS-ARMY	back mid-plate[2]
6	FFW	IFAK-Crye	soft armor under LEFT arm[1]
6	IBA	IFAK-ARMY*	front RIGHT abdomen
7	FFW	IFAK-Crye	soft armor under LEFT arm[1]
7	IBA	IFAK-ARMY*	Upper left back
8	FFW	IFAK-Crye	soft armor under LEFT arm[1]
8	IBA	IFAK-ARMY*	upper right front chest
9	FFW	IFAK-Crye	soft armor under LEFT arm[1]
9	FFW	CLS-Crye	Upper Back plate
9	FFW	Drop Pouch**	Lower back plate
9	IBA	IFAK-ARMY*	front RIGHT abdomen
9	IBA	CLS-ARMY	back mid-plate

Notes:
1 Standardized location
2 Weight of saline bag carried in Drop pouch by #9, simulated in weight of CLS-Army kit
3 No. 5 stuffed saline bag into CLS-Crye kit, no drop pouch carried

13 May 05, McKenna IMT course

No MLC data collected

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Abbreviations and Acronyms

AAR	after-action review
ACH	advanced combat helmet
ALICE	all-purpose lightweight individual carrying equipment
AMEDD	Army Medical Department
APG	Aberdeen Proving Ground
ARL	Army Research Laboratory
BDU	battle dress uniform
BIDS	ballistic impact detection system
CB	chemical-biological
CLS	combat lifesaver
EDE	engineering design event
FFW	Future Force Warrior
FRAGO	fragmentary order
GPS	global positioning system
IBA	interceptor body armor
IFAK	Individual first aid kit
IMT	individual movement techniques
IPT	integrated product team
LSDS	life sign detection system
MLC	medical load carriage
MOLLE	modular lightweight load-carrying equipment
MOPP	mission-oriented protective posture
MOUT	military operations in urban terrain
OPFOR	opposing force

ORP	objective rally point
PAPR	personal air-purifying respirator
PAVS	personal air ventilation system
PSG	platoon sergeant
RFI	ready for issue
SAW	squad automatic weapon
SME	subject matter expert
SPM	selectively permeable membrane
WPSM	war fighter physiological status monitor

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