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14. ABSTRACT

The U.S. Army Research Institute of Environmental Medicine (USARIEM) was tasked by the U.S. Army Training and Doctrine Command (TRADOC) to develop criterion-based physical requirements for entry into the seven physically demanding combat MOSs, including the 13 Series Field Artillery. Researchers from USARIEM completed three studies to develop a valid, safe, and legally defensible physical performance battery to predict a Soldier's ability to serve in the MOS. Study 1 involved measuring and identifying the physiological requirements of each of the tasks of the MOS in order to identify a set of criterion tasks encompassing the physical demands of all of the tasks of the MOS. Study 2 involved developing task simulations of the most physically demanding tasks (13B: casualty drag, transfer ammo with a FAASV; 13F: casualty evacuation, casualty drag, sandbag carry, move under direct fire, and foot march). In the final study, screening batteries using basic predictor tests for each MOS were developed to fit a range of needs of the Army.

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DEVELOPMENT OF A PHYSICAL EMPLOYMENT TESTING BATTERY FOR FIELD ARTILLERY SOLDIERS: 13B CANNON CREWMAN AND 13F FIRE SUPPORT SPECIALIST

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FOREWORD

This Technical Report is part of a series documenting the development of a physical employment screening test for seven Combat Arms Military Occupational Specialties (MOSs) as part of the Soldier 2020 initiative. The models presented herein are developed specifically using information from the 13B and 13F studies and the models apply to only those two MOSs. Additional reports describe the subsequent studies and models developed for the Combat Engineers (12B), Infantry (11B, 11C) and Armor (19D, 19K) MOSs. A final report will provide a single testing battery with acceptable predictive capability to identify candidates for each of the seven Combat Arms MOSs.

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LIST OF ACRONYMS

ACH	Advanced Combat Helmet
ACU	Army Combat Uniform
AIT	Advanced Individual Training
AKV	Armored Knight Vehicle
AOC	Area of Concentration
APFT	Army Physical Fitness Test
ASVAB	Armed Services Vocational Aptitude Battery
BCT	Basic Combat Training
BFV	Bradley Fighting Vehicle
CAT	Carrier Ammunition Track
EEOC	Equal Employment Opportunity Compliance
ESBI	Enhanced Side Ballistics Insert
ESAPI	Enhanced Small Arms Protective Insert
FA	Field Artillery
FAASV	Field Artillery Ammunition Supply Vehicle
FAPO	Field Artillery Proponent Office
FO	Forward Observer
FS3	Fire Support Sensor System
GLPS	Gun Laying Positioning System
HE	High Explosive
HEI-T	High Explosive Incendiary Tracer
HR	Heart Rate
IOTV	Improved Outer Tactical Vest
MEPS	Military Entrance Processing Station
MPAT	Multi-Purpose Anti-Tank
MOS	Military Occupational Specialty
NATO	North Atlantic Treaty Organization
OSUT	One Station Unit Training
PPE	Personal Protective Equipment
RPE	Rate of Perceived Exertion
SME	Subject Matter Expert
TRADOC	Training and Doctrine Command
USARIEM	U.S. Army Research Institute of Environmental Medicine
VO_2	Oxygen Uptake
VTC	Video Teleconference

BACKGROUND

Performing physically demanding tasks is an integral part of being a Soldier (33). In general, these tasks include combinations of lifting/lowering, lifting and carrying, pushing/pulling, climbing, digging, and walking/marching/running. Such tasks require a great deal of muscular strength, muscular endurance, and cardiovascular fitness. While recruits in the U.S. Army are required to complete a mental aptitude test (Armed Services Vocational Aptitude Battery (ASVAB)) in order to enlist in certain Military Occupational Specialties (MOSs), Soldiers are not currently selected for their MOS based on their ability to do the physical tasks necessary for that MOS. The safety and efficiency of Soldiers is based upon the ability of everyone in the team being capable of completing these physically demanding tasks. Thus, when assigning a Soldier to a MOS, it is important to match the physical capabilities of the Soldier with physical requirements of the critical tasks of that MOS. Otherwise, Soldiers who are physically unsuited to the MOS are at risk for injuring themselves, and those around them and have the potential to diminish larger group performance. In addition, training time and resources are misused on individuals who are not physically capable of being trained to perform these demanding tasks.

Presently, the only way that the Army assesses a Soldier's physical readiness for occupational and combat-related duties is through the Army Physical Fitness Test (APFT). This test creates a score based on the number of push-ups performed in two minutes, number of sit-ups performed in two minutes, and time to complete a 2-mile run. A number of studies have shown, however, that this score is not highly correlated with the performance of the physically demanding tasks performed by Soldiers (16, 22). Furthermore, the APFT score includes adjustments for age and sex, not only biasing for/against certain groups, but making it potentially legally indefensible if used as a screening tool for entrance into certain MOSs (12). Using physically demanding tasks corresponding to an MOS as a screening assessment is not practical and may violate the EEOC Uniform Guidelines on Employment Selection Procedures (9178). However, criterion-based physical performance tests (i.e., tests that are predictive of Soldiering task performance) can be used to predict whether Soldiers possess the physical capabilities needed for effective MOS performance.

The U.S. Army Research Institute of Environmental Medicine (USARIEM) has been tasked by the Training and Doctrine Command (TRADOC) to develop a new criterion-based physical testing procedure for entry into seven physically demanding combat MOSs. The seven Combat Arms MOSs are: 11B Infantryman, 11C Infantryman- Indirect Fire, 12B Combat Engineer, 13B Cannon Crewmember, 13F Fire Support, 19D Cavalry Scout, and 19K Armor Crewman. Understanding the physiological demands placed on these MOSs will allow for the development of valid, safe, and legally defensible physical performance tests to predict a Soldier's ability to serve in these MOSs. This is particularly important as the Army direct ground combat exclusion was lifted by the former Secretary of Defense (Leon Panetta), which will require the services to open these MOSs to females or justify the decision to keep them closed.

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DISCLAIMERS

The opinions or assertions contained herein are the private views of the author(s) and are not to be construed as official or as reflecting the views of the Army or the Department of Defense.

The investigators have adhered to the policies for protection of human subjects as prescribed in Army Regulation 70-25, and the research was conducted in adherence with the provisions of 32 CFR Part 219. Protocol # 9300.

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Portions of the data presented in this report have been previously reported.

EXECUTIVE SUMMARY

Currently, Soldiers in the U.S. Army are not selected for their MOS (Military Occupational Specialty) based on their ability to do the physical tasks necessary for that MOS. The U.S. Army Research Institute of Environmental Medicine (USARIEM) was tasked by the Training and Doctrine Command (TRADOC) develop criterion-based physical requirements for entry into seven physically demanding Combat Arms MOSs, including the 13B Cannon Crewman and 13F Fire Support Specialist.

Researchers from USARIEM completed three studies to develop a valid, safe, and legally defensible physical performance battery to predict a Soldier's ability to serve in these MOSs. Study 1, conducted in December 2013, involved measuring and identifying the physiological requirements of each of the tasks of the MOS in order to identify a set of criterion task encompassing the physical demands of all of the jobs of the MOS. From these data, as well as incorporating data from focus groups, casualty drag, transfer ammo with a FAASV (13B only), casualty evacuation (13F only), carry phase of the fighting position (13F only), and foot march (13F only) were identified as representative of all heavy lift, heavy drag, lift and carry, and load carriage tasks. These tests were vetted by SMEs, who also requested an additional test be added for the 13F: move under direct fire.

Once these tests were identified, it was important to determine if the task simulations were reliable to use as criterion tasks for development of a model. Study 2, conducted in May and December 2014, involved developing task simulations of these tasks. All of the criterion tasks were determined to have sufficient reliability to use in development of a final predictive model.

Finally, once reliable criterion tasks were developed, predictive models of criterion task performance were developed (Study 3, February-April 2015). Four 13B and three 13F test battery models were proposed to fit a range of needs of the Army (i.e., cost and space requirements). Potential predictor tests included squat lift, 38 cm upright pull, handgrip strength, standing long jump, medicine ball put, powerball throw, 2-minute arm ergometer, 1-minute sit-up, 1-minute push-up, and the 300m sprint.

With the test battery models developed, future work will require TRADOC to select a testing battery and identify acceptable performance on the criterion tasks in order to identify appropriate cut scores.

Note: This Technical Report is the one in a series documenting the development of a physical employment screening test for seven Combat Arms Military Occupational Specialties (MOSs) as part of the Soldier 2020 initiative. A report has already been written for the Combat Engineers (12B), and additional reports will be written for the studies on the Armor (19D, 19K), and Infantry (11B, 11C) MOSs. A final report will be written to develop one overarching test battery of five to seven tests to cover all seven Combat Arms MOSs.

Study 1: Physiological Observation

STUDY 1: INTRODUCTION

According to Payne & Harvey (24), the first steps in developing a physical testing battery are to identify the most physically demanding tasks and then quantify the physiological demands of the individual tasks. TRADOC began by reviewing field manuals training videos and physical task descriptions related to each of the MOSs MOSs of interest (11B Infantryman, 11C Infantryman- Indirect Fire, 12B Combat Engineer, 13B Cannon Crewmember, 13F Fire Support, 19D Cavalry Scout, and 19K Armor Crewman). A group of subject matter experts (SMEs) from each of the proponent schools then developed a task list and associated minimum standards based on this review. The result was a list of 32 physically demanding tasks relevant to these MOSs (Table 1.1). Of these tasks, nine were common to multiple MOSs, and 23 were specific to less than three of the MOSs. TRADOC then observed Soldiers from each MOS performing the tasks. If 90% of the Soldiers observed could not perform the tasks to standard, the task statements were revised until the 90% threshold was reached. As part of this TRADOC exercise, USARIEM researchers also observed the Soldiers. Quantifiable task details were recorded including quantity and weights of loads being moved or lifted, distances traveled, Soldier gear, and equipment required.

USARIEM researchers also conducted focus groups with enlisted Soldiers from each MOS. Both lower enlisted (Corporal/Specialist and below) and upper enlisted (Sergeant through Sergeant First Class) Soldiers completed surveys about each of the tasks identified as relevant to their MOS. Soldiers were asked how often they completed the tasks both in training and while deployed in order to better understand the frequency of performing the task. This was followed with a face-to-face focus group session where Soldiers were asked about the details collected during phase one, such as if the weights and distances were correct, and if there were any additional tasks which warranted consideration (19).

With the first two steps (task validation and focus groups) complete, the next phase of the project required the direct measurement of the identified physically demanding tasks. Quantifiable metrics of task performance and physiological responses were collected from members of each of the MOSs. These measurements included heart rate (HR), rate of perceived exertion (RPE), and metabolic cost. In addition to male Field Artillery (13B and 13F) Soldiers, female Soldiers from other MOSs also performed the tasks in order to include physiological responses from both sexes. These data were used to select the most physically demanding tasks for each MOS and to develop criterion task simulations.

Both the 13B Cannon Crewman and 13F Fire Support Specialist MOSs are included in the highest level (very heavy) of physical demands. Cannon Crewmen are responsible for manning and operating field artillery cannons. Fire Support Specialists conduct fire missions such as intelligence gathering for target processing. While a number of their tasks have been identified as having high physical demands, the exact physiological requirements of these tasks had not been quantified.

STUDY 1: METHODS

Data were collected at Ft. Bliss, TX during December 2013 from Soldiers of the 2nd Armored Brigade Combat Team, 1st Armored Division. Physiological measurements were collected on 20 males with 13B MOS and 10 females from other MOSs/AOCs while performing the 13B Cannon Crewman tasks (25B, 25U, 35F, 68W, 88M, 92Y, 94F, and 1 not reported). Twenty males with 13F MOS and 11 females with other MOSs volunteered for the 13F Fire Support Tasks (25U, 35M, 68W, 91B, 92A, 92F, 92G). Prior to testing, all Soldiers were briefed, signed a consent form, completed questionnaires about their demographics, and provided their most recent Army Physical Fitness Test (APFT) scores. Height and weight values were also collected prior to the start of testing.

All participants completed a training and deployment history questionnaire (see Appendix H). Participants were asked the duration of their Army service, time in the MOS, and time deployed. Then, for each of the tasks, Soldiers were asked if they had performed the task in training or while deployed (if applicable), and how many times they had performed each task in either setting.

Prior to testing, Soldiers completed a three-week train-up to familiarize themselves with the technical aspects of all of the tasks. See Appendix D for details of the training schedule.

TASK SIMULATIONS

Fourteen tasks were identified by TRADOC as relevant to the Field Artillery MOSs. Three of these tasks were not tested. Task 2 employing hand grenades was not tested because it has been demonstrated that skill plays a greater role than physiological demand, and that task performance is not always repeatable (34). Task 24 setting up Gun Laying Positioning System (GLPS) was also not tested because the technical demands outweighed the physical demands. Finally, Task 25 establishing an observation point was not tested as a distinct task due to its similarities to the foot march. Of the remaining 11 tasks, three were relevant to 13B, six were relevant to 13F, and two were relevant to both (Table 1.2).

Four tasks (prepare a fighting position, casualty evacuation, transfer ammo with a Field Artillery Ammunition Supply Vehicle (FAASV), and install/remove the Fire Support Sensor System (FS3)) were divided into two parts for the purpose of understanding the unique demands of different aspects of the task. For the fighting position, the two phases were filling sandbags and carrying sandbags. The casualty evacuation was performed under two conditions: as a team of two Soldiers and individually. For the team attempt, all females had male teammates and if the team did not complete the task, each team member was allowed to repeat the task with a different teammate. For transfer ammo with a FAASV, Soldiers were tested both on the outside (transferring from an ammunition point to the rear of the FAASV), and inside

(loading from the rear of the vehicle into the ammunition racks). Finally, the installation and removal of the FS3 were tested separately.

During each task Soldiers wore the designated uniform with appropriate load as defined by the SMEs from the Field Artillery Proponent Office (FAPO). The full breakdown of each load is illustrated in Appendix B. Briefly, the approximate weight of the basic Army Combat Uniform (ACU) was 12.4 lb. The fighting load included the uniform plus the weight of the personal protective equipment (PPE) and weapon (70.4 lb) for a total of 83 lb. The loads varied based on the size of the Soldier, particularly the weight of the body armor. The weight of the standard PPE could vary from 63.1-77.5 lb. The loads worn for each task are listed in the task descriptions. The 24-hour sustainment load consisted of everything included in the fighting load, plus 19 lb of additional supplies and equipment carried in an assault pack, for a total load of 102 lb. This load could also vary from 94 to 110 lb based on size. The task specific uniform can vary between 42.5-57.1 lb, which includes the ACU, Improved Outer Tactical Vest (IOTV) with Enhanced Small Arms Protective Insert (ESAPI) and Enhanced Side Ballistics Insert (ESBI), and Advanced Combat Helmet (ACH). The loads stated herein refer to size large body armor, so the loads represent the middle of the actual range of weight worn.

Descriptions of the testing conditions for each task, as well as the acceptable standard of completion provided by TRADOC (when applicable) are listed below. All testing instructions and data sheets for Study 1 can be found in Appendices G and H, respectively.

1. Foot March (13F; Figure 1.1)

Conduct a Tactical Movement

The standard tactical movement requires Soldiers to complete a 12-mile foot movement, wearing the 24-hour sustainment load (approximately 102 lb of equipment) in 24 hours. To obtain an estimate of energy expenditure during the task, Soldiers performed a 20-minute movement at 2.0-2.5 mph over various grades on a treadmill to simulate walking up and down hills. The grade changed for each segment and in the following order: 1.0%, 3.0%, 1.0%, 5.0%, 1.0%, 3.0%, and 1.0%.

Army Standard: Successful completion of the task

2. Employ Hand Grenades (13B & 13F; NOT TESTED)

While wearing a fighting load without a weapon (approximately 71 lb) throw a 1-lb hand grenade at least 30 m.

3. Fighting Position (13B & 13F; Figure 1.2)

Prepare a Fighting Position

Part A: Fill

While wearing a fighting load (approximately 83 lb), Soldiers shoveled sand from a large pile of loose sand into a bucket (to simulate a sandbag) using an

entrenchment tool. A bucket was used to standardize the amount of sand moved. Soldiers filled buckets 26 times 55 to 60% full (30-40 lb of sand).
Army Standard: Filled 26 sandbags in 52 minutes

Part B: Carry
The Soldier lifted and carried 26 pre-filled sandbags, weighing 40 lb each, a horizontal distance of 10 m where they built a fighting position within 26 minutes. The fighting position consisted of three rows in a rectangular formation. Each row consisted of three sandbags in length and three sandbags in height. One of the three rows only had two sandbags on the third level.
Army Standard: Carried 26 sandbags in 26 minutes

4a. Casualty Drag (13B & 13F; Figure 1.3)
Drag a Casualty to Immediate Safety (Dismounted)
Soldiers dragged a simulated casualty (approximately 271 lb) a distance of 15 m as quickly as possible while wearing a fighting load (approximately 83 lb). For the simulated casualty, a Survivor dummy (Dummies Unlimited, Pomona, CA) was modified to obtain the necessary weight. The dummy was outfitted with a modified Fighting Load Carrier to serve as a pulling handle.
Army Standard: Casualty dragged 15 m in 1-minute

4b. BFV Casualty Evacuation (13F; Figure 1.4)
Remove a Casualty from a Vehicle (Mounted)
As part of a two-Soldier team and while wearing a fighting load minus the weapon (approximately 71 lb), Soldiers removed a simulated casualty (approximately 207 lb, prorated at 103.5 lb/Soldier) from the commander's seat of a Bradley Fighting Vehicle (BFV). In order to standardize conditions, which would be impossible using a standard dummy with limbs that may catch in an irregular manner, the simulated casualty for this task was a haul bag (Black Diamond Zion, Salt Lake City, UT) modified to include straps that simulate the shoulder straps of a Combat Vehicle Crewman protective vest. Soldiers performed this task twice from the outside of the hatch. Once it was tested as a member of a two-person team with the bag weighted at 207 lb. Learning from the testing during the development of the 12B test battery (10), Soldiers also performed the task once solo, with the bag weighted at 103.5 lb.
Army Standard: Casualty removed from vehicle in 2 minutes

5. 25mm Barrel Install (13F; Figure 1.5)
Lift, Carry, and Install the Barrel of a 25mm gun on the BFV
As part of a two-Soldier team and wearing a fighting load (approximately 83 lb), Soldiers lifted, carried (25 m) and emplaced the barrel of the M242 25mm gun (107 lb, prorated at 53.5 lb/Soldier) for the BFV. This involved placing the barrel onto the hood of the BFV, and climbing up onto the hood/deck. The Soldiers took turns supporting the barrel, while the other Soldier climbed onto the BFV. Once on the hood, the barrel was lifted as a team, and rotated into place.
Army Standard: Successful completion of the task

6. Feeder Assembly (13F; Figure 1.6)

Remove the Feeder Assembly of a 25mm gun on the BFV

While wearing approximately 49 lb of task specific PPE, a Soldier removed the M242 feeder assembly (59 lb) from the gun on the BFV and placed it on the floor in the rear of the vehicle. This involved lifting, pulling and lowering the assembly out of the slot, holding it while moving across the vehicle seat, and placing it on the floor behind the seat.

Army Standard: Successful completion of the task

7. Ammo Can Carry (13F; Figure 1.7)

Load 25mm HEI-T Ammunition Cans onto the BFV

While wearing a fighting load minus the weapon (approximately 71 lb), Soldiers lifted 30 cans of 25mm ammunition (45 lb), carried them 15 m, and placed them onto the tailgate of a BFV or a platform of similar height and dimensions. The can dimension were 36 x 33 x 13 cm. Soldiers carried one or two cans at a time.

Army Standard: Successful completion of the task

21. Transfer Ammo with a FAASV (13B; Figure 1.8)

Transfer Ammunition (M795 HE Rounds) with an M992 Field Artillery Ammunition Supply Vehicle (FAASV)

While wearing approximately 49 lb of task specific PPE and a heart rate monitor, the Soldiers completed two subtasks in order to test individual demands of transferring ammunition with an M992 FAASV (also known as a CAT). The subtasks are outlined below.

Part A: Outside

Soldiers moved thirty M795 HE Rounds (approximately 105 lb each) from a pallet into the M992 FAASV or a simulated platform.

Part A: Inside

Soldiers moved thirty M795 HE Rounds (approximately 105 lb each) from the floor of the FAASV into the designated locations on the ammunition rack inside the FAASV.

Army Standard: Carried 30 rounds in 15 minutes for each phase

22) Lift Wheel Assembly (13B; Figure 1.9)

Emplace 155mm Howitzer (Lift Wheel Assembly)

As part of a two-Soldier team and wearing a fighting load (approximately 83 lb), the wheel assembly of a 155mm Howitzer (135 lb, prorated 67.5 lb/Soldier) was lifted from the ground to the emplacement position (height = 2 m, distance = 0.5 m). Time started on a verbal command and stopped when the wheel assembly was emplaced.

Army Standard: Successful completion of the task

23. Life Spade Trail Arm and Blade (13B; Figure 1.10)

Displace 155mm Howitzer (Lift Spade Trail Arm and Blade)

As part of a two-Soldier team and wearing a fighting load (approximately 83 lb), the spade trail arm and blade of a 155mm Howitzer (204 lb, prorated 102 lb/Soldier) was lifted to the displacement position (height = 2 m, distance = 0.5 m). Time started on a verbal command and stopped when the spade trail arm and blade was emplaced.
Army Standard: Successful completion of the task

24. Set Up GLPS (13B; NOT TESTED)
Set Up Gun Laying Positioning System (GLPS)
Wearing / Carrying 75.43 to 89.97 lb fighting load and given the four containerized components of a GLPS located 3 m from the assembly site, Soldiers assembled, mounted, and sighted GLPS within 8 minutes.

25. Establish an Observation Point (13F; NOT TESTED)
Establish an Observation Point
Conduct a 24-kilometer dismounted tactical movement with supported maneuver unit, carry Forward Observer (FO) specific equipment to perform fire support tasks.

26. Install/Remove FS3 (13F; Figure 1.11)
Install/Remove Fire Support Sensor System (FS3) on M1200
As part of a two-Soldier team and wearing a fighting load (approximately 83 lb), Soldiers lifted, carried (3 m), and installed the Fire Support Sensor System (FS3) (120 lb, prorated 60 lb/Soldier) onto the M1200 Armored Knight Vehicle (AKV) and then removed it. A third Soldier was present to provide stability to the FS3 once it was lifted onto the M1200.
Army Standard: Successful completion of the task

Soldiers were instructed to perform the tasks at the rate they would normally perform the task. All tests were graded “Go” or “No-Go” depending on whether they completed the task to standard. Because the foot march test was modified from the testing standard (completing a full foot march), Soldiers were graded only on whether or not they completed the 20 minutes foot march.

PHYSIOLOGICAL MEASUREMENTS

Measurements varied by task (see Table 1.2). Time to completion was recorded for all tasks. Ratings of perceived exertion (4) were also recorded for all tasks, with those tasks deemed aerobically-intensive graded on the 6-20 scale (Tasks 1, 3, 7, and 21), and tasks primarily driven by strength (Tasks 4a, 4b, 5, 6, 22, 23, and 26) graded on the CR-10 (i.e., 1-10) scale. Tasks with an approximate duration of greater than 5 minutes were deemed aerobic tasks, while the remaining tasks were identified as strength tasks.

Metabolic data were also collected for the aerobic tasks using an Oxycon Mobile Metabolic Unit (CareFusion, San Diego, CA) for Tasks 3, 7, and 21, and using a Parvo

Medics TrueOne 2400 Cart (Salt Lake City, UT) for Task 1. Data were output using 1-minute averaging, and then were averaged over the course of the task, leaving out the first minute. Metabolic variables of interest included average heart rate, average oxygen uptake (VO_2) in absolute units (L/min), average VO_2 relative to body mass (ml/kg/min), and percent of estimated VO_2max. VO_2max was estimated using the following equation (21):

Predicted VO_2max (ml·kg·min^{-1}) =110.9 – 2.79 (2-mile run time [min])-0.25 (weight [kg])

Absolute total O_2 consumption (L, product of average VO_2 and time) adjusted for body mass (ml/kg) was also calculated. For all tasks, except Tasks 5 and 6, HR at the end of the task was recorded using a Polar heart rate chest-strap monitor and watch (Polar Electro Model T31, Kempele, Finland).

STATISTICAL ANALYSES

All statistics were calculated using SPSS Version 20 (IBM Corporation, Armonk, New York). Significance was set at the $p<0.05$ level. Each MOS was analyzed independently.

For each task and outcome variable, mean and standard deviations were calculated separately for each sex. Differences between sexes in characteristics were assessed using unpaired t-tests. Sex differences in percentage of individuals who completed the task to standard were assessed using a Pearson's chi-square test. Two-factor (task, sex) ANOVAs were run for each physiological variable using data from those who successfully completed the task to ensure that the data corresponded to acceptable performance. The aerobic and strength tasks were tested separately. Significant main effects of task were separated using a post-hoc Scheffe's adjustment to determine differences in physiological demand across tasks. Marginal means were calculated by task for the interaction, and tested using post-hoc unpaired t-tests for differences across in the physiological demands by sex for each task.

STUDY 1: RESULTS

SOLDIER VOLUNTEER CHARACTERISTICS

Soldier characteristics are summarized in Table 1.3. For both MOSs, males were taller and heavier than the females ($p<0.01$). Males and females had similar time military experience ($p\geq0.08$), APFT total scores ($p\geq0.34$), and estimated VO_2max ($p\geq0.12$); however, males had higher raw scores for the push-ups and 2-mile run ($p<0.01$).

The data from the training and deployment questionnaire for both the 13B and 13F are shown in Table 1.4. For the most commonly performed aerobic task the 13B completed in training was transfer ammo with a FAASV followed by both fighting position phases. The most common strength tasks were lift wheel assembly followed by

lift spade trail arm and blade. The two most frequently performed tasks in a deployed setting were lift wheel assembly and lift spade trail arm and blade; however, only one Soldier performed it while deployed. Building the fighting position and casualty drag were performed while deployed by multiple Soldiers.

The 13F training data indicate that all performed the eight tasks at some point during their training. The most commonly performed aerobic task during training was the foot march followed by fighting position. Additionally, the foot march is the most common aerobic tasks performed while deployed. The casualty drag and casualty evacuation were the most common strength tasks practiced during training. While deployed, the most common strength tasks were to install/remove FS3 followed by the casualty drag.

TASK COMPLETION

Table 1.5 indicates the number of Soldiers tested for each task, as well as the number who completed each task to the standard. All the 13B and 13F Soldiers were able to participate in the every task, with the exception of one 13F Soldier on the ammo can carry.

For the 13B, three tasks had pass rates lower than 100%. The casualty drag had a pass rate of 83% (five failures). For transfer ammo with a FAASV, the outside phase had a passing rate of 93% while the inside phase had a passing rate of 56%. For each of these tasks, there were a greater percentage of females who were unable to complete the tasks than males ($p \leq 0.04$). None of the females were able to finish transfer ammo with a FAASV in the allotted time. The most rounds loaded by the females was 19 out of 30.

For the 13F, there were also three tasks which had pass rates lower than 100%. They were the foot march (93.5%), casualty drag (77.4%), and casualty evacuation (83.9%). Again, for each of these tasks, there were a greater percentage of females who were unable to complete the tasks than males ($p \leq 0.05$).

PHYSICAL DEMANDS OF 13B TASKS

A summary of 13B tasks deemed most difficult for each measure, by nature of being in the top rank, is provided in Table 1.6. The aerobic tasks that took the longest for the 13B were the inside phase of transfer ammo with a FAASV and the fill phase of the fighting position (Figure 1.12, TOP LEFT). Both phases of transfer ammo with a FAASV had the highest measures for RPE (Figure 1.13, TOP LEFT). The carry phase of the fighting position and both phases of the FAASV had the highest values for end task heart rate (Figure 1.14, LEFT), average heart rate (Figure 1.14, BOTTOM LEFT), absolute oxygen uptake (Figure 1.15, TOP LEFT), relative oxygen uptake (Figure 1.15, MIDDLE LEFT), and oxygen uptake normalized to predicted VO_2max (Figure 1.15, BOTTOM LEFT). The inside phase of transfer ammo with a FAASV also had the highest absolute (Figure 1.16, TOP LEFT) and normalized to body mass total oxygen consumption (Figure 1.16, BOTTOM LEFT).

For strength tasks, the heaviest load of the 13B tasks were the 270-lb dragged for the casualty drag. While not truly a strength task, the 105 lb lifted for the transfer ammo with a FAASV is also of note, as it was a greater lift than the other strength tasks. The casualty drag took the greatest time to complete (Figures 1.12, BOTTOM LEFT) in addition to having the highest RPE values (Figure 1.13, BOTTOM LEFT).

Females took longer than the males to complete the filling phase of the fighting position, the outside phase of the FAASV, and the casualty drag. Ratings of perceived exertion were also higher for the females during the outside phase of the FAASV and the casualty drag. There were no differences by gender in heart rate, but VO_2 (both absolute and relative) was higher in the males than the females in all tasks where the data were collected. In addition, total oxygen (O_2) consumption (both absolute and relative) was greater in the males than females for the outside phase of the FAASV. Since none of the females completed the inside phase of the FAASV to standard, no gender comparisons could be made on this task. A summary of differences in physiological demands by sex is provided in Table 1.7.

PHYSICAL DEMANDS OF 13F TASKS

A summary of 13F tasks deemed most difficult for each measure is provided in Table 1.8. For the 13F Soldiers, the foot march was the aerobic task that took the longest to complete (Figure 1.12, TOP RIGHT). The carry phase of the fighting position was the aerobic task that had the highest values for RPE (Figure 1.13, TOP RIGHT), end-task heart rate (Figure 1.14, TOP RIGHT) and average heart rate (Figure 1.14, BOTTOM RIGHT). The carry phase of the fighting position and ammo can carry were both shown to have the greatest average oxygen uptake absolute (Figure 1.15, TOP RIGHT), relative (Figure 1.15, MIDDLE RIGHT) and normalized to predicted VO_2max values (Figure 1.15, BOTTOM RIGHT). Whether absolute or normalized to body mass, the greatest total oxygen consumption was measured during the foot march simulation (Figure 1.16, RIGHT).

The heaviest loads of the 13F tasks were the 270-lb dragged for the casualty drag and 103.5 prorated lb lifted for the casualty evacuation. The 25mm barrel install, remove feeder assembly, install/remove FS3, and casualty drag took the longest time to complete (Figure 1.12, BOTTOM RIGHT). The casualty drag also had the highest RPE out of all the strength tasks (Figure 1.13, BOTTOM RIGHT).

Females took longer than the males to complete both phases of the fighting position, loading ammo cans, and the casualty drag. The foot march, ammo cans, casualty evacuation casualty drag, feeder assembly, and installation of the FS3 were perceived to have a higher RPE in females. Heart rate at the end of the foot march was higher in the females, but there was no difference in average heart rate during the task. Females had a lower absolute VO_2 than males during both phases of the fighting position and the ammo can carry, but these differences disappeared when normalized to body mass or estimated VO_2max. In absolute terms, total O_2 consumption was greater in males compared to females for the foot march, but when normalized to body mass, there were no difference by sex for the foot march. However, females had

greater relative total O_2 consumption for both phases of the fighting position and the ammo can carry. A summary of differences in physiological demands by sex is provided in Table 1.9.

STUDY 1: DISCUSSION

This descriptive study identified the frequency and physiological demands of the most physically demanding tasks performed by 13B Cannon Crewman and 13F Fire Support Specialist MOSs. From these data the following tasks were identified as the most demanding common and/or essential tasks performed by 13B: casualty drag and inside phase of transfer ammo with a FAASV. Of the aerobic tasks, the inside phase of transfer ammo with a FAASV had the highest values for all measures reported (time, RPE, end-task HR, absolute and relative VO_2). Of the strength tasks, the casualty drag had the longest time to completion and highest RPE.

From these data the following tasks were identified as the most demanding common and/or essential tasks performed by 13F: foot march, carry phase of the fighting position, casualty drag, and casualty evacuation. Of the aerobic tasks, the foot march had the longest time to completion and the highest total energy cost (total O_2), while the carry phase of the fighting position had the highest end-task heart rate and average rate of oxygen consumption. Of the strength tasks, the casualty evacuation had the greatest weight being lifted and the casualty drag had the highest RPE.

PHYSICAL DEMANDS OF TASKS

For the purposes of identifying the most physically demanding tasks, it is possible to break down the tasks further based on their constituent movements. The tasks tested consist of both aerobically demanding tasks and strength demanding tasks. The aerobic tasks can be subdivided into repeated lift and carry tasks (13B: fighting position and transfer ammo with a FAASV; 13F: fighting position and ammo can carry), and extended duration load carriage (13F: foot march). The strength tasks can be broken into heavy lift (13B: transfer ammo with a FAASV, lifting the wheel assembly, and lifting the trail arm and blade; 13F: casualty evacuation, 25mm barrel install, feeder assembly, and install FS3) and heavy drag (13B & 13F: casualty drag)

The physical demands of the 13B aerobic and strength tasks can be found in Table 1.6. For aerobic tasks, the inside phase of transfer ammo with a FAASV having among the highest values for all measures tested. Although the other tasks may have had longer carry distances or a similar amount of repetitions, the combination of the heavy loads and the necessary height the rounds needed to be lifted vertically ranked the inside phase of transfer ammo with a FAASV the most physically demanding aerobic task. The carry phase of the fighting position did have similar demands for end-task heart rate and rate of oxygen consumption, despite the carrying distance being longer (15 m) with a lighter load lifted (35 lb v. 105 lb). However, the carry phase of the fighting position had a lower RPE, and a lower mean time to complete than transfer ammo with a FAASV. The sandbag fill had similar mean time to complete as the inside phase of transfer ammo with a FAASV but had lower physical demands than both the

carry phase of the fighting position and both phases of transfer ammo with a FAASV (RPE, end-task HR, and VO_2). Although the outside phase of transfer ammo with a FAASV had the same load and a longer carry distance (5 m), it had a lower lift height (0.7 m) or approximately waist height which made it less physically demanding than the inside phase. Therefore the inside phase of was considered most difficult. The physical demands of the 13B strength tasks revealed that the casualty drag was the most physically demanding strength task. Transfer ammo with a FAASV is overall both the most demanding heavy lift task and most difficult lift and carry task. It was the most demanding for the length of time required to complete the task and received the highest mean rate of perceived exertion values. Furthermore, when comparing the vertical heavy lift tasks (transfer ammo with a FAASV, lift wheel assembly, and lift spade trail arm and blade) transfer ammo with a FAASV had the heaviest individual weight lifted. Lift wheel arm assembly and recover a spade trail arm and blade took only seconds to complete and were performed as a two-Soldier team to lift approximately a 131-lb wheel arm and a 170-lb spade trail arm. The prorated loads (67.5 lb and 102 lb, respectively) were less than the M795/M107 round (about 105 lb) lifted vertically and carried for transfer ammo with a FAASV. Therefore, because the inside phase of transfer ammo with a FAASV requires a Soldier to lift a 105-lb round to shoulder height (same relative height as the wheel and spade trail arms in Tasks 22 and 23), this task is also the most difficult heavy lift task for the 13B MOS.

The physical demands of the 13F aerobic and strength tasks can be found in Table 1.8. For the aerobic tasks, it was revealed that the foot march and carry phase of the fighting position were representative of the most physically demanding load carriage and lift and carry tasks of the 13F MOS. The foot march was the only load carriage task tested and was unique compared to the three other aerobic tasks, which were all relatively short duration lift and carry tasks. The carry phase of the fighting position was among most demanding for rate of perceived exertion, end-task heart rate, and rate of oxygen consumption. The sandbag fill had the lowest physical demands of all the aerobic tasks and ammo can carry had similar rates of oxygen consumption as the carry phase of the fighting position, but lower RPE values and end-task heart rates. The physical demands of the 13F strength tasks revealed that casualty drag and casualty evacuation were representative of the heavy drag and heavy lift job tasks of the 13F. The casualty drag had the highest RPE values of the strength tasks. The casualty evacuation as a team task had the second highest RPE values, similar to that of the install phase of Task 26. However, the final task or task simulation must be an individual task. Therefore, the prorated weight of the install FS3 system on an AKV was 60 lb, which was considered much less than the prorated weight of Task 4b casualty evacuation of 103.5 lb.

SEX DIFFERENCES IN PHYSIOLOGICAL MEASUREMENTS

Differences in task performance by sex are summarized in Tables 1.7 and 1.9. Notably, during the aerobic tasks which was matched for pace (foot march), there was no difference in VO_2, but the RPE and heart rate were higher in the females than the males. In tasks which were self-paced (ammo can carry, fighting position, FAASV) females were frequently slower and worked at a lower absolute (but not always relative)

VO_2. Heart rates were similar between males and females on these self-paced activities. This suggests that when allowed to self-pace, females and males picked a similar settled into a speed which resulted in the same relative workload.

For both MOS, females took longer for the casualty drag. In addition, they perceived the casualty drag and casualty evacuation as being more challenging than the males. Females were less likely to complete these tasks successfully than males. These two tasks involve the heaviest weights of all the strength tasks. This is likely, in part, due to the fact that females generally have less lower-limb muscle mass than males (31). If females are going to be permitted to join these MOS, it is likely that some type maximal leg strength test will be necessary in order to ensure that Soldiers have the necessary strength to perform these tasks.

TESTING CONSIDERATIONS

Further discussion of the foot march is warranted; observations from this task simulation on a treadmill indicated that it did not capture the full physical demands of conducting a tactical movement while deployed. The energy requirements of the foot march suggest that it is not a physically demanding task; however, these results are deceiving. This difference in energy requirements and perceived exertion between the foot march, ammo can carry, and carry phase of the fighting position may be due to the brief simulation of the task using a treadmill. While the weights and speeds were matched to a typical tactical movement (foot march), the task should be performed over a much longer distance (12 miles) for a longer duration. While the simulation of foot march in the present study may have captured the physical demand early in the march, it likely failed to capture any increase in difficulty and discomfort caused from prolonged load carriage. TRADOCs task standards validation data indicated that under certain conditions, as few as 59% of 237 Soldiers attempting the task were able to complete a 12-mile foot march. While many of these observations with high failure rates were observed in extreme heat, there was attrition during all of the TRADOC observations. Contrary to those observations, 29 of the 31 Soldiers (93.5%) in this study completed the 20-minute simulation. Thus, while we measured the energy requirements early in the task, this study did not capture the full spectrum of physical demands of a foot march. Future studies should assess the physical demands of a complete this task (either through direct testing or simulations) in order to get a better understanding of the physiological response during the later phases of the march, particularly as fatigue starts to influence performance.

A number of the tasks required teamwork in groups of two or more participants. During these tasks, the performance of one individual will affect the others performing the task. For example, the weaker person may be carrying less of the load, or a less aerobically fit individual may require the task be performed at a slower rate. Likewise, the more the stronger or fitter person is able to compensate for another Soldier, the less of a demand is placed on the weaker one. In addition, if the load is not distributed evenly, the task may not be the same for each member of the team. Thus, interpretation of the physical demands of these tasks should be performed with care, taking this influence into account. While the average data is still valid, given different

combinations of individuals, it is likely that performance could be more variable. This is particularly true since tasks were completed at a work (i.e., submaximal) pace, and not necessarily at an all-out effort. Simulations must be designed to reflect the demands of a single individual to assess an individual's capacity to perform the task.

FUTURE TASK SIMULATIONS

All of the physical demands required to successfully perform the jobs of an MOS should be captured in a set of tasks asks identified for simulations. Additionally, these tasks should:

- Test individuals, not teams
- Allow for a range of scores to show differences between people (cannot be go/no-go)
- Accurately measure unique physical capabilities
- Be safe (not endanger Soldiers)
- Require minimal, available equipment
- Be reliable (same person gets same score on different days)
- Require minimal skill and practice
- Be time efficient

The 13B did not have a load carriage task, while the 13F were required to complete one. Thus, while the 13B do not need a task simulation to capture load carriage, the 13F should include the foot march in future studies. For the 13B and 13F, separate tasks are needed for the repeated lift and carry and the heavy lift. Transfer ammo with a FAASV was the most difficult 13B repeated lift and carry. It was in the highest rank for all physiological measures recorded. The carry phase of the fighting position was the most difficult lift and carry task for the 13F by virtue of being in the highest rank for heart rate, RPE and VO_2.

Both MOSs had only one task that could be considered a heavy drag task: the casualty drag. This task should be included in future studies. For the heavy lift, lifting the rounds of the FAASV was the heaviest weight for the 13B, so no additional task is needed to represent this physical domain. For the 13F, the prorated weight of 103.5 lb for the evacuation of the casualty captures the weights of all of the lifting tasks.

LIMITATIONS

While this study was designed to simulate real world conditions, we were not able to account for all variables. Some tasks had to be modified to allow for testing (e.g., haul bag used for casualty evacuation). Tasks were completed on successive days, so any cumulative fatigue or discomfort may have affected performance on later days. While this may affect performance on individual tasks, it is not uncommon for Soldiers in the field to have to perform these physical tasks on consecutive days. In addition, several tasks were completed as teams of two or more people. This makes it difficult to fully understand the demands of the task on an individual, as the two Soldiers may not be evenly distributing the burden of the task.

Most notably, all tasks were tested in a controlled garrison environment. Soldiers were instructed exactly how to perform the task, based on recommendations provided by SMEs. It is possible that in a real situation, there may be variations on the task which may increase or decrease the individual demands, such as material on which the casualty is dragged, distance of carry (ammo cans, sandbags, MPAT rounds), or weight of the casualty. In addition, at no time were the Soldiers in immediate danger. In a deployed, high-stress situation, the physiological demands are likely increased, and tasks may be performed repeatedly, or in an entirely different manner.

STUDY 1: CONCLUSIONS

The present study determined the physiological demand for the common and/or essential physically demanding job tasks of 13B and 13F Field Artillery Soldiers. The casualty drag and transfer ammo with a FAASV was considered to be represented of physically demanding tasks of the 13B MOS. Among the most physically tasks for the 13F MOS are the carry phase of the fighting position, casualty evacuation, casualty drag, and foot march.

STUDY 1: RECOMMENDATIONS

1. For the 13B MOS the following tasks should be presented to a panel of SME's for consideration as representative of the most physically demanding job tasks: casualty drag and transfer ammunition with a FAASV.
2. For the 13F MOS the following tasks should be presented to a panel of SME's for consideration as representative of the most physically demanding job tasks: foot march, prepare a fighting position (sandbag carry), casualty drag, and casualty evacuation
3. The foot march should be assessed using a full or a modified version in the field, so that the true physical demands can be compared to the simulation.
4. Tasks involving two or more Soldiers should be simplified into single Soldier tasks so that demands on the individual can better be determined.

Table 1.1. List of the 32 Physically Demanding Tasks of Combat Arms Soldiers

	TASK	IN 11B	IN 11C	EN 12B	FA 13B	FA 13F	AR 19D	AR 19K
1	Conduct Tactical Movement / Foot March	X	X	X		X	X	X
2	Employ Hand Grenades	X	X	X	X	X	X	X
3	Prepare a Fighting Position (Fill and Emplace Sandbags)	X	X	X	X	X	X	X
4a	Drag a Casualty to Immediate Safety	X	X	X	X	X	X	X
4b	Remove a Casualty from a Wheeled Vehicle	X		X		X	X	
5	Maintain 25mm Gun on BFV – Install the Barrel	X		X		X	X	
6	Maintain 25mm Gun on BFV – Remove Feeder Assembly	X		X		X	X	
7	Load 25mm H-EIT Tracer Ammunition Can on BFV	X		X		X	X	
8	Load TOW Missile Launcher on BFV	X					X	
9	Move Over, Through, or Around Obstacles	X	X					
10	Move Under Direct Fire	X	X	[1]		[1]	[1]	[1]
11	Prepare Dismounted TOW Firing Position	X						
12	Engage Targets with a Caliber .50 M2 Machine Gun	X						
13	Lay a 120mm Mortar – Emplace Base Plate		X					
14	Lay a 120mm Mortar – Emplace Cannon		X					
15	Lay a 120mm Mortar for Deflection and Elevation (Traverse)		X					
16	Fire a Mortar (Lift and Hold Round, Place in Tube)		X					
17	Mount M2 .50 Cal Machine Gun Receiver on an Abrams Tank							X
18	Stow Ammunition on an Abrams Tank (Load 120mm MPAT Round to the Ready Rack)							X
19	Load the 120mm Main Gun							X
20	Remove a Casualty from an Abrams Tank							X
21	Transfer Ammunition with an M992 Carrier (CAT)				X			
22	Emplace 155mm Howitzer / Lift Wheel Assembly				X			
23	Displace 155mm Howitzer / Recover Spade Trail Arm and Blade				X			
24	Set Up Gun Laying Positioning System (GLPS)				X			
25	Establish an Observation Point					X		
26	Prepare M1200 Armored Knight Vehicle for Operation					X		
27	Quickly Create a Footpath through Various Obstacles (Carry / Employ Antipersonnel Obstacle Breaching System (APOBS))			X				
28	Prepare Obstacle with the H6 40 lb Cratering Charge			X				
29	Operate a Modular-Pack Mine System (MOPMS)			X				
30	Assist in the Construction of a Bailey Bridge			X				
31	Load / Install a Volcano			X				

IN=Infantry, FA=Field Artillery, AR=Armor, EN=Engineers

[1] Following Study 1, move under direct fire was determined to be essential to 12B, 13F, 19D and 19K as well.

Table 1.2. Summary of Field Artillery Tasks and Measurements from Ft. Bliss

Task #	Performed by 13B	Performed by 13F	Occupational Related Tasks	Measures
Aerobic Tasks				
1		X	Conduct a Tactical Movement (Foot March)	Time, RPE 6-20, HR, VO_2
3	X	X	Prepare a Fighting Position (Fill and Emplace Sandbags)	Time, RPE 6-20, HR, VO_2
7		X	Load 25mm HEI-T Ammunition Cans onto the Bradley Fighting Vehicle	Time, RPE 6-20, HR, VO_2
21	X		Transfer Ammunition with an M992 Field Artillery Ammunition Supply Vehicle (FAASV)	Time, RPE 6-20, HR, VO_2
Strength Tasks				
4a	X	X	Drag a Casualty to Immediate Safety (Dismounted)	Time, RPE CR-10
4b		X	Remove a Casualty from a Vehicle (Mounted)	Time, RPE CR-10
5		X	Lift, Carry, and Install the Barrel of a 25mm gun on the Bradley Fighting Vehicle	Time, RPE CR-10
6		X	Remove the Feeder Assembly of a 25mm gun on the Bradley Fighting Vehicle	Time, RPE CR-10
22	X		Emplace 155mm Howitzer (Lift Wheel Assembly)	Time, RPE CR-10
23	X		Displace 155mm Howitzer (Lift Spade Trail Arm and Blade)	Time, RPE CR-10
26		X	Install/Remove Fire Support Sensor System (FS3) on M1200	Time, RPE CR-10

Table 1.3. Soldier Characteristics: Study 1

13B: Cannon Crewman			
	Males (n=23)	**Females (n=15)**	**p-value**
Age (years)	21.6 ± 2.3	22.1 ± 3.8	0.66
Height (cm)	182.8 ± 7.3	168.9 ± 6.2	<0.01
Mass (kg)	88.4 ± 9.4	67.8 ± 9.4	<0.01
Time in Military (years)	1.7 ± 1.4	2.9 ± 4.0	0.25
Time in MOS (years)	1.7 ± 1.4	2.2 ± 1.9	0.44
Number Deployed (%)	4 (20%)	2 (20%)	–
Time Deployed (years) *for only those who have deployed*	0.7 ± 0.2	0.7± 0.9	0.93
Army Physical Fitness Test Score (points)	250.9 ± 22.0	258.9 ± 14.4	0.34
Push-ups (# / 2 min)	64.6 ± 12.4	45.4 ± 10.3	<0.01
Sit-ups (# / 2 min)	66.9 ± 12.0	66.9 ± 10.4	1.00
Two-Mile Run Time (min)	14.4 ± 1.0	17.0 ± 0.9	<0.01
Predicted VO_2max (ml/kg/min)	50.2 ± 3.6	48.0 ± 2.8	0.12
13F: Fire Support Specialist			
	Males (n=23)	**Females (n=15)**	**p-value**
Age (years)	24.9 ± 4.9	24.8 ± 6.9	0.97
Height (cm)	179.8 ± 5.0	163.9 ± 5.4	<0.01
Mass (kg)	84.3 ± 14.0	64.4 ± 9.1	<0.01
Time in Military (years)	4.0 ± 2.5	2.4 ± 1.7	0.08
Time in MOS (years)	3.1 ± 2.4	2.0 ± 1.4	0.20
Number Deployed (%)	9 (45%)	1 (9%)	–
Time Deployed (years) *for only those who have deployed*	1.1 ± 0.4	0.83	0.53
Army Physical Fitness Test Score (points)	254.6 ± 27.0	260.4 ± 39.4	0.64
Push-ups (# / 2 min)	67.8 ± 13.2	46.9 ± 11.8	<0.01
Sit-ups (# / 2 min)	69.8 ± 12.1	69.8 ± 11.9	0.99
Two-Mile Run Time (min)	14.7 ± 1.2	17.1 ± 1.4	<0.01
Predicted VO_2max (ml/kg/min)	50.1 ± 5.9	48.5 ± 5.2	0.47

Table 1.4. Frequency of Task Performance in Training and Deployment Environments

13B: Cannon Crewman		**Males**		**Females**	
		In Training (n=20)	**Deployed (n=4)**	**In Training (n=10)**	**Deployed (n=2)**
Aerobic Tasks	**3: Fighting Position**	27.2 ± 40.1 (0-100)	1.0 ± 2.6 (0-10)	8.4 ± 11.4 (0-25)	0.5 ± 1.6 (0-5)
	21: Transfer Ammo with FAASV [a]	112.1 ± 445.0 (0-2000)	0.0 —	9.1 ± 9.0 (0-30)	0.0 —
Strength Tasks	**4a: Casualty Drag**	9.0 ± 14.2 (1-50)	0.5 ± 1.2 (0-4)	18.0 ± 32.4 (0-100)	0.0 —
	22: Lift Wheel Arm Assembly [a]	224.3 ± 377.6 (0-1000)	150.0 ± 670.8 (0-3000)	13.5 ± 11.8 (0-30)	0.0 —
	23: Lift Spade Trail Arm and Blade [a]	150.7 ± 313.0 (0-1000)	200.0 ± 894.4 (0-4000)	12.5 ± 10.3 (0-25)	0.0 —
13F: Fire Support Specialist		**Males**		**Females**	
		In Training (n=20)	**Deployed (n=9)**	**In Training (n=11)**	**Deployed (n=1)**
Aerobic Tasks	**1: Foot March**	177.7 ± 455.7 (2-2000)	86.5 ± 162.9 (0-650)	8.5 ± 8.2 (0-25)	0.0 —
	3: Fighting Position	66.5 ± 200.6 (0-1000)	5.5 ± 14.1 (0-50)	1.4 ± 2.5 (0-8)	0.0 —
	7: Ammo Can Carry	2.9 ± 6.2 (0-25)	0.1 ± 0.2 (0-1)	0.6 ± 1.5 (0-5)	0.0 —
Strength Tasks	**4a: Casualty Drag**	65.2 ± 220.9 (1-1000)	1.3 ± 2.5 (0-10)	3.9 ± 4.6 (0-15)	0.0 —
	4b: BFV Casualty Evacuation	57.6 ± 222.3 (0-1000)	0.8 ± 2.4 (0-10)	4.5 ± 5.8 (0-20)	0.0 —
	5: 25mm Barrel Install	3.1 ± 4.5 (0-15)	0.1 ± 0.2 (0-1)	3.2 ± 1.6 (0-5)	0.0 —
	6: Feeder Assembly	2.8 ± 3.6 (0-12)	0.0 ± 0.2 (0-1)	3.1 ± 2.2 (0-7)	0.0 —
	26: Install/Remove FS3 [a]	12.6 ± 24.8 (0-100)	4.7 ± 12.4 (0-40)	2.8 ± 1.9 (0-5)	0.0 —

[a] Data for MOS-specific tasks while deployed shown only for male Soldiers who retained the MOS (13B, n=4; 13F, n=9)

Values Mean ± SD (Range);
In Training: Total # of times task*, not including train-up for study;*
Deployed: Average # of times per year deployed.

Table 1.5. Number Tested and Completion Rates of all Tasks

13B: Cannon Crewman		Number Tested			Completion Rate			Gender Completion P-Value
		All	Male	Female	All	Male	Female	
Aerobic Tasks	**3: Fighting Position (FILL)**	30	20	10	100%	100%	100%	—
	3: Fighting Position (CARRY)	30	20	10	100%	100%	100%	—
	21: FAASV (OUTSIDE)	30	20	10	**93%**	100%	**80%**	**0.04**
	21: FAASV (INSIDE)	30	20	10	**57%**	**85%**	**0%**	**<0.01**
Strength Tasks	**4a: Casualty Drag**	30	20	10	**83%**	100%	**50%**	**<0.01**
	22: Lift Wheel Arm Assembly	30	20	10	100%	100%	100%	—
	23: Lift Spade Trail Arm and Blade	30	20	10	100%	100%	100%	—
13F: Fire Support Specialist		**Number Tested**			**Completion Rate**			**Gender Completion P-Value**
		All	Male	Female	All	Male	Female	
Aerobic Tasks	**1: Foot March**	31	20	11	**94%**	100%	**82%**	**0.05**
	3: Fighting Position (FILL)	31	20	11	100%	100%	100%	—
	3: Fighting Position (CARRY)	31	20	11	100%	100%	100%	—
	7: Ammo Can Carry	31	20	11	100%	100%	100%	—
Strength Tasks	**4a: Casualty Drag**	31	20	11	**77%**	100%	**37%**	**<0.01**
	4b: BFV Casualty Evacuation	31	20	11	**81%**	100%	**55%**	**<0.01**
	5: 25mm Barrel Install	31	20	11	100%	100%	100%	—
	6: Feeder Assembly	31	20	11	100%	100%	100%	—
	26: Install FS3	31	20	11	100%	100%	100%	—
	26: Remove FS3	31	20	11	100%	100%	100%	—

Bolding indicates <100% successful completion rate

Table 1.6. Summary of Physical Demands of Tasks of 13B

			Task in top rank of physical demand by:					
		Prorated Load Carried[a] (lb)	**Time**	**RPE**	**End HR**	**Mean HR**	**VO_2 (absolute or relative)**	**Total O_2 (absolute or relative)**
Aerobic Tasks	***3: Fighting Position (FILL)*** *Repeated Lift & Carry*	*35*	*†*					
	3: Fighting Position (CARRY) *Repeated Lift & Carry*	*35*			*†*	*†*	*†*	
	21: FAASV (OUTSIDE) Repeated Lift & Carry	105		†	†	†	†	
	21: FAASV (INSIDE) Repeated Lift & Carry	105	†	†	†	†	†	†
Strength Tasks	***4a: Casualty Drag*** *Heavy Drag*	*270*	*†*	*†*				
	22: Lift Wheel Arm Assembly Heavy Lift	67.5						
	23: Lift Spade Trail Arm and Blade Heavy Lift	102						

[a]: Load does not include uniform
†: In top rank for measure (significantly greater than all other tasks, $p<0.05$)
Italics: Task Common to Multiple Combat Arms MOSs
Gray: Not measured

Table 1.7. Tasks with Sex Differences (13B)

		Time	RPE	End HR	Mean HR	VO_2	Total O_2
Aerobic Tasks	**3: Sandbag Fill**	F>M	F=M	F=M	F=M	ABS: F<M REL: F<M %MAX: F<M	ABS: F=M REL: F=M
	3: Sandbag Carry	F>M	F=M	F=M	F=M	ABS: F<M REL: F<M %MAX: F<M	ABS: F=M REL: F=M
	21: FAASV (OUTSIDE)	F>M	F>M	F=M	F=M	ABS: F<M REL: F<M %MAX: F<M	ABS: F<M REL: F<M
	21: FAASV (INSIDE)	—	—	—	—	—	—
Strength Tasks	**4a: Casualty Drag**	F>M	F>M				
	22: Lift Spade Trail Arm and Blade	F=M	F=M				
	23: Lift Wheel Arm Assembly	F=M	F=M				

$p<0.05$
M: Male, F: Female
For VO_2 and Total O_2, ABS: Absolute (L/min), REL: Relative to Body Mass (ml/kg/min), %MAX: Percent estimated VO_2max
Gray: Not measured

Table 1.8. Summary of Physical Demands of Tasks of 13F

			Task in top rank of physical demand by:					
		Prorated Load Carried[a] (lb)	**Time**	**RPE**	**End HR**	**Mean HR**	**VO_2 (absolute or relative)**	**Total O_2 (absolute or relative)**
Aerobic Tasks	***1: Foot March*** *Load Carriage*	*19.5*	*†*					*†*
	3: Fighting Position (FILL) *Repeated Lift & Carry*	*35*						
	3: Fighting Position (CARRY) *Repeated Lift & Carry*	*35*		*†*	*†*	*†*	*†*	
	7: Ammo Can Carry *Repeated Lift & Carry*	*45*					*†*	
Strength Tasks	***4a: Casualty Drag*** *Heavy Drag*	*270*		*†*				
	4b: BFV Casualty Evacuation (TEAM) *Heavy Lift*	*103*		*†*				
	4b: BFV Casualty Evac (SOLO) *Heavy Lift*	*103*						
	5: 25mm Barrel Install *Heavy Lift*	*53.5*	*†*					
	6: Feeder Assembly *Heavy Lift*	*59*	*†*					
	26: Install FS3 Heavy Lift	60	†					
	26: Remove FS3 Heavy Lift	60	†					

[a]: Load does not include uniform
†: In top rank for measure (significantly greater than all other tasks, $p<0.05$)
Italics: Task Common to Multiple Combat Arms MOSs
Gray: Not measured

Table 1.9. Tasks with Sex Differences (13F)

		Time	RPE	End HR	Mean HR	VO_2	Total O_2
Aerobic Tasks	**1: Foot March**	F=M	F>M	F>M	F=M	F=M	ABS: F<M REL: F=M
	3: Fighting Position (FILL)	F>M	F=M	F=M	F=M	ABS: F<M REL: F=M %MAX: F=M	ABS: F=M REL: F>M
	3: Fighting Position (CARRY)	F>M	F=M	F=M	F=M	ABS: F<M REL: F=M %MAX: F=M	ABS: F=M REL: F>M
	7: Ammo Cans	F>M	F>M	F=M	F=M	ABS: F<M REL: F=M %MAX: F=M	ABS: F=M REL F>M
Strength Tasks	**4a: Casualty Drag**	F>M	F>M				
	4b: Cas Evac (TOP)	F=M	F>M				
	4b: Cas Evac (BOTTOM)	F=M	F>M				
	5: 25mm Barrel Install	F=M	F=M				
	6: Feeder Assembly	F=M	F>M				
	26: Install FS3	F=M	F>M				
	26: Remove FS3	F=M	F=M				

$p<0.05$
M: Male, F: Female
For VO_2 and Total O_2, ABS: Absolute (L/min), REL: Relative to Body Mass (ml/kg/min), %MAX: Percent estimated VO_2max
Gray: Not measured

Figure 1.1. Image of Simulated Foot March on Treadmill (Task 1)

Figure 1.2. Images of Soldier Building a Fighting Position (Task 3)

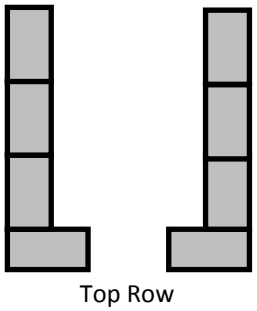


Figure 1.3. Image of Soldier Dragging the Simulated Casualty (Task 4a)

Figure 1.4. Image of Soldier Evacuating the Simulated Casualty from a BFV (Task 4b)

Figure 1.5. Image of Soldiers Installing the Barrel of the 25mm Gun on a BFV (Task 5)

Figure 1.6. Image of Remove the Feeder Assembly of a 25mm Gun on the BFV (Task 6)

Figure 1.7. Images of Soldier Loading 25mm HEI-T Ammunition Cans (Task 7)

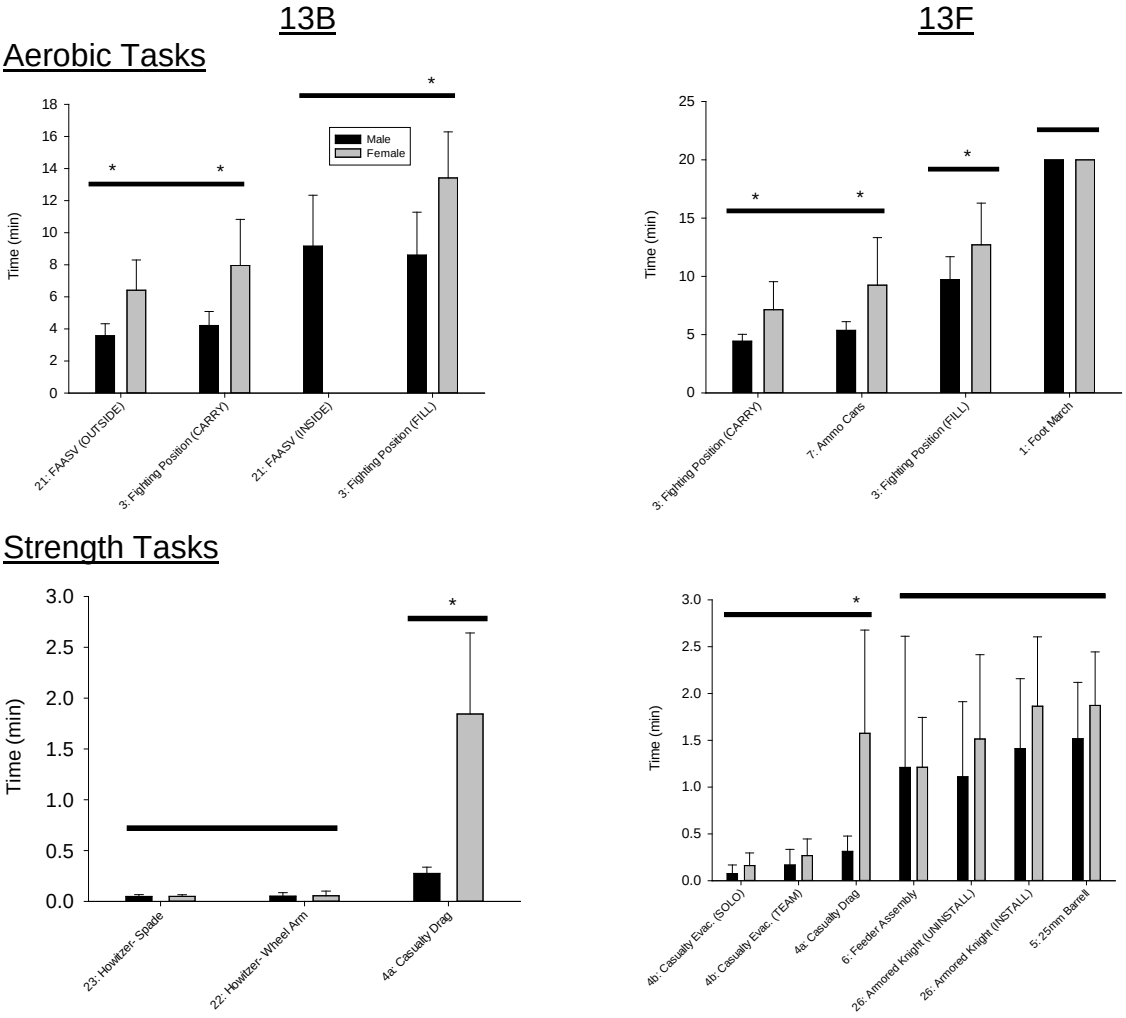
Figure 1.8. Images of Soldiers Transferring Ammunition with a FAASV (Task 21)

Figure 1.9. Image of Soldiers Emplacing 155mm Howitzer (Lift Wheel Assembly) (Task 22)

Figure 1.10. Image of Soldiers Displacing 155mm Howitzer (Lift Spade Trail Arm and Blade) (Task 23)

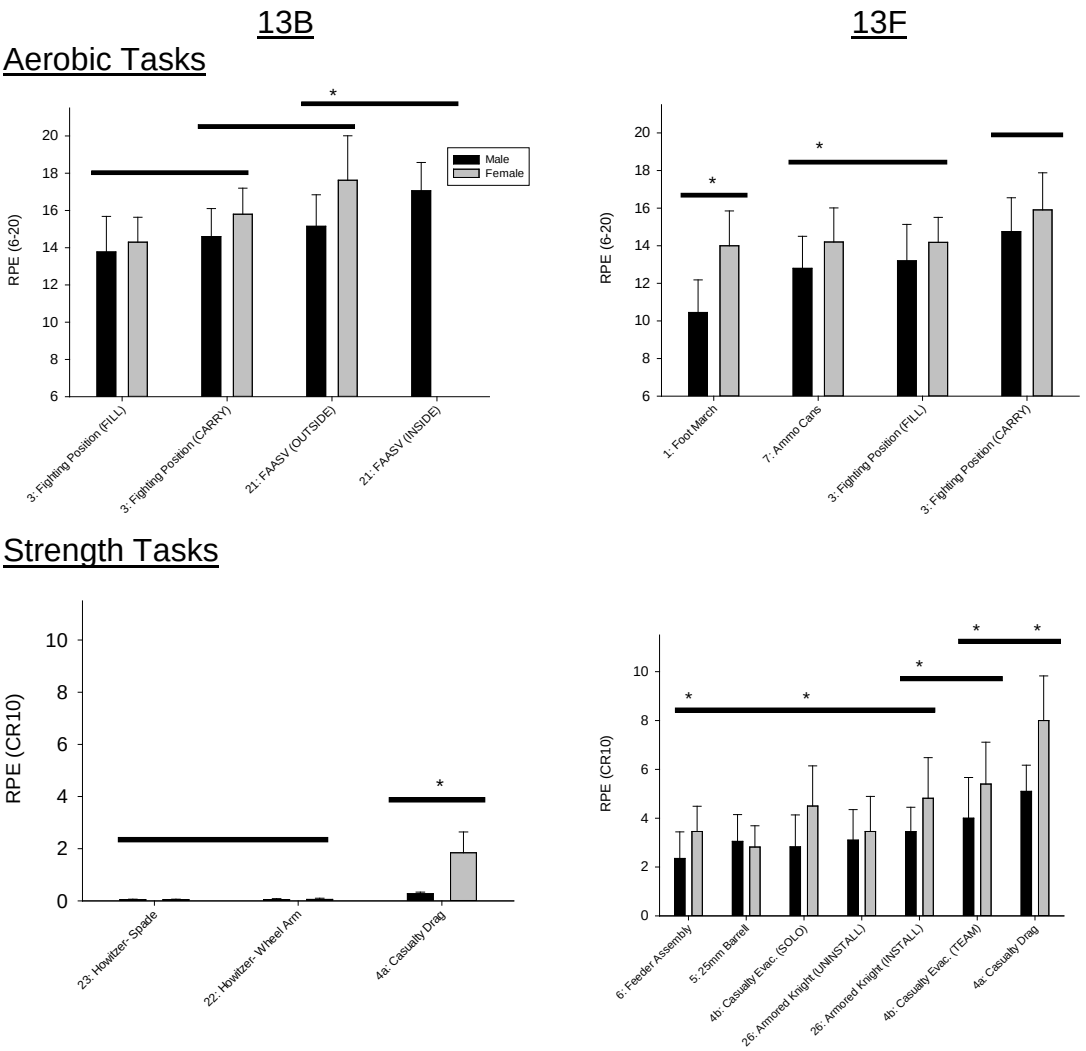
Figure 1.11. Images of Soldiers Installing/Removing Fire Support Sensor System (FS3) on M1200 (Task 26)

Figure 1.12. Time to Completion for Aerobic (TOP) and Strength (BOTTOM) Tasks



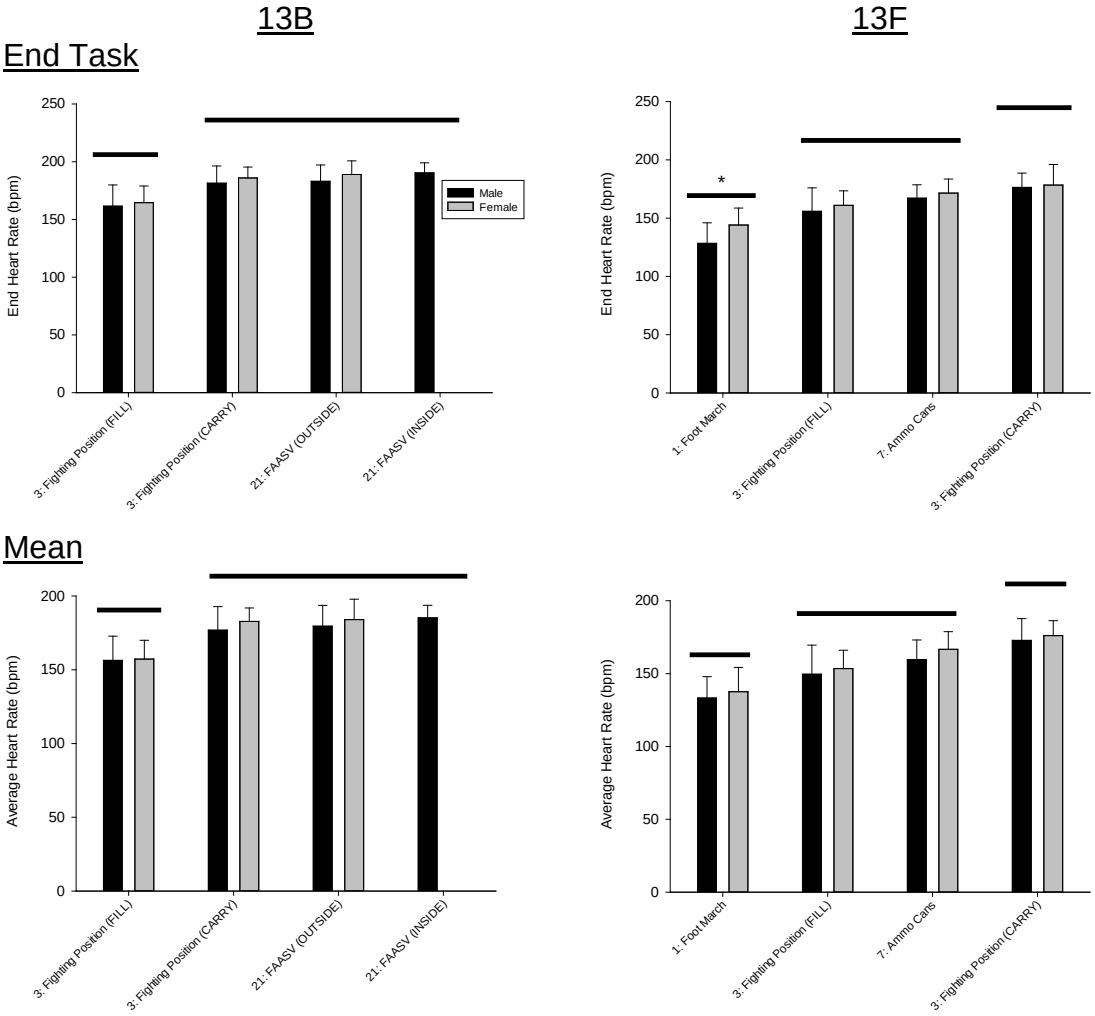
Horizontal bars group tasks with similar demands. Bars over single task indicate demands are not similar to any other tasks.

Figure 1.13. Ratings of Perceived Exertion for Aerobic (TOP) and Strength (BOTTOM) Tasks



Horizontal bars group tasks with similar demands. Bars over single task indicate demands are not similar to any other tasks.

Figure 1.14. End Task (TOP) and Mean (BOTTOM) Heart Rates for Aerobic Tasks

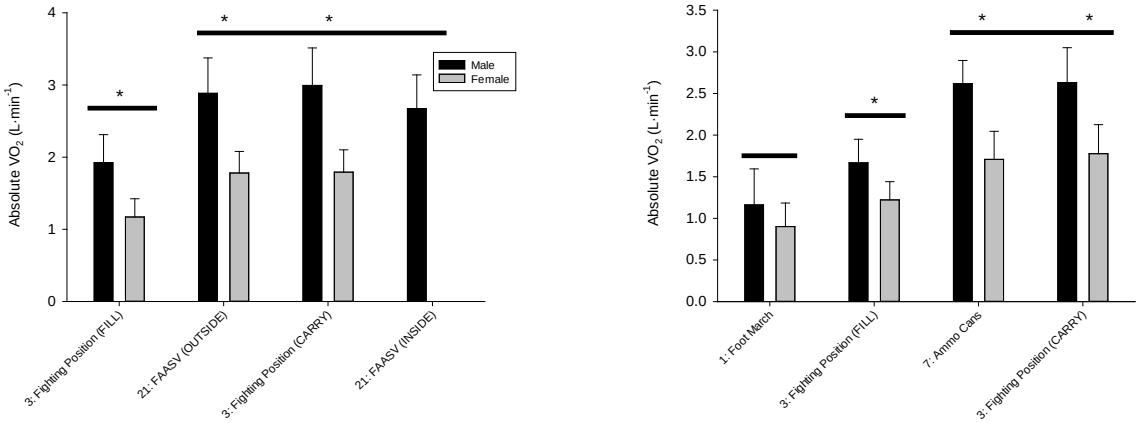


Horizontal bars group tasks with similar demands. Bars over single task indicate demands are not similar to any other tasks. Mean HR only shown for tasks recorded using a metabolic system.

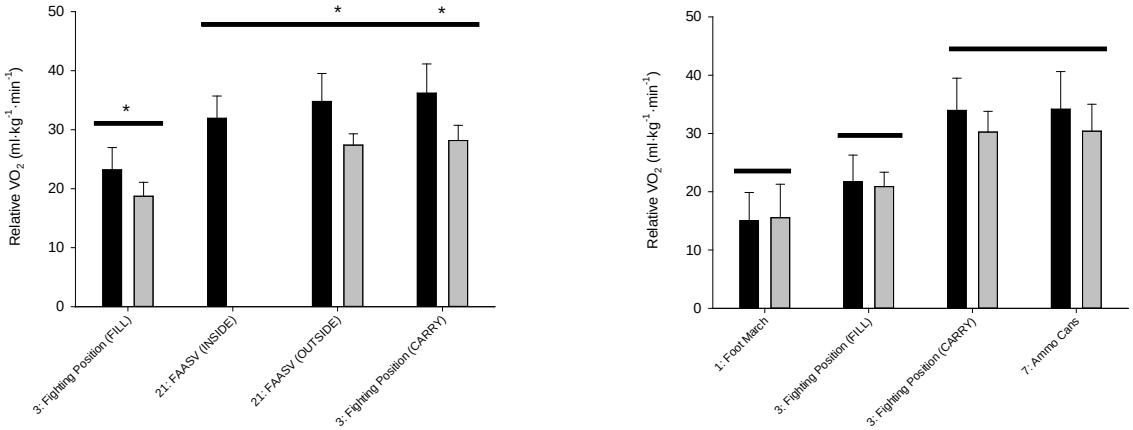
Figure 1.15. Average Absolute (TOP), Body-Mass Normalized (MIDDLE), and Predicted VO_2max Normalized (BOTTOM) Rate of Oxygen Consumption during Aerobic Tasks

13B 13F

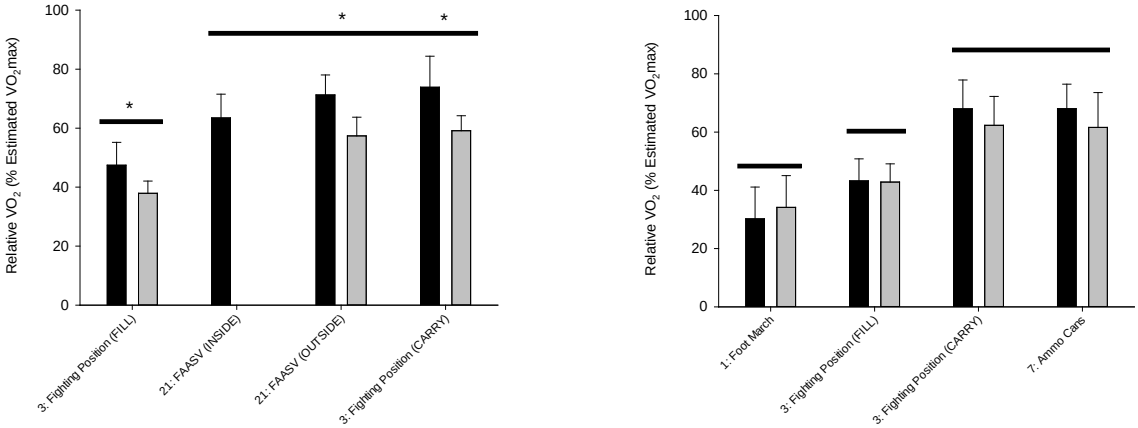
Absolute



Normalized to Body Mass

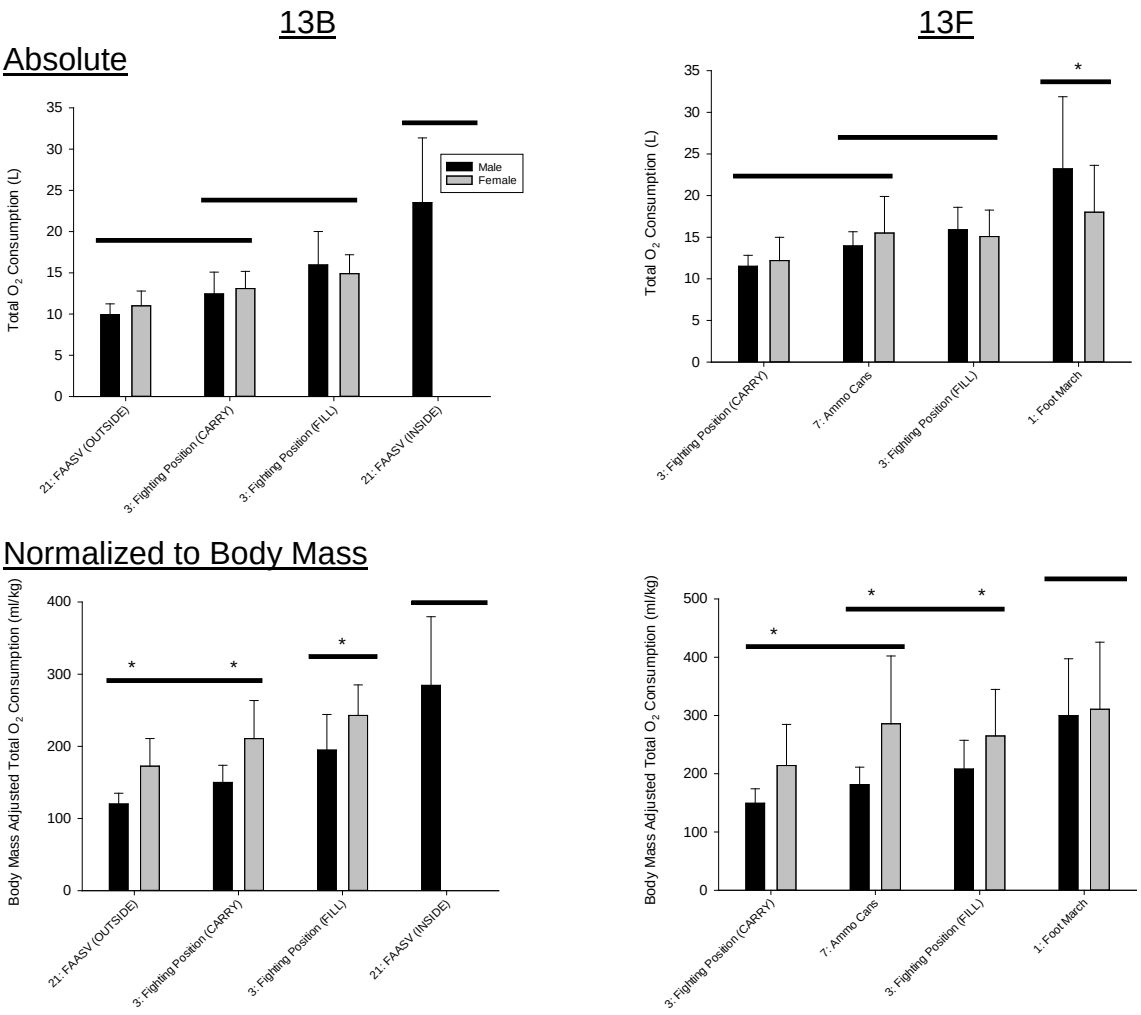


Normalized to Predicted VO_2 max



Horizontal Bars group tasks with similar demands. Bars over single task indicate demands are not similar to any other tasks.

Figure 1.16. Absolute (TOP) and Body-Mass Normalized (BOTTOM) Total Oxygen Consumption during Aerobic Tasks



Horizontal Bars group tasks with similar demands. Bars over single task indicate demands are not similar to any other tasks.

Study 2: Criterion Task Development and Reliability

STUDY 2: INTRODUCTION

In Study 1, the physiological demands of the common and essential physically demanding tasks of 13B Cannon Crewman and 13F Fire Support Specialist were defined and compared across tasks. The large number of critical tasks identified for the 13 Series MOSs (six 13B; nine 13F) required the down-selection of the task list to remove redundancies and include only the most physically demanding tasks within each task category (i.e., pulling, lifting, load carriage, agility/sprinting) and physical domains (aerobic, strength, power). During this process, the frequency of performance of each task both in training and while deployed was considered as well as the criticality of the test, both to the mission and the safety of others. The selected tasks became the criterion measure tasks for the Field Artillery MOSs.

In order to develop a valid test to predict performance on these criterion measure tasks, a standardized criterion task simulation were developed. These task simulations had to meet a number of requirements. First, the simulations must be tests each Soldier individually, not in teams. Thus, any tasks involving more than one Soldier were required to be deconstructed into a single Soldier task. Second, the task simulations must allow for a range of scores to show differences between Soldiers and cannot simply be a pass/fail. Third, each task should measure unique physical capabilities, be safe and easy to administer, and require minimal skill or learning. Fourth, in order to test large numbers of Soldiers the test should require minimal and available equipment as well as efficient. Most importantly, the tasks need to be reliable meaning that the same individuals would have similar scores across repeated task trials.

CRITERION TASK SELECTION PROCESS AND SUBJECT MATTER EXPERT APPROVAL

The set of five (13B) and eight (13F) physically demanding Field Artillery tasks from Study 1 were divided into groups based on the physical domains of the tasks. Based on the physical demands measured in Study 1, one task from each physical domain was selected to be a criterion measure task. The casualty drag was selected for the heavy drag given the uniqueness of the task and its importance in protecting the Soldiers. Transfer ammo with a FAASV was selected for the heavy lift as well as repetitive lift and carry.

A summary of the criteria for selecting the heavy lift task, lift and carry task, and load carriage tasks are summarized in Tables 2.1 and 2.2 for the 13B and 13F, respectively. For the 13F Fire Support Specialist, the foot march was selected as the load carriage task. Sandbag carry was selected as the repetitive lift and carry task because it was measured to be among the tasks with the highest RPE, average HR and rate of oxygen consumption. In addition, it is common to all Combat Arms MOSs and the equipment is readily available. Casualty drag was selected for the heavy drag representative job task given the uniqueness of the task and its importance in protecting the Soldier. Casualty evacuation was selected for the heavy lift task, because it is the heaviest weight the 13Fs would be expected to lift. This task can be modified and

assessed as an individual task with a range of scores and is critical for the safety of other Soldiers.

Four tests from were truncated in order to optimize the time required for testing. With the sandbag carry, it was decided to truncate the task from the original 26 bags to 16 bags, as the VO_2 x repetition curve from Study 1 indicates Soldiers reached steady state by the completion of approximately 13 bags (Figure 2.1). The weight of the sandbags was increased to 40 lb which was the upper end of the 30-40 lb range for sandbags provided by the task statements. This allowed the task more closely mimic the ammo can carry (45 lb) while maintaining fidelity with the sandbag carry. Thirty seconds was determined to be the maximal time for the dummy drag, as 80% of the Soldiers could complete the 15-m within that timeframe (Figure 2.2). The distance for the foot march was shortened to 4 miles based on data collected on 4 other MOSs (unpublished data) and conversations with SMEs about reducing injuries and trainability of a foot march. Finally, the two enforced rest periods were added to transfer ammo with a FAASV to better match the work/rest ratio of a three-person team performing the task.

On 7 October 2014, a video teleconference (VTC) was held between USARIEM researchers and a group of 14 13B and 13F Sergeants First Class SMEs from the Field Artillery Proponent Office (FAPO) at Ft. Sill, OK. The SMEs were briefed on an overview of the project, the results from the physiological testing and focus groups, followed by USARIEM's plan for the criterion tasks for the 13B and 13F. The SMEs were then asked if they agreed with the criterion tasks selected, how the criterion tasks would be simulated, and if they had any concerns. The SMEs approved of the task selection and the proposed task simulation methods. While not original listed as a Field Artillery task, the SMEs requested that the move under fire test be added to the requirement of the 13F. USARIEM agreed and added the task to the list of criterion simulations (See Appendix E for minutes of the VTC presented to SMEs).

STUDY 2: METHODS

Data were collected at Joint Base Lewis-McChord, WA from May 5-16, 2014 (Group Alpha) and at Ft. Carson, CO December 8-19, 2014 (Groups Bravo & Charlie). A total of 149 active duty Soldiers (79 males, 70 females) were recruited for participation in this portion of the study. These Soldiers were split evenly between both installations such that about 25 males and 25 females participated at each. At Joint Base Lewis-McChord Soldiers were part of the 7th Infantry Division or the 593rd Expeditionary Sustainment Command, and at Ft. Carson Soldiers were part of the 4th Infantry Division. Soldiers held a number of different MOSs. The sample size was determined by using the sample size estimation formula of Hopkins 2000 (15) and data on repetitive lifting tasks from Pandorf 2003 (23), which indicated that 37 Soldiers would be needed to accurately find a difference in scores at the $p<0.05$ level.

Soldiers were briefed on all of the tasks prior to consenting. Following consent and screening, participating Soldiers were asked to complete an information sheet that contained demographics and task performance history. Anthropometrics (height, weight) were also collected prior to testing.

Participating Soldiers were asked to complete a familiarization or practice trial once prior to each testing session. Each task was performed once per day over the course of four testing days. Between different job task simulations, the Soldiers were provided with a minimum of 10 minutes to rest. All aspects of the testing (instructions, uniform, etc.) were matched as closely as possible at each testing session. All testing instructions and data sheets for Study 2 can be found in Appendices I and J, respectively.

CRITERION TASK DESCRIPTIONS

Group Alpha: Common MOS Tasks

Sandbag Carry (13F Repeated Lift and Carry)

Soldiers lifted and carried 16 sandbags weighing 40 lb while wearing a fighting load minus the weapon (approximately 71 lb). Sandbags were carried 10 m and placed on the floor in a 4 long x 2 wide x 2 high position as quickly as possible. Time to complete the task was collected.

Casualty Drag (13B & 13F Heavy Drag)

In order to ensure a score for all participants, the casualty drag was modified from the task previously described in Study 1 (Task 4a: Drag a casualty to immediate safety). Soldiers dragged the simulated casualty (approximately 271 lb) up to 15 m as fast as they could in 30 seconds, while wearing a fighting load with a weapon (approximately 83 lb). If the Soldier failed to pull the casualty 15 m in 30 seconds, the distance the casualty was dragged was measured. Scores were calculated as the velocity (m/s) at which the dummy was moved.

Casualty Evacuation from a Vehicle (13F Maximal Heavy Lift; Figure 2.3)

This task was simulated using a platform with a hole designed to simulate the hatch of a BFV and heavy bag to simulate the casualty. A heavy bag, the same model used in Study 1, was about the same length as the average torso and head of a Soldier. The bag was placed in the hole with the handles of the bag level with the platform (see Figure 2.3).

Prior to initiating the task, each Soldier practiced proper lifting technique using a pair of kettlebells. Then on the platform, while wearing a fighting load minus the weapon (approximately 71 lb), Soldiers squatted and grasped the handles of the heavy bag, then stood up and pulled the bag through the hole in the platform. Soldiers were required to place the heavy bag onto the platform for successful task completion. An initial load of 50 lb was used for additional familiarization and warm-up. With the successful completion of each lift, the weight of the simulated casualty was increased in 10-, 20- or 30-lb increments. Following at least 3 minutes of rest at the higher loads (>80% one repetition

maximum), the process was repeated until the Soldier reached volitional fatigue, failed to lift the bag during two consecutive attempts, or a maximum load of 210 lb was reached. The maximum load represented the weight of an average Soldier wearing a Vehicle Crewman Uniform. If Soldiers were not able to lift the bag following an increment of more than 20- or 30 lb, the Soldier was allowed to test on the skipped weights (i.e., 10- or 20 lb less than the failed attempt). The maximal load successfully lifted was recorded.

Group Bravo: MOS Specific Tasks

Move Under Fire Simulation (13F Agility; Figure 2.4)

During this task, Soldiers wore a fighting load (approximately 83 lb) and carried a simulated weapon at the ready. Soldiers began the task in the prone position. Upon command, Soldiers sprinted approximately 6.6 m to a marker and assume the predetermined position for that marker (either the kneeling or prone position). They remained in this position for 5 seconds. Upon signal, Soldiers would get up and sprint to the next marker and assume the predetermined position for that marker. The order of the positions was kneel, kneel, prone. This was repeated until they sprinted a total of 100 m (15 rushes). The course is diagramed in Figure 2.4. Soldiers were instructed to run through the finish line. Time to complete the task was recorded.

Transfer Ammunition with an M992 Field Artillery Ammunition Supply Vehicle (FAASV) (13B Heavy Lift & Repeated Lift and Carry; Figure 2.5)

While wearing approximately 49 lb of task specific equipment, each Soldier had 21 minutes to move thirty M795 HE Rounds (approximately 100 lb each) from the floor of the FAASV into the designated locations on the ammunition rack inside the FAASV. The highest point on the rack that the Soldier was required to place the round was equal to the shoulder height of the Soldier. Soldiers were given openings lower on the rack to make up for any that were above their shoulder height (see Figure 2.5). The 21 minutes were broken up into three 5-minute active loading segments with two 3-minute rest periods. Time to complete the task (not including the 3-minute rest period) was recorded. If the Soldier was actively moving around at the end of the 5-minute active period, he or she was asked to place it down and the next active period started from where the round was placed.

Partial credit was given for a round that was not fully emplaced. One third of a round was awarded for lifting the round, two thirds for moving it to the bustle rack, and full credit was awarded when the whole round was emplaced in the bustle rack. The rate of loading (rounds/min) was calculated either by dividing 30 rounds by the elapsed time (if all rounds loaded before time expired) or by dividing the number of completed rounds by 15 minutes (if not all rounds were loaded).

Group Charlie: Foot March

Foot March (13F Load Carriage)

The load carriage simulation required Soldiers to complete a movement of 4 miles, while wearing the basic Soldier uniform, personal protective equipment (to include weapon), and 24-hour sustainment load (approximately 103 lb). Soldiers were instructed to complete the task as quickly as possible while walking on a supervised course. Running and the 'airborne shuffle' were not allowed. Soldiers were allowed to take breaks as needed. Soldiers were instrumented with a timing chip (SPORTident Model SIAC1, Arnstadt, Germany). Time to completion was recorded.

STATISTICAL ANALYSES

All statistics were calculated using SPSS Version 20 (IBM Corporation, Armonk, New York). Significance was set at the $p<0.05$ level. Descriptive statistics were calculated for each trial to characterize group performance for each task across trials. The statistical approach to determining the reliability was based on the method by Spiering et al (34) in determining reliability of other military-relevant tasks.

Two-Way (sex x trial) repeated measures analysis of variance (ANOVA) was employed for each test to evaluate the presence of a learning effect between trials (2, 34). Tukey's post-hoc multiple comparison tests was applied to detect significant pairwise differences when significant trial differences were detected by the repeated measures ANOVAs. While there was evidence for a significant learning effect for a number of the tasks ($p<0.05$); however, this did not differ by gender, so data were collapsed by gender for all analyses. Reliability coefficients and their associated 95% confidence intervals (95% CI) were examined across trials to determine whether levels of reliability stabilize after a given number of trials. This procedure facilitated specific recommendations for numbers of practice sessions needed prior to administration of the performance tests for scoring.

Random error in the measurements was assessed as relative reliability and absolute reliability (2). Relative reliability was assessed with intraclass correlation coefficients (ICCs) while absolute reliability was assessed using Standard Error of Measurement (SEM) and 95% limits of agreement (95% LOA). ICCs were calculated using a two-way random effects, single-measure reliability model. SEMs are reported in both in absolute units and as a percentage of the mean. The 95% LOA was calculated as either the 95% ratio LOA of the test-retest error if the error of the test-retest data scaled with the mean was random (as determined by a Bland-Altman plot), or as the absolute 95% LOA if the Bland-Altman plot indicated the test-retest error was homoscedastic.

STUDY 2: RESULTS

Soldier characteristics are provided in Table 2.3. The Soldiers were members of 48 different MOSs (including 13B). Enlisted Soldiers ranged from E2-E7, and there were three officers (two O1, one O2).

RELIABILITY TESTING

Mean scores for each of the task simulations during each test session are provided in Table 2.4. For the Common MOS tasks, the average weight for the casualty evacuation was 154.0 ± 22.1 lb; average time for the sandbag carry was 2.10 ± 0.61 minutes, and average velocity for the casualty drag was 1.07 ± 0.36 m/s. Significant improvements in score were recorded during the second tests of the sandbag carry and casualty evacuation compared to their first attempt, indicating a possible learning effect. There was, however, no additional difference in the scores during the third and fourth trials. There were no significant differences in individual's scores across trials for the casualty drag.

For the MOS specific tasks, the average time for the move under fire was 2.26 ± 0.23 minutes and the rate for transfer ammo with a FAASV was 3.10 ± 1.67 rounds/min. Significant improvements between trials occurred between the first and second trial for both tasks. Transfer ammo with a FAASV also improved between the second and third trials; however, there was no additional improvement between the third and fourth trials.

The average time for the foot march was 80.29 ± 12.09 minutes. There were no significant changes in performance across trials.

Reliability data are presented in Table 2.5. Success trial ICCs of the tasks ranged from 0.76 (95% CI: 0.61-0.86) for the foot march to 0.96 (95% CI: 0.94-0.98) for the casualty evacuation. In terms of the absolute reliability tests, the SEMs ranged from 3% of the mean to 14% (15% if the learning effect is not accounted for). The 95% LOAs were 33% for the sandbag carry time, 0.35 m/s for the casualty drag, 25.7 lb for the casualty evacuation, 0.16 minutes for the move under fire, 1.22 rounds/min for the FAASV, and 16.34 minutes for the foot march.

STUDY 2: DISCUSSION

This study identified and established the reliability of the criterion tasks to be used in the development of a testing battery for Field Artillery Soldiers.

TASK SELECTION

The six tasks selected represent a mix of physical requirements. Included are a long-duration load carriage, a repeated lift and carry, a heavy lift, a heavy drag and an agility task. Criterion tasks used by other countries have included a similar combination of tasks. For example, the physical performance batteries developed by the United Kingdom (26) and Australia (3) both include load carriage, jerry can carry, and a maximal box lift. The Australian (3) and Canadian (6) batteries also include tasks of agility, such as combat rushes.

LEARNING EFFECTS

There were significant improvements for the sandbag carry, casualty evacuation, move under fire, and transfer ammo with a FAASV between the first and second days.

For the sandbag carry, casualty evacuation, move under fire, there were no additional improvements after the second trial, while transfer the ammo with a FAASV had no additional improvements after the third trial. Prior to testing of all tasks, Soldiers were given a brief familiarization and practice. Additional familiarization or improvement in the test instructions could mitigate this learning effect. For implementation purposes, a practice for each of these tasks should be provided. On the final test battery, a lower range of passing scores may also need to be accepted to account for this ability to improve with practice.

RELIABILITY

Three measures of reliability was used in this study: ICC, SEM, and 95% LOA. The ICC is an indicator of relative reliability. High ICCs are indicative of a test which is able to consistently rank participants, independent of actual score (i.e., the order of completing the task relative to their peers). As such, all of the criterion tasks had ICCs with upper bounds of their 95% CI >0.80. The test with the lowest ICC (0.76 (95% CI: 0.61-0.86)) was the foot march. The literature does not contain consistent guidelines as to what an acceptable cut-off score is for reliability. Literature values suggest that an ICC > 0.75 is considered acceptable for clinical research (38); however ,the authors are unaware of any legally acceptable standard.

Two measures of absolute reliability (SEM & 95% LOA) provide an indication of the variability between repeated tests, independent of participants rank in the sample. The SEM is a traditionally used measure of reliability which describes the general variability of the sample around its true value. It is difficult to interpret this value's meaning on the reliability of an individual's score or delineate specific cut-offs of what is acceptable reliability. A separate value is the 95% LOA, which treats the data as a population of test-retest differences (2) and calculates test-retest differences for 95% of the population. Absolute LOA are used when there would be uniform error across all scores (e.g., ± 5 lb for both a score of 100 and 200 lb), while Ratio LOA is used when the results indicate individuals with a higher score would have greater error (e.g., ± 5% of the score: ± 5 lb for a score of 100 lb, ± 10 lb for a score of 200 lb). Thus, acceptability of the 95% LOA depends on the minimal necessary precision for the test score. When using these criterion tasks to develop a predictive battery, the 95% LOAs should be taken into account as cut-scores are developed.

Reliability of the tests was comparable to those observed during reliability of other soldiering task simulations. The learning effect of the sandbag carry and casualty evacuation are similar to those previously observed during repeated box lift and carry (23, 34) and 1RM maximal box lifts (34). The ICC of 0.76 and SEM of 5.47% for the foot march were similar to the ICC of 0.81 and SEM of 5% observed during a 3.2-kg load carriage trial (34). Likewise, the reliability of the 15-m casualty drag in the present study (ICC 0.90, SEM 11%) were similar to those observed while dragging a casualty 50m (ICC 0.86, SEM 9%) (34). The greater reliability observed during a lift task than a carry task is consistent with the findings during a previous attempt at developing a physical employment battery for the Army (22).

LIMITATIONS

When interpreting the reliability of these tasks a number of factors need to be considered. First, many of the tasks were performed inside of a motor pool, protected from the elements. They were also performed at approximately the same time of day with trained researchers. Thus, the data represents the reliability of these tests under those same conditions. Likewise, the foot march and move under fire were completed outdoors. There was no precipitation and temperatures varied from 1-14°C on testing days. Under differing weather locations or courses, the reliability may be less.

There are several other factors which could increase or decrease the reliability we observed. Any prior training of Soldiers, soreness or discomfort (both prior to testing or as a result of the testing), or changes in motivation could have an effect. These factors were known a priori by research staff and steps were taken to control their impact (e.g., use of the same instructions, warm-up and practice prior to actual task). While every attempt was made to control for these factors, it is unlikely that their influence was completely removed.

STUDY 2: CONCLUSIONS

The selected criterion measure tasks reported in this chapter show high reliability. They have also been approved by SMEs as accurately capturing the physical demands of all tasks performed by their respective MOSs. Thus, they seem appropriate for use in the development of a predictive battery to select 13B and 13F Soldiers for training.

STUDY 2: RECOMMENDATIONS

- The two 13B and five 13F criterion measure tasks were approved by SMEs and show generally high reliability. They are appropriate to be used for development of a predictive test; however, the absolute reliability should be considered when developing cut-scores.

- Additional familiarization and/or improvements to task instructions should be applied to the sandbag carry, casualty evacuation, move under fire, stow ammo, and load the main gun tasks in order to minimize any learning effect.

- This approach to determining the reliability of soldiering tasks may be useful for additional tasks.

Table 2.1. Factors Considered during Down-Selection of 13B Criterion Measure Tasks

Heavy Lifting Tasks				
	Lift Wheel Assembly	**Recover Trail Arm and Blade**	**Transfer Ammo with FAASV**	
Covers weight range of other heavy lifting tasks		X	X	
Can be an Individual Test			X	
Minimal Skill or Training	X	X		
Risk of Injury to Self or Others, if unsuccessful	X	X	X	
Common to other Combat MOS				
Minimal Equipment				
Repeated Lift and Carry Tasks				
	Sandbag Fill (Wt.: 35 lb)	**Sandbag Carry (Wt.: 35 lb)**	**FAASV (ground to floor) (Wt.: 105 lb)**	**FAASV (floor to bustle rack) (Wt.: 105 lb)**
Greater Load Carried			X	X
Longer Duration	X			X
Greater RPE			X	X
Greater Heart Rate		X	X	X
Greater Energy Cost		X	X	X
Common to other Combat Arms MOSs	X	X		

Table 2.2. Factors Considered during Down-Selection of 13F Criterion Measure Tasks

Heavy Lifting Tasks				
	25mm Barrel Install	**Feeder Assembly**	**Install/ Remove FS3**	**Casualty Evacuation**
Covers weight range of other heavy lifting tasks				X
Can be an Individual Test	X	X		X
Minimal Skill or Training		X		X
Risk of Injury to Self or Others, if unsuccessful	X		X	X
Common to other Combat MOS				X
Minimal Equipment				X
Repeated Lift and Carry Tasks				
	Sandbag Fill (Wt.: 35 lb)	**Ammo Can Carry (Wt.: 45 lb)**	**Sandbag Carry (Wt.: 35 lb)**	
Greater Load Carried			X	
Longer Duration			X	
Greater RPE		X	X	
Greater Heart Rate		X	X	
Greater Energy Cost	X	X	X	
Common to other Combat Arms MOSs			X	
Equipment Readily Available			X	

Table 2.3. Soldier Characteristics: Study 2

Group Alpha: Common MOS Tasks *Sandbag Carry, Casualty Drag, and Casualty Evacuation*	**Males (n=25)**	**Females (n=25)**	**p-value**
Age (years)	24.6 ± 4.8	25.0 ± 4.3	0.80
Height (cm)	180.5 ± 7.3	165.7 ± 6.1	<0.01
Mass (kg)	84.9 ± 9.8	67.2 ± 8.3	<0.01
Time in Military (years)	3.4 ± 3.8	2.9 ± 3.0	0.67
Time in MOS (years)	2.7 ± 2.8	2.6 ± 2.1	0.91
Number Deployed (%)	10 (40%)	7 (28%)	–
Time Deployed (years) *for only those who have deployed*	0.9 ± 0.2	1.3 ± 0.6	0.04
Army Physical Fitness Test Score (points)	266.1 ± 22.8	266.0 ± 31.1	0.99
Push-ups (# / 2 min)	67.6 ± 12.2	42.8 ± 12.1	<0.01
Sit-ups (# / 2 min)	67.8 ± 11.8	70.4 ± 11.4	0.44
Two-Mile Run Time (min)	14.1 ± 1.8	16.6 ± 1.9	<0.01
Predicted VO_2max (ml/kg/min)	51.7 ± 5.1	49.1 ± 6.3	0.12

Group Bravo: MOS Specific Tasks *Move Under Direct Fire, and Transfer Ammo with a FAASV*	**Males (n=25)**	**Females (n=25)**	**p-value**
Age (years)	24.3 ± 4.1	22.6 ± 3.0	0.11
Height (cm)	178.9 ± 6.6	164.3 ± 7.3	<0.01
Mass (kg)	82.5 ± 9.8	65.2 ± 8.6	<0.01
Time in Military (years)	3.7 ± 3.2	2.9 ± 2.7	0.29
Time in MOS (years)	3.3 ± 2.2	2.5 ± 2.3	0.24
Number Deployed (%)	13 (52%)	7 (28%)	–
Time Deployed (years) *for only those who have deployed*	1.1 ± 0.6	1.5 ± 1.2	0.36
Army Physical Fitness Test Score (points)	267.8 ± 20.3	272.2 ± 26.5	0.51
Push-ups (# / 2 min)	67.7 ± 9.5	46.5 ± 11.7	<0.01
Sit-ups (# / 2 min)	72.4 ± 10.3	70.0 ± 10.7	0.45
Two-Mile Run Time (min)	14.1 ± 1.1	16.5 ± 1.3	<0.01
Predicted VO_2max (ml/kg/min)	52.4 ± 3.8	49.9 ± 4.4	0.04

Table 2.3. Soldier Characteristics: Study 2 (continued)

Group Charlie: Foot March	**Males (n=29)**	**Females (n=20)**	**p-value**
Age (years)	23.0 ± 3.3	25.3 ± 4.7	0.05
Height (cm)	176.9 ± 6.5	169.1 ± 6.6	<0.01
Mass (kg)	80.2 ± 12.1	68.6 ± 7.9	<0.01
Time in Military (years)	3.3 ± 2.4	2.7 ± 1.7	0.33
Time in MOS (years)	3.0 ± 2.4	2.6 ± 1.7	0.47
Number Deployed (%)	16 (55%)	9 (45%)	–
Time Deployed (years) *for only those who have deployed*	1.1 ± 0.7	0.9 ± 0.3	0.42
Army Physical Fitness Test Score (points)	270.1 ± 19.0	266.6 ± 23.5	0.57
Push-ups (# / 2 min)	71.8 ± 11.1	43.3 ± 11.4	<0.01
Sit-ups (# / 2 min)	71.7 ± 10.1	68.4 ± 13.9	0.35
Two-Mile Run Time (min)	13.3 ± 2.8	15.8 ± 4.0	0.01
Predicted VO_2max (ml/kg/min)	53.6 ± 4.4	48.6 ± 5.8	<0.01

Table 2.4. Performance (Mean ± SD) During Repeated Measurements of Criterion Task Simulations

Test		n	Trial 1	n	Trial 2	n	Trial 3	n	Trial 4
Sandbag Carry (min)	**M**	25	**1.73 ± 0.25***	25	1.62 ± 0.22	25	1.68 ± 0.21	25	1.70 ± 0.23
	F	25	**2.71 ± 0.80***	25	2.60 ± 0.74	25	2.40 ± 0.51	25	2.42 ± 0.49
Casualty Drag (m/s)	**M**	25	1.41 ± 0.26	25	1.39 ± 0.25	25	1.32 ± 0.26	25	1.31 ± 0.24
	F	25	0.79 ± 0.25	25	0.78 ± 0.22	25	0.78 ± 0.22	25	0.78 ± 0.19
Casualty Evac (lb)	**M**	24	**186 ± 28***	24	195 ± 26	24	196 ± 26	25	198 ± 25
	F	25	**106 ± 34***	25	113 ± 27	25	117 ± 32	25	119 ± 31
Move Under Fire (min)	**M**	25	**2.14 ± 0.08***	25	2.12 ± 0.11	24	2.09 ± 0.09	22	2.12 ± 0.10
	F	24	**2.45 ± 0.26***	24	2.42 ± 0.20	22	2.40 ± 0.23	21	2.39 ± 0.26
FAASV (Rounds/min, 15 min max)	**M**	25	**3.25 ± 1.18***	25	4.14 ± 1.28*	24	4.54 ± 1.26*	23	4.96 ± 1.20
	F	22	**1.39 ± 0.69***	21	1.79 ± 1.08*	21	2.09 ± 1.15*	18	2.31 ± 1.30
Foot March (min)	**M**	29	76.8 ± 5.84	29	74.6 ± 9.32	27	72.1 ± 7.65	20	74.4 ± 9.05
	F	21	92.7 ± 11.3	19	89.7 ± 12.6	17	86.3 ± 11.5	13	85.4 ± 12.4

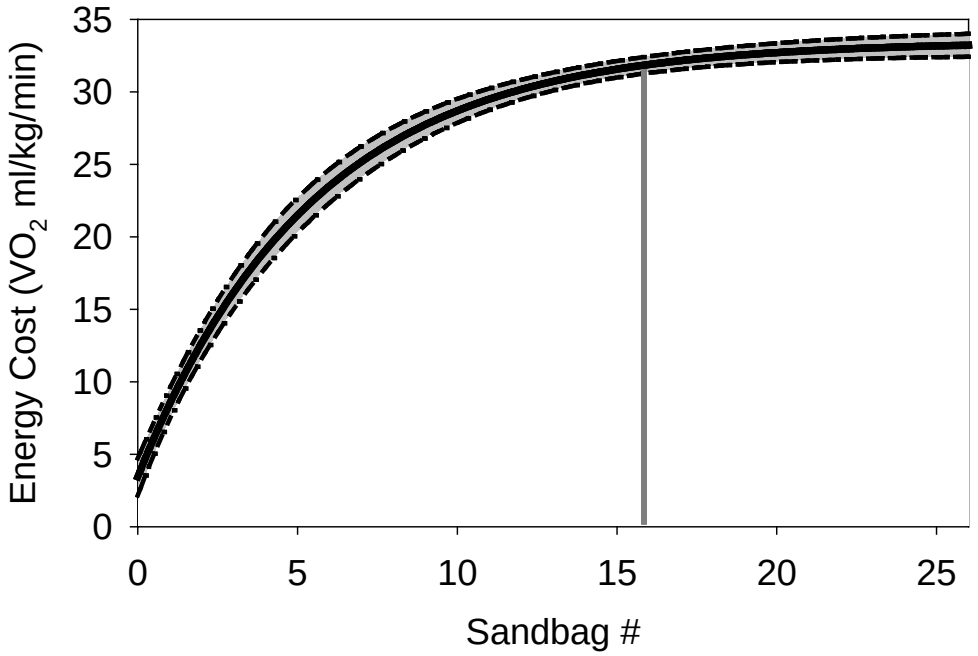
*** Significantly different from following trial, $p<0.05$**

Table 2.5. Relative and Absolute Reliability of Criterion Task Simulations

Test	n	Trial Comparison	Relative	Absolute		
			ICC (2,1) [95%CI]	SEM (% of Mean)	95% LOA	95% Ratio LOA
Sandbag Carry (min)	50	1 vs 2	0.87 [0.78-0.92]	0.27 (12%)	0.75	
		2 vs 3	0.85 [0.75-0.91]	0.25 (12%)		33%
Casualty Drag (m/s)	50	1 vs 2	0.90 [0.83-0.94]	0.13 (11%)	0.35	
Casualty Evac (lb)	49	1 vs 2	0.94 [0.90-0.97]	15.25 (10%)	32.9	
		2 vs 3	0.96 [0.94-0.98]	9.26 (6%)	25.7	
Move Under Fire (min)	49	1 vs 2	0.90 [0.82-0.94]	0.08 (3%)	0.21	
	46	2 vs 3	0.93 [0.88-0.96]	0.06 (3%)	0.16	
FAASV (Rounds/min, 15 min max)	46	1 vs 2	0.93 [0.88-0.96]	0.40 (15%)		40%
	44	2 vs 3	0.93 [0.88-0.96]	0.44 (14%)	1.22	
	42	3 vs 4	0.93 [0.88-0.96]	0.45 (13%)	1.25	
Foot March (min)	48	1 vs 2	0.76 [0.61-0.86]	5.89 (7%)	16.34	

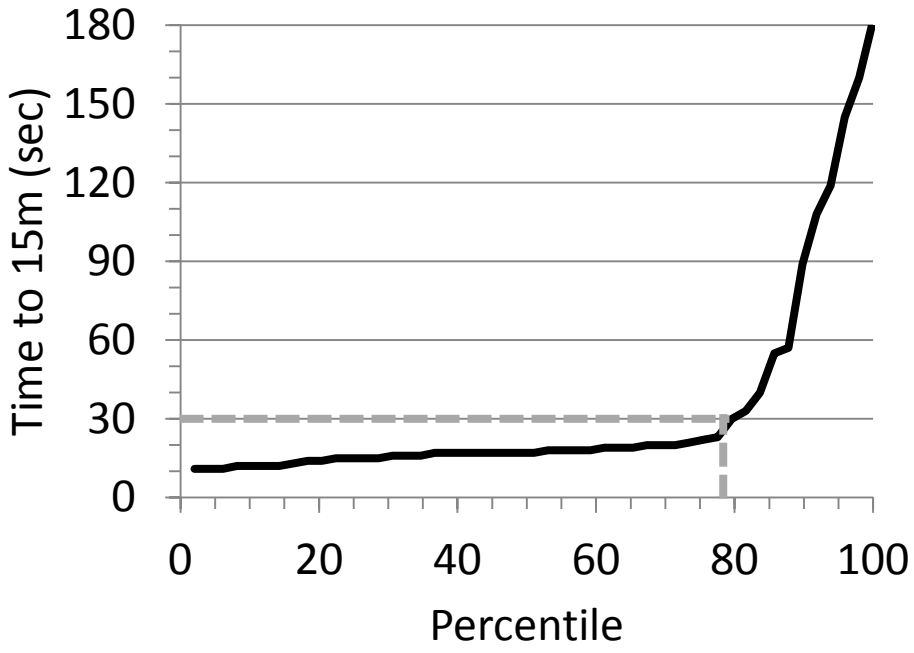
Due to a significant learning effect for sandbag carry, casualty evacuation, and move under fire, 1 vs 2 indicate reliability including learning effect, while 2 vs 3 is without a learning effect. For the FAASV, 1 vs 2 and 2 vs include the learning effect, while 3 vs 4 is without a learning effect

Figure 2.1. Energy Cost over Time from of the Sandbag Carry Task from Study 1



Solid line: Mean
Vertical line: Proposed Cutoff
Shaded area: 95% Confidence Interval of Mean

Figure 2.2. Distribution of Dummy Drag Times from Study 1



Dashed line represents maximal time allowed for criterion testing.

Figure 2.3. Diagrams and Photos of the Casualty Evacuation Simulation

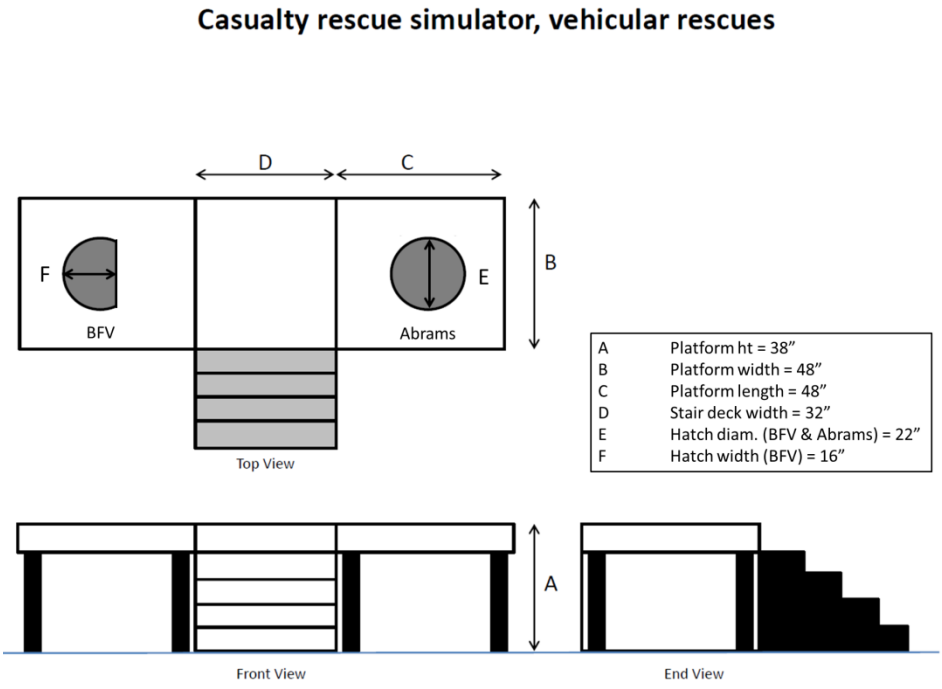


Figure 2.4. Diagram and Photos of the Move Under Fire Simulation

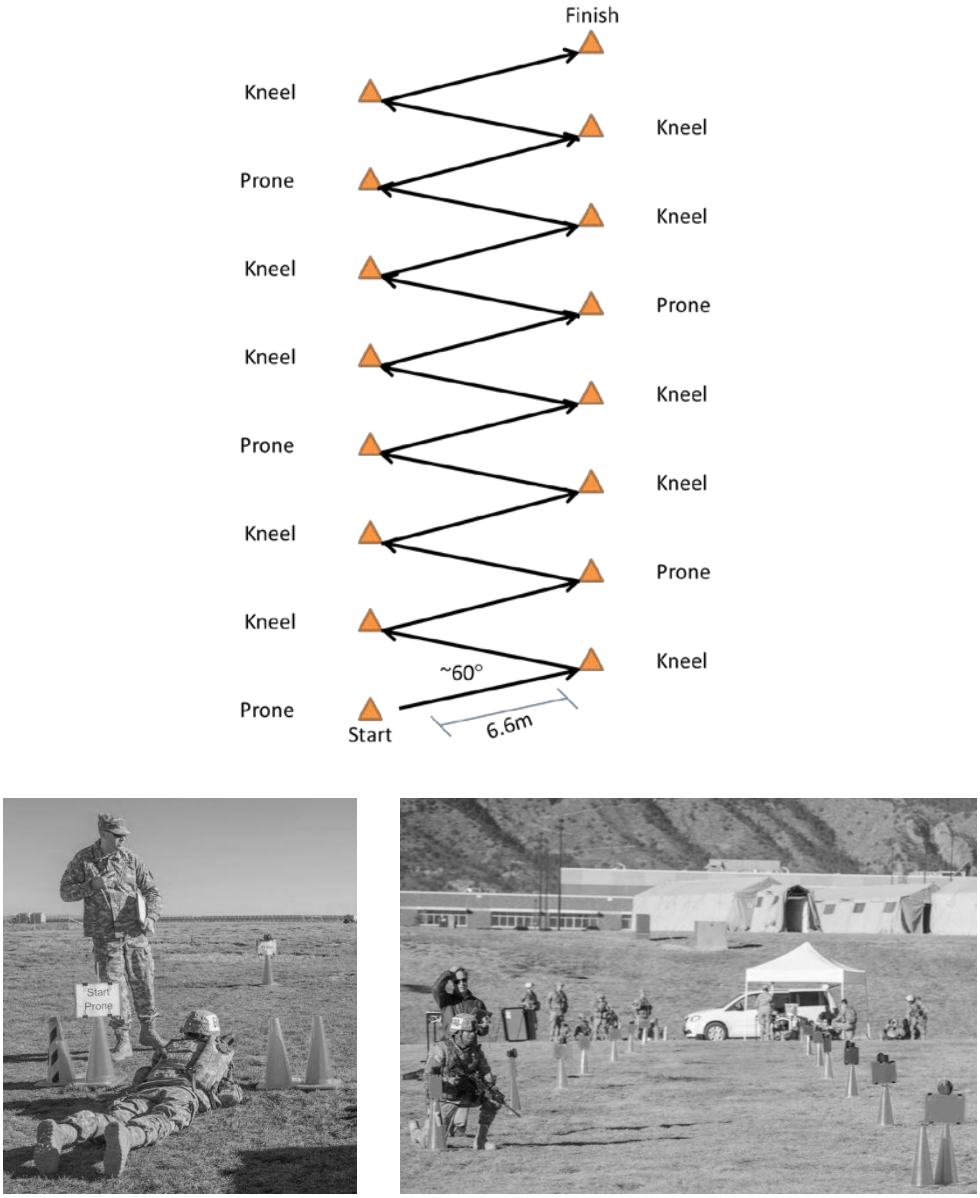
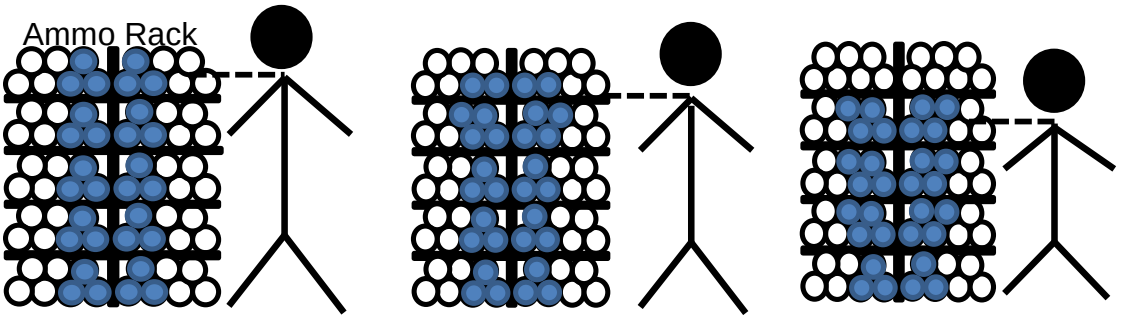


Figure 2.5. Diagrams and Photos of the Transfer Ammo with a FAASV Simulation



Ammo rack loaded to shoulder height. Filled circles represent spaces a Soldier of a given height would be expected to load.

Study 3: Predictor Test Model Development

STUDY 3: INTRODUCTION

As it is not usually an efficient use of time and resources to employ the actual job task to determine physical readiness or success in a MOS, basic predictor tests that do not assess learned skills are better suited for these purposes. For example, devoting a BFV (or even a mock BFV) for performance prediction tests in a Military Entrance Processing Station (MEPS) would take up a large amount of space, and would likely pose a risk of injury to the recruit. In addition, use of predictor tests that include skills that are learned in training or on the job do not comply with the EEOC Uniform Guidelines on Employee Selection Procedures (1978).

Pre-employment test batteries prior to military entrance have been (or are currently being) developed by the Armed Forces of Australia (25), Canada (6, 9) and the United Kingdom (26, 27). The physical employment batteries developed for military personnel by these other NATO countries are provided in Table 3.1. Canada developed a minimum physical fitness standard, based on the following five physically demanding tasks every Soldier should be expected to complete in an emergency: escape to cover, sandbag fortification, pickets and wire carry, picking and digging, vehicle extrication, and stretcher carry (28). They also collected physiological performance data such as strength measures and exercise test performance (e.g., sit-ups, pull-ups, vertical jump height, etc.). Using these physiological measures, they developed predictive model to set minimum fitness standards using performance on four tests: 30 x 26-kg sandbag lifts, 10 x 20-m shuttles alternating between carrying a 20-kg sandbag and unloaded, 20-m rushes, and 20m sandbag drag (6). A prior pre-employment screening has been developed by the U.S. Army (22). This screening included a step test and incremental lift test. It was implemented on a trial, non-mandatory basis, but it was dropped due to an inability to determine its effectiveness.

Little information is available to show a relationship between field-expedient physical tests and MOS specific task performance of U.S. Soldiers. This may be due to the previous of lack of well-defined physical performance standards or criterion tasks for the Combat Arms MOSs. Prior work has shown that the combination of anthropometrics, body composition and isometric upright pull may be predictive of performance in the most physically demanding MOS; however these tests were not implemented (30, 36). Furthermore, these predictive models included gender and anthropometric data, which would no longer be considered legally-defensible as pre-employment measures. Thus, the purpose of this study was to identify a battery of reliable, field-expedient physical tests to predict criterion task performance for the 13B and 13F MOSs.

STUDY 3: METHODS

Data were collected from February 22 – March 11, 2015 and April 6 – April 20 at Ft. Carson, CO. A total of 227 active duty Soldiers (154 Males, 73 Females) were recruited for participation in Study 3. Soldiers were of the 4th Infantry Brigade Combat

Team (IBCT), 4th Infantry Division. All male Soldiers held the 13B Cannon Crewman or 13F Fire Support Specialist MOSs, while the female Soldiers were recruited from any MOS. Soldiers were briefed on all of the tasks prior to consenting. Following consent and screening, participating Soldiers were asked to complete an information sheet that contained demographics and task performance history.

Sample size estimates were run using SamplePower 3.0.1 (IBM Corp, Armonk, New York). For any single task, 55 subjects will be sufficient for 80% power to detect significance of simple regressions with a moderate effect size ($R^2 = 0.13$) at an alpha of 0.05 (8). To establish the ability of the predictive tests to determine performance in the criterion tasks, a sample size of 90 subjects allows for 80% power to detect statistical significance for predictive tests which includes a five variable regression at a moderate effect size ($R^2 = 0.13$, (8)). A sample of females was also included in order to test for any differential effects of sex.

TESTING OVERVIEW

Testing Overview

For the 13B, the testing included two criterion tasks and 14 predictor tests. The criterion tasks identified in Studies 1 and 2 were casualty drag and transfer ammo with a FAASV. The 13F testing consisted of five criterion tasks and 14 predictor tests. The criterion tasks identified in Studies 1 and 2 were the foot march, sandbag carry, casualty drag, casualty evacuation, and move under direct fire. The 13B and 13F completed the same 14 predictor tests, which included the following tests: beep test, Illinois agility test, standing long jump, handgrip, upright pull at 38 cm, medicine ball put, isometric biceps curl, 1-minute sit-up, 1-minute push-up, powerball throw, 300m sprint, squat lift, powerball throw, resistance pull with Exer-Genie, and an arm ergometer test. Due to the low enrollment, a subset of Soldiers from both the 13B and 13F each performed both sets of the criterion job tasks.

Soldiers were divided into 26 squads of about 10 Soldiers each for testing with groups alternating between rest and testing days. Prior to testing, Soldiers completed a briefing on the proper wear of gear for the foot march, and two practices for transfer ammo with a FAASV. The first day of testing consisted of the criterion job tasks (sandbag carry, casualty drag and casualty evacuation) and two predictor tests (handgrip and arm ergometer). The remaining 12 predictive tests were performed on the second test day. Following the predictive testing, all Soldiers signed up to complete the 13F tasks performed tactical movement. Following a weekend to recover, the last two criterion job tasks, transfer ammo with a FAASV (13B cohort) and move under direct fire (13F cohort), were tested.

TESTING PROCEDURES

All criterion tasks from both MOSs were administered as described in Study 2 (See previous chapter). Two modifications were made. Due to inclement weather, the move under fire course was moved inside. To accommodate the task in the available

space, the course used a horseshoe shape rather than the straight line (See Appendix K). Additionally, to allow additional Soldiers the ability to complete the casualty drag, the time limit was extended to 60 seconds. All testing instructions and data sheets for Study 3 can be found in Appendices K and L, respectively.

The predictor tests were administered as follows:

Beep Test

Soldiers continuously ran between two lines 20m apart in time to recorded beeps. Soldiers began standing behind one of the lines facing the second line. When instructed by a recording, they began running at a slow pace. Soldiers continued running between the two lines, placing at least one foot on the opposite line and turning when signaled by the recorded beeps. After each minute, a tone indicated an increase in speed, and the pace of the beeps became faster. If the line was not reached before the beep sounded, the Soldier was given a warning and continued to run to the line, turned and tried to catch up with the pace within two more ‘beeps’. The test was stopped when the Soldier failed to reach the line for two consecutive beeps after a warning. The total number of shuttles completed was recorded (20).

Illinois Agility Test (Figure 3.1)

The length of the course is 10 m and the width (distance between the start and finish points) is 5 m. Four cones were used to mark the start, finish and the two turning points. Another four cones were placed down the center an equal distance apart. Each cone in the center was spaced 3.3 m apart. Soldiers began by lying prone (head to the start line) with their hands by their shoulders. On the 'go' command the stopwatch was started, and the Soldier got up as quickly as possible and ran around the course in the direction indicated, without knocking the cones. Time to complete the course was recorded (13).

Standing Long Jump

Soldiers stood behind a line marked on the ground with feet slightly apart. A two-foot take-off and landing was used, with swinging of the arms and bending of the knees to provide forward drive. Soldiers attempted to jump as far as possible, landing on both feet without falling backwards. Three attempts will were allowed. The two furthest distances jumped (cm) were averaged (18).

Handgrip

Soldiers held a handgrip dynamometer (Jamar Plus+, Sammons Preston, Bolingbrook, IL) in their hand, with the elbow at a right angle and at the side of the body. The handle of the dynamometer was adjusted such that the base rested on first metacarpal (heel of palm), while the handle rested on middle of four fingers. When ready, Soldiers squeezed the dynamometer with maximum isometric effort for about 3-5 seconds. No other body movements were allowed. Three trials were given for each hand. The highest two trials (kg) on each side were averaged (1).

Upright Pull at 38 cm

The Soldier assumed a squatting position with their buttocks against a wall, head and shoulders up and arms extended while grasping the handle of the dynamometer in a mixed grip. On command, the Soldier pushed down by extending the knees and pulled up by extending the hips to exert maximum force on the handle. The peak force produced was recorded. Soldiers were given a minimum of three trials, with about 1-minute rest in between each trial. If there was more than a 10% difference in the three scores, they were given up to two additional trials. The highest two trials within 10% of each other were averaged to determine an overall score (17).

Medicine Ball Put

Soldiers sat with their back firmly against a chair placed against a wall, while holding a 2-kg medicine ball with both hands. On command, the Soldier touched his/her chest with the ball and pushed it as far forward as possible. The distance between the landing point and the front of the chair was measured. Soldiers were given two practices and three attempts. The average of two furthest distances (cm) of the three attempts was used for analysis (14).

Isometric Biceps Curl

Soldiers stood on a wooden platform holding onto a bar with palms facing up, elbows at right angle and forearms parallel to the floor. The bar was attached to a chain attached to the platform, and an inline dynamometer with a force display recorded force production. On command they pulled upward on the bar maximally for 3-5 seconds. The highest two of three trials were averaged for record (29).

One Minute Sit-Up

The sit-up test used the same rules as the APFT (37), with the exception that the test was only one minute in duration. Briefly, Soldiers began by lying on their back with the knees bent at a 90-degree angle. Their feet could be up to 12 inches apart and were held down by a second individual. Soldier's fingers were interlocked behind their head. On the command 'go,' the sit-up was started by raising the upper body forward to or beyond the vertical position (meaning that the base of the neck is above the base of the spine), and then the body was lowered until the bottom of the shoulder blades and the backs of the hands touched the ground. Soldiers performed as many correct sit-ups as possible in one minute.

One Minute Push-Up

The push-up test used the same rules as the APFT (37), with the exception that the test was only one minute in duration. Briefly, Soldiers began with their arms straight, hands a comfortable distance apart, and body straight. Soldier's feet could be up to 12 inches apart. On the command 'go,' the push-up was started by bending elbows and lowering the body until the upper arms were

at least parallel to the ground. Soldiers then returned to the starting position. Soldiers performed as many correct push-ups as possible in one minute.

Powerball Throw

The powerball throw test required throwing a 20-lb medicine ball for a maximum distance to measure total body power. Soldiers began the test by standing with their heels on the starting line and facing the opposite direction in which the ball would be thrown. They held the ball with both hands and while keeping their arms extended they brought the ball down between their legs with bent knees. In one motion, they threw the ball up and back over their head. The distance from the starting line to the point at which the ball landed was measured. Soldiers completed two practice throws and three trials for record. If there was more than a 10% difference in the two highest scores, they were provided up to two additional trials. If Soldiers stepped backwards over the throwing line from which the throw distance was measured prior to releasing the ball, the trial was repeated (35)

300 Meter Sprint

Soldiers ran 300 m around a track as quickly as possible. Prior to testing, Soldiers were allowed time to warm up and stretch. Times (min) were collected using a stopwatch.

Squat Lift

Soldiers lifted pairs of weights (dumbbells) ranging from 25-110 lb (total weight: 50-220 lb). The Soldiers were provided instructions on proper lifting technique prior to beginning the test. Beginning by standing with their feet shoulder-width apart, Soldiers squatted and grasped the handles of the weights at their sides, and performed a squat lift. A warm up weight of 50 lb (two 25-lb dumbbells) was used for three lifts and coaching was provided to ensure safe lifting technique. For testing, the weight started at 60 lb and increased by 20 lb (10 lb per dumbbell), with at least 1-minute of rest between trials, until the Soldier could no longer lift the dumbbell with proper lifting technique or they reached the maximum weight of 220 lb.

Resistance Pull with Exer-Genie

Soldiers held a 24-kg kettlebell attached with a strap to an Exer-Genie (Exer-Genie, Inc., Thousand Oaks, CA) and pulled it for 20 m and/or 90 seconds, which ever came first (Figure 3.15). The pulling resistance offered by the apparatus was set to approximately 100 lb. Prior to starting testing or after a long break, the Exer-Genie was warmed up by pulling the rope through it several times.

Soldiers were instructed to pull on the kettlebell attached to the rope while stepping backwards as quickly as possible. A maximum time limit of 90 seconds was set. If the Soldier failed to pull the kettlebell a distance of 20 m in the 90 seconds allotted time, the distance completed was measured and recorded. Time

to complete and distance were recorded and converted to speed for imputation into the predictive model(s).

2-Minute Arm Ergometer (Figure 3.2)

Soldiers cranked an Arm Ergometer (Model 881E, Monark AB, Varberg, Sweden) as fast as possible, for two minutes. The workload was fixed at 50 watts. Soldiers were in a kneeling position facing the Arm Ergometer with the center crank adjusted to shoulder height. The total number of revolutions was recorded (11, 12).

Subject Matter Expert Observations:

Subject Matter Experts were identified by TRADOC to observe and rate each Soldier's performance as they completed each of the criterion task simulations (Appendix N). The SMEs were not in the supervisory chain of participating Soldiers. The purpose of these ratings was to rate the speed (pace) and ability of each Soldier to determine where their performance fell in comparison to other Soldiers in that MOS.

STATISTICAL ANALYSES

Descriptive statistics were calculated for each task to characterize group performance on each test. Correlation coefficients appropriate to score distributions were computed to quantify strength of association among test variables.

Unpaired T-tests were used to compare group characteristics by gender. Descriptive statistics were calculated for each task to characterize each sex, as well as group performance on each test. Criterion task test scores were converted to z-scores in order to create a common scale for all criterion tasks. Z-scores for the tactical movement, sandbag carry, move under direct fire, and load the main gun were inverted (i.e., multiplied by -1) so that better scores were greater numbers. For each individual, the z-scores for all criterion tasks of their MOS were summed to create a total criterion task performance score. Multiple linear regression models were developed using forward stepwise procedures to produce equations predicting the total criterion task score, with each model using the field-expedient physical performance tests as predictor variables. Several models were developed to provide options for several courses of action depending on the availability of funding and equipment. For each model, secondary analyses were performed in order to identify predictive ability of the model for each individual criterion task.

STUDY 3: RESULTS

Soldier characteristics are provided in Table 3.2. While all of the males Soldiers were either 13Bs or 13Fs, female Soldiers were members of 29 different MOSs. Enlisted Soldiers ranged from E1-E6, and there were four female officers (two O1, one O2, one O3). For both cohorts, the males were taller and heavier than the females ($p<0.01$). On the APFT, males performed more push-ups and had a faster run time

(p<0.01). Males and females in the 13B cohort had a similar APFT total scores (p=0.46); however, for the 13F cohort, females had a higher APFT score (p=0.02).

TESTING PERFORMANCE

Summaries and distributions of scores for the 13B criterion job tasks are provided in Table 3.3. Z-score distributions for the 13B criterion job tasks, as well as the total summed performance z-score, are provided in Table 3.4. For the predictor tests performance for the 13B, summaries and distributions are shown in Table 3.5. For the 13F, performances on the criterion job tasks are provided in Table 3.6 for the raw scores and Table 3.7 for the z-scores. Predictor test summaries are found in Table 3.8.

Additional statistical analyses for both MOSs can be found in Appendix M.

13B Prediction Models

Bivariate correlation amongst the criterion tasks and predictor tests are provided in Table 3.9. All of the predictor and criterion tasks for both 13B had significant correlations.

Four performance predictor models for the 13B (Table 3.10) were developed using data from 197 Soldiers for whom complete datasets were available:

- The first model included all of the predictor tests. In this model, the powerball throw, handgrip (left and right sum), 300m sprint, medicine ball put, and the upright pull came out as significant predictors (Full Model Adjusted $R^2 = 0.85$, $p < 0.01$).
- A second model limited to only four tests resulted in a battery of tests that included: the powerball throw, handgrip (sum), 300m sprint, and medicine ball put (Full Model Adjusted $R^2 = 0.85$, $p<0.01$).
- The third model omitted any equipment that required calibration (as requested by Mr. Brinkley, G3/5/7 TRADOC), which excluded the arm ergometer, handgrip, upright pull, biceps curl, and resistance pull tests as potential covariates. The resulting model consisted of the powerball throw, 300m sprint, medicine ball put, and a squat lift (Full Model Adjusted $R^2 = 0.80$, $p<0.01$).
- The fourth and final model consisted of tests which only required a stopwatch and tape measure, which excluded the arm ergometer, handgrip, upright pull, biceps curl, powerball throw, medicine ball put, and squat lift tests as potential covariates. For this model, the standing long jump, 300m sprint, and 1-minute push-up tests were the significant predictors (Full Model Adjusted $R^2 = 0.52$, $p<0.01$).

Correlations of the four models with the individual criterion job tasks ranged from r = 0.73 to 0.90. The casualty drag had the strongest correlations (r = 0.90-0.73) while transfer ammo with a FAASV had correlations from r = 0.84-0.70. Summaries of all of

the models, as well as their correlations with individual criterion tasks are provided in Table 3.11. Additional statistics on the models are provided in Appendix M.

13F Prediction Models

Bivariate correlation amongst the criterion tasks and predictor tests are provided in Table 3.12. All of the predictor tests and criterion tasks for both 13F had significant correlations.

Three performance predictor models for the 13F (Table 3.13) were developed using data from 146 Soldiers for whom complete datasets were available:

- The first model included all of the predictor tests. In this model, the squat lift, powerball throw, 300m sprint, and arm ergometer came out as significant predictors (Full Model Adjusted $R^2 = 0.84$, $p<0.01$).
- A second model omitted the arm ergometer, as the cost of the device may be prohibitive. The significant predictors in this model were the squat lift, powerball throw, 300m sprint, and medicine ball put (Full Model Adjusted $R^2 = 0.84$, $p<0.01$). This model is also notable in that it required no calibrated equipment.
- The third and final model consisted of tests which only required a stopwatch and tape measure. For this model, 300m sprint, standing long jump, 1-minute push-up, and 1-minute sit-up were the significant predictors (Full Model Adjusted $R^2 = 0.62$, $p<0.01$).

Correlations of the three models with the individual criterion tasks ranged from 0.61 to 0.88. The casualty drag had the strongest correlation for the full and no calibrated equipment models (r = 0.88 for both), but move under direct fire had the strongest correlation (r = 0.81) for the stopwatch and tape measure model. For all models, the sandbag carry had the lowest correlations (r = 0.74-0.61). Summaries of all of the models, as well as their correlations with individual criterion tasks are provided in Table 3.14. Additional statistics on the models are provided in Appendix M.

STUDY 3: DISCUSSION

This study validated the ability of 14 simple physical tasks to predict performance of at least one of the MOS Specific criterion tasks. From those tests, a collection of three to four potential testing models were constructed to predict physical performance on the 13B and 13F criterion tasks. While not exactly the same, most of the models capture similar fitness requirements to those developed by other countries (Table 3.15).

INDIVIDUAL PREDICTORS

All 14 predictor tests had significant correlations with the six criterion job tasks ($p<0.05$) with a range from r = 0.18 to 0.86. In general, the highest correlations were with the ability for the strength and power tests to predict the strength and power demanding tasks. While it was expected that the resistance pull would be a strong

predictor of the casualty drag, correlations were lower than expected (r = 0.42 & 0.60). During testing, subtle variations in the amount of resistance provided by the device were observed, requiring frequent recalibration. While this would not be an issue for a training device, it makes the device less reliable as a testing apparatus. It is recommended that a new method for a field expedient resistance pull test be developed for use in future studies.

The lowest predictive power was observed for the sit-up (r = 0.36-0.18). Although, the sit-up test is a very field expedient test and may be correlated with overall fitness (7), it is not a very specific measure of any one aspect of fitness relevant to the selected criterion tasks. Sit-up testing primarily assesses endurance of the abdominal (core) musculature. Of the criterion tasks, core endurance may contribute to task performance, such as aiding in the ability to carry a load for long distances, but is unlikely to be a key limiting factor.

13B PREDICTION MODELS

For the 13B, four possible outcome models were provided based on four categories of predictor tests. All of the models for 13B showed significant predictive power, and were much stronger than a model based solely on APFT performance for (R^2 = 0.55, data not shown).

The first 13B model, which included all the covariates, is the best predictor of performance on the criterion tasks. This test battery includes the powerball throw, handgrip, 300m sprint, medicine ball put, and upright pull at 38 cm (R^2 = 0.86). This model is optimal for predictive accuracy; however, it is possible to develop predictive models, albeit with more predictive error, which have a little less requirement of space, budget, training, and maintenance. The handgrip and the upright pull test at 38 cm tests require the use of devices that require occasional calibration and replacement cost. All five of these tests are primarily strength and power tasks, with minimal aerobic requirements. This may be due to the heavy strength demands of the two criterion tasks of 13B.

The second model, restricted to just four tests, resulted in a model that includes the same tasks as the first model with the exception of the upright pull (R^2 = 0.85). This second testing battery maintains similar predictive power of the first model and eliminates the need of the upright pull dynamometer.

The third model excludes any calibrated equipment. As a result, all of the equipment is readily able to be purchased at a sporting goods store. This model resulted in a test battery consisting of four tests: the powerball throw, 300m sprint, medicine ball put, and squat lift (R^2 = 0.82). The squat lift test measures lower-body strength. There was only a slightly greater loss in predictive power from Model 2 to Model 3 in comparison to Model 1 to Model 2. This is likely due to the similar physical nature and high correlation (r = 0.84; Appendix M) among the squat lift and upright pull tests. The risk of slightly decreasing in predictive power has a beneficial factor of the selected tests requiring minimal equipment, specifically a medicine ball, a tape

measure, a stop watch, and dumbbells. This makes it a substantially cheaper option to implement.

The final model for the 13B eliminates the need to purchase any equipment other than a stopwatch and a tape measure. This model produced a test battery including the standing long jump (a measure of lower-body power), 300m sprint, and 1-minute push-up (upper-body endurance and strength). While this test battery is the least expensive, its predictive value is substantially lower than the previous models and below the generally accepted cut off of $R^2 = 0.60$ ($R^2 = 0.58$).

13F PREDICTION MODELS

For the 13F three possible outcome models were provided based on three sets of predictor tests. All of the models for both 13F showed significant predictive power, and were much stronger than a model based solely on APFT performance for ($R^2 = 0.50$, data not shown).

The first 13F model, which included all the covariates, is the best predictor of performance on the criterion tasks based on those predictors tested. This test battery includes the squat lift, powerball throw, 300m sprint, and arm ergometer ($R^2 = 0.85$). Notably, this model consists of tests that capture various aspects of fitness: lower-body strength (squat lift) and endurance (300m sprint), as well as upper-body power (powerball throw) and endurance (arm ergometer). This model is optimal for predictive accuracy; however it is possible to develop predictive models, albeit with more predictive error, which have a little less requirement of space, budget, training, and maintenance. The squat lift test requires the use of several heavy dumbbells in order to be administered. The arm ergometer has been successfully implemented as pre-employment screening testing for other organizations as it is space efficient, accurate and may be feasible for use in a limited number of test sites; however, purchasing and maintaining the equipment for a large number of sites is a limitation of this predictor test.

The second model, with the arm ergometer excluded, resulted in a model that includes the same tasks as the first model but with the medicine ball put replacing the arm ergometer test. This second testing battery maintains equivalent predictive power of the first model ($R^2 = 0.85$ v. 0.84), without the necessity and expenses of an arm ergometer. Additionally, all the equipment needed for this model could be purchased easily at a sporting goods store. The medicine ball put does require a space with about a 3-m high ceiling and a 10- to 15-m open area for medicine ball landing points.

The third and final 13F model eliminates the need for any calibrated equipment that is not readily purchased at a sporting goods store. This model resulted in a test battery consisting of four tests: 300m sprint, 1-minute push-up (upper-body endurance), standing long jump (lower-body power), and 1-minute sit-up (core endurance) ($R^2 = 0.62$). There was a considerable increase in predictive error from Models 1 and 2 to Model 3 and the predictive power is just above the generally accepted cut score of $R^2 = 0.60$. Although Model 3 provides substantial benefits in the ease of testing, there is a great loss in predictive accuracy.

ESTABLISHMENT OF CUT POINTS AND FOLLOW-UP

Once a predictive model is selected, the next step will be the identification of acceptable cutoffs for each predictor test. First, for each of the criterion tasks, a minimum acceptable score for the safe and efficient performance of each criterion task simulation will need to be determined. The determination of this score should include several elements including requirements of the job task and trainability of an incoming recruit. Requirements of the job can be established by TRADOC based on the needs and training of the Army. Since these predictive tests are to be administered to incoming recruits and not Soldiers who currently retain the MOS, it will be necessary to account for the ability to train an incoming recruit in One Station Unit Training (OSUT). Improvements of up to 6% in VO_2peak and lower-body strength have been shown following 8 weeks of BCT (32).

From here, it will be possible to identify cut-scores for the predictive tests. There will be some error in the predictions since no model is perfect. Thus, it may be necessary to adjust the cut-scores to optimize the number of individuals who are incorrectly identified as passing or failing a test. By selecting a higher standard to represent in superior performance, this will decrease the number of false positives (i.e., people who pass the test battery but would not be successful in the MOS) but also increase the number of false negatives (i.e., people who fail the test battery but would be successful in the MOS). Along with values for the cut-scores, the type of cut-offs need to be established as well. For testing batteries, such as the ones presented in this report, there are three main types of cut scores: multiple hurdle, compensatory, and hybrid (12). For a multiple hurdle test, a potential recruit would need to reach a minimum score on each test to pass the test (e.g., scoring at least 60/100 points on all four tests). With the compensatory model, recruits must reach a total score based on the predictors, but they may make up for a poor performance on one predictor with a better performance on another (e.g., requiring a total score of 240 points on all four tests scored out of 100 points). The hybrid combines these two approaches, where there is a minimal acceptable score on each test, but the total score must be greater than the sum of the acceptable scores (e.g., scoring 50/100 points on all four tests and requiring a total score of 240).

After implementation of this test battery, long-term observation of Field Artillery recruits is crucial for the full validation of the model. The test should be administered to all Soldiers entering the 13B and 13F MOSs and these Soldiers should be tracked throughout their first term of enlistment. The information recorded should include success/failure and time in Initial Military Training, performance on critical tasks, injuries, attrition from the Army, Enlisted Evaluation Reports and reclassification to other MOSs. The entry standards for the test battery must be adjusted based on these data. This will require creation of an on-line database, standardized measurement and recording of these data, and periodic longitudinal analyses of the data.

LIMITATIONS

It should be noted that the models developed for both the 13B and 13F MOSs are discrete testing batteries. It is not possible to simply swap one test out for another. While any given predictor has the core fitness domain (such as upper-body endurance) that it captures, each test also has unique features. For example, push-ups and the arm-ergometer both capture upper body endurance, but due to their differing methodology, if one was substituted for the other, the result may not be an optimal test battery.

The models were fit using an automated step-wise regression procedure. This procedure does not take into account the fitness domains of any of the tests. All of the tests selected in this procedure were primarily focused on muscular strength, muscular power, or muscular endurance. No aerobic capacity or agility tests came out significant in any of the models. It is clear from Study 1 that many of the tasks are very aerobically demanding. As such it may be of value to add an additional test to endure that recruits are of sufficient aerobic fitness.

The models developed all depend on one important element: the correct selection of the criterion tasks. The job performance score being predicted is based on the two 13B and five 13F criterion tasks. While our research indicates that these are the appropriate criterion tasks and capture many aspects of the physically demanding tasks of the 13B and 13F, it is possible that there are critical aspects of other tasks not being captured. It may be necessary to revise the model if additional physically demanding tasks are identified, or if the task demands change due to changes in equipment.

STUDY 3: CONCLUSIONS

The present study developed four models for the 13B and three models 13F MOSs in order to effectively predict performance on MOS-specific criterion tasks that were identified in Studies 1 and 2. For the 13B, the strongest model included the 300m sprint, handgrip, medicine ball put, powerball throw, and upright pull predictor tests. The strongest model for the 13F included 300m sprint, arm ergometer, powerball throw and the squat lift. The other models that are provided serve as sufficient alternatives based on cost, feasibility, and equipment availability.

STUDY 3: RECOMMENDATIONS

- The Army should select one of the four predictor test models that best meets their logistical needs and constraints. Consideration should be given to the components of physical fitness assessed by the model.

  The four models for 13B were (from best to worst predictive ability):
  - 300m sprint, handgrip, medicine ball put, powerball throw, and upright pull
  - 300m sprint, handgrip, medicine ball put, and powerball throw
  - 300m sprint, medicine ball put, powerball throw, and the squat lift
  - 300m sprint, 1-minute push-up, and standing long jump

  The three models for 13F were (from best to worst predictive ability):
  - 300m sprint, arm ergometer, powerball throw, and squat lift
  - 300m sprint, medicine ball put, powerball throw, and squat lift
  - 300m sprint, 1-minute push-up, standing long jump, and 1-minute sit-up

- Follow-up studies should confirm the validity of the selected model in a separate group of Soldiers.
- In order to establish cut-points, acceptable scores on the criterion tasks need to be verified and/or established, which can then be used to identify critical scores on the predictor tests.
- The predictive test model should be administered through a series of Soldiers entering BCT/AIT, and continued through the early years of their career, in order to establish the predictive accuracy of the model. Longitudinal follow-ups should be considered on a routine basis to ensure the continued acceptability of the prediction model.
- Before selecting on of the above testing batteries, models that incorporate the same test of other Combat Arms MOSs (i.e., 11B, 11C, 12B, 19D, 19K) should be explored and considered for use as the Pre-Employment Screening Test.

Table 3.1. Physical Pre-Employment Test Batteries Developed by the Armed Forces of Australia, Canada, and the United Kingdom

Country	Soldiering task tests	Field-expedient tests
Australia (3)	<u>All Corps</u> • Load Carriage • Combat Rushes • Jerry Can Carry • Heavy Equipment Lift <u>Artillery</u> • All Corps + moving ammunition for a M777A2 conducting a 10-round fire for effect <u>Infantry</u> • All Corps + Casualty Drag	<u>All Corps</u> • Weight Load March • Fire and Movement • Jerry Can Carry • Box Lift and Place <u>Artillery</u> • All Corps + repeatedly lift and carry 10m an inert artillery round <u>Infantry</u> • All Corps + Simulated Casualty Drag
Canada (6, 9, 28)	• Escape to Cover • Sandbag Fortification • Pickets and Wire Carry • Picking and Digging • Vehicle Extrication • Stretcher Carry	• Sandbag Lift • Intermittent Loaded Shuttles • 20-M Rushes • Sandbag Drag
United Kingdom (5, 26, 27)	• Jerry Can Carry • Load Carriage • Single Ammo Box Lift	• 1.5-Mile Run/Beep Test • Jerry Can Carry • Static Lift • Sit-up • Push-up

Table 3.2. Soldier Characteristics: Study 3

13B Cohort	**Males (n=124)**	**Females (n=73)**	**p-value**
Age (years)	23.3 ± 3.4	23.8 ± 4.0	0.37
Height (cm)	179.7 ± 6.9	165.1 ± 6.0	<0.01
Mass (kg)	85.6 ± 11.8	66.1 ± 9.1	<0.01
Time in Military (years)	2.9 ± 2.0	2.7 ± 2.0	0.49
Time in MOS (years)	2.9 ± 2.0	2.4 ± 1.7	0.16
Number Deployed	80 (65%)	27 (37%)	–
Time Deployed (years) *for only those who have deployed*	1.0 ± 0.6	0.9 ± 0.5	0.28
Army Physical Fitness Test Score (points)	258.7 ± 25.7	261.9 ± 33.4	0.46
Push-ups (# / 2 min)	66.4 ± 12.4	43.6 ± 12.1	<0.01
Sit-ups (# / 2 min)	71.3 ± 10.5	70.3 ± 11.6	0.56
Two-Mile Run Time (min)	14.5 ± 1.2	16.8 ± 1.4	<0.01
Predicted VO_2max (ml/kg/min)	50.6 ± 5.2	49.1 ± 4.7	0.05
13F Cohort	**Males (n=96)**	**Females (n=49)**	**p-value**
Age (years)	23.2 ± 3.1	24.0 ± 4.2	0.21
Height (cm)	179.6 ± 6.5	165.1 ± 6.1	<0.01
Mass (kg)	84.8 ± 13.2	67.4 ± 9.1	<0.01
Time in Military (years)	3.2 ± 2.0	2.9 ± 2.2	0.42
Time in MOS (years)	3.3 ± 2.1	2.6 ± 1.9	0.09
Number Deployed	78 (81%)	18 (37%)	
Time Deployed (years) *for only those who have deployed*	1.0 ± 0.6	1.0 ± 0.6	0.91
Army Physical Fitness Test Score (points)	251.3 ± 29.8	264.4 ± 33.8	0.02
Push-ups (# / 2 min)	64.2 ± 12.2	44.4 ± 11.3	<0.01
Sit-ups (# / 2 min)	70.7 ± 10.7	71.6 ± 12.5	0.69
Two-Mile Run Time (min)	14.7 ± 1.2	16.7 ± 1.4	<0.01
Predicted VO_2max (ml/kg/min)	50.2 ± 5.6	49.2 ± 4.8	0.30

Table 3.3. Raw Criterion Task Performance (13B)

		Casualty Drag Speed (m/s)			FAASV (rounds/min)		
		M	**F**	**C**	**M**	**F**	**C**
n		124	73	197	124	73	134
Mean		1.17	0.35	0.87	1.17	0.35	2.21
SD		0.30	0.25	0.49	0.30	0.25	1.07
Minimum		0.42	0.01	0.01	0.42	0.01	7.92
Percentiles	**5**	0.73	0.07	0.10	0.73	0.07	4.68
	10	0.81	0.09	0.15	0.81	0.09	3.42
	25	0.97	0.15	0.45	0.97	0.15	2.48
	50	1.18	0.29	0.93	1.18	0.29	1.88
	75	1.38	0.53	1.22	1.38	0.53	1.55
	90	1.59	0.65	1.49	1.59	0.65	1.42
	95	1.73	0.81	1.60	1.73	0.81	1.33
Maximum		2.04	1.21	2.04	2.04	1.21	1.08

M: Male; F: Female; C: Combined

Table 3.4. Criterion Task Performance Converted to Z-Scores (13B)

		Casualty Drag Speed (m/s)			FAASV (rounds/min)			Summed Z-Sum		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		124	72	196	124	73	196	124	72	196
Mean		0.53	-1.24	-0.12	0.55	-0.93	0.00	1.08	-2.17	-0.11
SD		0.64	0.49	1.04	0.81	0.45	1.00	1.21	0.83	1.90
Minimum		-1.07	-1.93	-1.93	-1.31	-1.85	-1.85	-1.88	-3.48	-3.48
Percentiles	**5**	-0.42	-1.82	-1.75	-0.73	-1.53	-1.40	-0.83	-3.24	-3.10
	10	-0.25	-1.78	-1.64	-0.49	-1.46	-1.26	-0.54	-3.14	-2.75
	25	0.10	-1.64	-1.01	-0.03	-1.26	-0.88	0.38	-2.80	-1.80
	50	0.54	-1.36	0.02	0.59	-0.96	-0.11	0.99	-2.31	0.29
	75	0.96	-0.83	0.62	0.93	-0.69	0.74	1.77	-1.60	1.22
	90	1.40	-0.59	1.19	1.68	-0.41	1.34	2.85	-1.17	2.40
	95	1.71	-0.27	1.43	1.85	-0.23	1.80	3.23	-0.92	3.08
Maximum		2.37	0.20	2.37	2.86	1.05	2.86	4.28	0.63	4.28

M: Male; F: Female; C: Combined

Table 3.5. Predictor Test Performance (13B)

		Beep Test Shuttles (#)			Medicine Ball Put (cm)			Illinois Agility Test (min) [a]		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		124	72	196	124	72	196	124	72	196
Mean		62	42	55	654.10	427.24	570.77	0.32	0.35	0.33
SD		15	11	17	86.02	53.83	133.21	0.03	0.02	0.03
Minimum		37	37	22	37.00	300.50	300.50	0.50	0.41	0.50
Percentiles	**5**	41	25	29	527.00	349.00	365.50	0.36	0.40	0.38
	10	46	27	33	546.50	354.50	400.00	0.35	0.38	0.37
	25	52	33	44	597.25	397.75	444.50	0.34	0.37	0.35
	50	62	41	53	646.00	418.25	592.50	0.32	0.35	0.33
	75	73	52	63	699.00	453.25	672.00	0.30	0.32	0.30
	90	84	57	80	780.50	510.00	742.00	0.30	0.34	0.31
	95	91	60	85	801.00	530.00	786.50	0.29	0.32	0.29
Maximum		104	68	104	914.50	556.00	914.50	0.27	0.31	0.27

		Upright Pull (lb)			Biceps Curl (lb)			Standing Long Jump (cm)		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		124	73	197	124	72	196	124	73	197
Mean		323.37	188.11	273.25	107.52	58.12	89.22	207.70	161.00	190.40
SD		54.36	38.29	81.74	20.54	10.54	29.62	26.60	19.90	33.20
Minimum		184.50	114.55	114.55	63.50	28.20	28.20	151.5	101.5	101.5
Percentiles	**5**	233.35	121.80	144.00	76.50	41.15	47.55	164.5	131.0	138.5
	10	259.55	139.90	163.80	85.30	47.00	51.00	170.0	136.0	147.5
	25	289.13	160.45	198.75	96.30	50.90	63.50	187.5	147.5	164.0
	50	320.28	188.90	284.65	105.33	57.30	92.75	210.8	160.5	187.5
	75	352.43	205.45	335.35	117.35	65.15	109.35	224.5	175.5	216.5
	90	391.75	235.80	380.55	130.60	71.70	124.75	242.0	185.0	235.0
	95	413.00	262.10	404.45	140.55	76.40	131.75	249.5	195.0	243.5
Maximum		467.85	286.15	467.85	203.65	81.40	203.65	274.5	199.0	274.5

		Push-Ups (#)			Resistance Pull (m/s)			Powerball Throw (cm)		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		124	72	196	124	72	196	124	72	196
Mean		51	32	44	0.86	0.39	0.71	603.50	313.90	496.20
SD		10	8	13	0.47	0.17	0.45	110.60	67.70	170.30
Minimum		25	16	16	0.33	0.07	0.07	312.5	171.5	171.5
Percentiles	**5**	35	18	23	0.51	0.15	0.23	432.5	212.0	246.0
	10	40	22	26	0.53	0.19	0.28	477.5	239.5	272.5
	25	43	26	35	0.63	0.25	0.50	533.5	272.0	341.5
	50	50	33	43	0.76	0.33	0.64	598.8	294.5	512.0
	75	56	38	52	0.87	0.54	0.82	660.3	356.0	621.5
	90	66	42	61	1.04	0.59	0.96	760.0	396.5	707.5
	95	70	44	67	1.96	0.64	1.78	805.0	419.5	779.5
Maximum		80	50	80	3.81	0.86	3.81	903.5	498.0	903.5

M: Male; F: Female; C: Combined

[a]Scores inverted so faster times = higher percentile

Table 3.5. Predictor Test Performance (13B) (continued)

		Sit-Ups (#)			Arm Ergometer (Rev / 2min)			Handgrip Sum (lb)		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		124	72	196	124	73	197	124	73	197
Mean		48	45	47	253	181	226	185.72	123.01	162.24
SD		6	6	6	30	33	47	34.45	26.08	43.80
Minimum		33	33	33	168	74	74	110.95	65.65	65.65
Percentiles	**5**	39	35	37	207	129	142	133.05	77.95	94.55
	10	41	37	39	218	135	155	142.95	82.45	106.20
	25	44	41	43	234	154	194	158.95	104.60	131.55
	50	47	45	47	254	185	232	184.25	123.85	159.30
	75	52	48	51	273	205	262	209.75	139.95	198.55
	90	55	53	55	288	225	280	230.40	156.55	219.00
	95	59	56	57	300	230	292	241.75	163.10	235.30
Maximum		64	60	64	345	241	345	274.15	181.40	274.15

		300m Sprint (min) [a]			Squat Lift (lb)		
		M	**F**	**C**	**M**	**F**	**C**
n		124	72	196	124	73	197
Mean		0.89	1.06	0.96	213	140	186
SD		0.09	0.10	0.12	13	33	42
Minimum		1.23	1.35	1.35	160	80	80
Percentiles	**5**	1.05	1.25	1.20	180	100	100
	10	1.00	1.20	1.12	180	100	120
	25	0.94	1.11	1.03	220	120	140
	50	0.89	1.05	0.94	220	140	220
	75	0.83	1.00	0.86	220	160	220
	90	0.79	0.94	0.81	220	200	220
	95	0.77	0.91	0.78	220	220	220
Maximum		0.72	0.87	0.72	220	220	220

M: Male; F: Female; C: Combined

[a]Scores inverted so faster times = higher percentile

Table 3.6. Raw Criterion Task Performance (13F)

		Foot March Time (min) [a]			Sandbag Carry Time (min) [a]			Move Under Fire Time (min) [a]		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		96	49	145	96	49	145	96	49	145
Mean		71.90	88.60	77.5	1.83	3.09	2.3	2.17	2.58	2.31
SD		5.75	9.50	10.7	0.31	1.16	0.9	0.14	0.20	0.25
Minimum		88.22	107.82	107.8	3.43	6.72	6.72	2.50	3.27	3.27
Percentiles	**5**	81.78	106.72	98.2	2.37	6.15	4.17	2.47	2.92	2.75
	10	78.75	104.73	92.8	2.20	4.82	3.27	2.38	2.78	2.65
	25	75.97	95.05	82.7	1.97	3.28	2.40	2.25	2.67	2.48
	50	71.68	88.5	75.5	1.78	2.65	1.95	2.17	2.57	2.25
	75	67.79	82.1	69.8	1.66	2.35	1.73	2.07	2.47	2.12
	90	64.62	74.7	65.7	1.48	2.03	1.55	2.02	2.40	2.03
	95	62.22	73.65	63.6	1.45	2.02	1.48	1.97	2.30	1.98
Maximum		58.77	69.38	58.8	1.22	1.95	1.22	1.92	2.17	1.92

		BFV Cas Evac Weight (lb)			Casualty Drag Speed (m/s)		
		M	**F**	**C**	**M**	**F**	**C**
n		96	49	145	96	49	145
Mean		185	103	158	1.17	0.34	0.89
SD		32	34	51	0.30	0.23	0.48
Minimum		80	50	50	0.50	0.01	0.01
Percentiles	**5**	110	60	70	0.72	0.07	0.11
	10	140	60	80	0.79	0.09	0.16
	25	170	80	110	0.98	0.15	0.50
	50	210	100	170	1.15	0.30	0.98
	75	210	120	210	1.36	0.50	1.22
	90	210	150	210	1.60	0.65	1.49
	95	210	170	210	1.73	0.81	1.66
Maximum		210	190	210	2.04	1.02	2.04

M: Male; F: Female; C: Combined

[a]Scores inverted so faster times = higher percentile

Table 3.7. Criterion Task Performance Converted to Z-Scores (13F)

		Foot March Time (min) [a]			Sandbag Carry Time (min) [a]			Move Under Fire Time (min) [a]		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		96	49	145	96	49	145	96	49	145
Mean		0.54	-0.99	0.03	0.44	-1.02	-0.06	0.61	-0.99	0.07
SD		0.53	0.87	1.08	0.35	1.34	1.08	0.54	0.77	0.98
Minimum		-0.95	-2.74	-2.74	-1.42	-5.22	-5.22	-0.67	-3.68	-3.68
Percentiles	**5**	-0.36	-2.64	-1.87	-0.18	-4.57	-2.27	-0.54	-2.31	-1.65
	10	-0.08	-2.46	-1.37	0.01	-3.02	-1.23	-0.21	-1.78	-1.26
	25	0.17	-1.58	-0.44	0.28	-1.25	-0.22	0.31	-1.33	-0.61
	50	0.56	-0.98	0.21	0.49	-0.51	0.30	0.64	-0.93	0.31
	75	0.92	-0.39	0.73	0.64	-0.16	0.55	1.03	-0.54	0.83
	90	1.21	0.29	1.11	0.84	0.20	0.76	1.23	-0.28	1.16
	95	1.43	0.38	1.30	0.88	0.22	0.84	1.42	0.11	1.36
Maximum		1.74	0.77	1.74	1.15	0.30	1.15	1.62	0.64	1.62

		BFV Cas Evac Weight (lb)			Casualty Drag Speed (m/s)			Summed Z-Sum		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		96	49	145	96	49	145	96	49	145
Mean		0.52	-1.05	0.01	0.52	-1.23	-0.07	2.65	-5.28	-0.03
SD		0.63	0.66	0.99	0.63	0.49	1.02	1.61	2.97	4.34
Minimum		-0.91	-2.09	-2.09	-0.91	-1.93	-1.93	-1.21	-12.17	-12.17
Percentiles	**5**	-0.43	-1.89	-1.77	-0.43	-1.82	-1.73	-0.43	-11.88	-8.15
	10	-0.28	-1.89	-1.27	-0.28	-1.78	-1.28	0.37	-10.00	-7.38
	25	0.12	-1.50	-0.39	0.12	-1.63	-0.67	1.78	-7.41	-3.20
	50	0.47	-1.12	0.27	0.47	-1.33	0.19	2.81	-4.28	1.71
	75	0.91	-0.73	0.70	0.91	-0.90	0.73	3.71	-3.20	3.37
	90	1.42	-0.14	1.06	1.42	-0.59	1.14	4.33	-2.09	4.09
	95	1.71	0.25	1.18	1.71	-0.25	1.43	4.98	-1.62	4.47
Maximum		2.37	0.64	1.62	2.37	0.20	3.95	6.82	-0.23	6.82

M: Male; F: Female; C: Combined

[a] Z-Scores inverted so faster (shorter) times = positive Z-score

Table 3.8. Predictor Test Performance (13F)

		Beep Test Shuttles (#)			Medicine Ball Put (cm)			Illinois Agility Test (min) [a]		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		95	47	142	96	48	144	96	48	144
Mean		60	43	55	650.90	426.13	575.97	0.32	0.36	0.33
SD		16	12	17	83.36	54.20	129.95	0.02	0.02	0.03
Minimum		27	22	22	493.00	300.50	300.50	0.38	0.41	0.41
Percentiles	**5**	39	25	29	529.00	337.00	380.00	0.36	0.40	0.38
	10	42	28	33	552.50	354.50	401.00	0.35	0.38	0.38
	25	48	33	44	598.00	396.75	453.25	0.33	0.38	0.35
	50	56	42	52	634.00	418.25	598.00	0.32	0.36	0.33
	75	70	52	63	696.00	453.25	667.50	0.30	0.32	0.30
	90	85	57	80	780.50	500.00	743.50	0.30	0.34	0.31
	95	91	62	86	801.00	537.00	786.50	0.28	0.32	0.29
Maximum		104	68	104	914.50	556.00	914.50	0.26	0.31	0.26

		Upright Pull (lb)			Biceps Curl (lb)			Standing Long Jump (cm)		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		96	49	145	96	49	145	96	49	145
Mean		314.80	185.35	271.06	104.79	59.04	89.33	207.90	159.70	191.60
SD		59.56	36.06	80.93	19.13	11.10	27.46	26.70	20.50	33.70
Minimum		184.50	114.55	114.55	66.50	28.20	28.20	159.0	101.5	101.5
Percentiles	**5**	210.80	121.80	144.40	76.45	35.25	50.30	162.5	130.0	139.0
	10	243.55	139.75	163.80	82.10	45.10	54.95	170.0	134.0	146.5
	25	274.43	157.00	203.05	92.75	53.40	66.50	191.0	144.0	167.5
	50	310.93	186.30	274.10	101.73	59.90	92.75	208.8	159.0	191.5
	75	355.15	205.15	334.50	114.88	66.75	107.55	223.5	175.0	217.5
	90	382.85	235.80	376.65	130.60	72.80	124.35	243.0	183.5	236.5
	95	418.80	253.10	392.20	141.75	76.70	131.35	254.5	193.0	246.0
Maximum		467.85	262.50	467.85	183.00	81.40	183.00	274.5	199.0	274.5

		Push-ups (#)			Resistance Pull (m/s)			Powerball Throw (cm)		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		96	49	145	96	48	144	96	49	145
Mean		50	32	44	0.76	0.39	0.64	590.60	308.70	495.30
SD		12	8	14	0.23	0.15	0.27	108.80	66.00	164.90
Minimum		25	15	15	0.24	0.07	0.07	312.5	171.5	171.5
Percentiles	**5**	33	20	23	0.49	0.18	0.23	395.0	224.5	249.0
	10	37	21	25	0.55	0.21	0.28	450.0	239.5	273.0
	25	43	25	34	0.63	0.27	0.49	515.3	269.0	351.5
	50	50	32	43	0.75	0.35	0.63	593.3	287.5	513.5
	75	55	38	51	0.84	0.54	0.79	649.5	351.5	620.0
	90	64	42	60	0.94	0.59	0.90	743.5	396.5	675.5
	95	76	48	66	1.03	0.61	0.96	778.0	419.5	762.0
Maximum		94	50	94	2.11	0.64	2.11	903.5	498.0	903.5

M: Male; F: Female; C: Combined

[a]Scores inverted so faster times = higher percentile

Table 3.8. Predictor Test Performance (13F) (continued)

		Sit-Ups (#)			Arm Ergometer (Rev / 2 min)			Handgrip Sum (lb)		
		M	**F**	**C**	**M**	**F**	**C**	**M**	**F**	**C**
n		95	49	144	96	49	145	96	49	145
Mean		48	45	47	247	180	224	179.87	122.76	160.57
SD		6	6	6	31	33	45	33.72	22.96	40.75
Minimum		33	34	33	168	74	74	89.35	77.50	77.50
Percentiles	**5**	39	35	37	187	129	147	132.75	79.30	96.50
	10	40	37	39	206	135	161	141.00	89.75	108.80
	25	44	40	43	227	155	190	155.58	108.70	133.00
	50	48	45	47	248	184	230	178.83	122.00	158.75
	75	52	49	51	270	200	257	202.18	136.40	191.85
	90	55	53	54	287	228	276	223.35	156.55	214.05
	95	56	56	56	299	230	288	239.95	160.00	225.15
Maximum		62	58	62	338	233	338	272.60	172.90	272.60

		300m Sprint (min) [a]			Squat Lift (lb)		
		M	**F**	**C**	**M**	**F**	**C**
n		96	48	144	96	49	145
Mean		0.90	1.08	0.96	209	139	186
SD		0.09	0.12	0.13	18	30	41
Minimum		1.15	1.53	1.53	160	80	80
Percentiles	**5**	1.08	1.25	1.20	160	100	100
	10	1.00	1.23	1.13	180	100	120
	25	0.96	1.14	1.04	200	120	160
	50	0.90	1.07	0.95	220	140	200
	75	0.84	1.02	0.87	220	160	220
	90	0.79	0.95	0.80	220	180	220
	95	0.76	0.92	0.77	220	200	220
Maximum		0.74	0.87	0.74	220	220	220

M: Male; F: Female; C: Combined

[a]Scores inverted so faster times = higher percentile

Table 3.9. Correlations amongst Criterion Tasks and Predictor Tests (13B)

	Casualty Drag Speed	FAASV
Beep Test	0.45**	0.58**
Med Ball Put	0.85**	0.77**
Illinois Agility	-0.50**	-0.51**
Upright Pull	0.83**	0.77**
Biceps Curl	0.80**	0.76**
SLJ[1]	0.69**	0.65**
Push-Up	0.60**	0.61**
Resistance Pull	0.42**	0.40**
Powerball Throw	0.86**	0.75**
Sit-Up	0.26**	0.32**
Arm Ergometer	0.74**	0.74**
Handgrip (sum)	0.79**	0.76**
300m Sprint	-0.62**	-0.61**
Squat Lift	0.81**	0.72**

**p<0.01; *p<0.05
[1]Standing Long Jump

Table 3.10. Regression Results of Full Predictive Models: Unstandardized Coefficients (13B)

	Best Model		**Best 4-Predictor Model**		**No Calibrated Equipment**		**Stopwatch and Tape Measure Only**	
Tests Excluded from Model			*Arm Ergometer*		*Arm Ergometer* *Handgrip* *Upright Pull* *Biceps Curl* *Resistance Pull*		*Arm Ergometer* *Handgrip* *Upright Pull* *Biceps Curl* *Medicine Ball Put* *Powerball* *Squat Lift*	
	ß	**Std. Error**	**ß**	**Std. Error**	**ß**	**Std. Error**	**ß**	**Std. Error**
Constant	-3.963**	0.712**	-3.777**	0.723**	-4.256**	0.869**	-4.017*	1.789*
Powerball	0.002**	0.001**	0.003**	0.001**	0.003**	0.001**		
Handgrip	0.011**	0.002**	0.013**	0.002**				
300m Sprint	-2.369**	0.536**	-2.525**	0.543**	-2.191**	0.622**	-2.504*	1.165*
Med Ball Put	0.004**	0.001**	0.004**	0.001**	0.005**	0.001**		
Upright Pull	0.004**	0.001**						
SLJ[1]							0.024**	0.004**
Push-Up							0.039**	0.009**
Squat LIit					0.009**	0.003**		
R-squared	**0.86**		**0.85**		**0.83**		**0.58**	
Adj. R-squared	**0.86**		**0.85**		**0.82**		**0.58**	
Std. Error of Measurement	**0.723**		**0.737**		**0.805**		**1.240**	

n=197; * p<0.05, ** p<0.01 for covariates.
p<0.01 for all full models.
Covariates not shown did not significantly contribute to any models.
[1] Standing Long Jump

Table 3.11. Regression Results of Predictive Models: Predictive Capabilities (13B)

		All Tests Combined Full Model Adj. R^2	Individual Test r	
			Foot March	Sandbag Carry
Best Model	Powerball Throw + Handgrip (sum) + 300m Sprint + Medicine Ball Put + Upright Pull	**0.86**	0.90	0.84
Best 4-Predictor No Arm Ergometer	Powerball Throw + Handgrip (sum) + 300m Sprint + Medicine Ball Put	**0.85**	0.90	0.83
No Calibrated Equipment	Medicine Ball Put + Powerball Throw + 300m Sprint + Squat Lift	**0.82**	0.90	0.80
Stopwatch and Tape Measure Only	SLJ[1] + 1-min Push-Up + 300m Sprint	**0.58**	0.73	0.70

[1]Standing Long Jump

Table 3.12. Correlations amongst Criterion Tasks and Predictor Tests (13F)

	Foot March	Sandbag Carry	Move Under Fire	Casualty Evacuation	Casualty Drag
Beep Test	-0.54**	-0.42**	-0.58**	0.41**	0.36**
Medicine Ball Put	-0.65**	-0.63**	-0.71**	0.74**	0.84**
Illinois Agility	0.55**	0.50**	0.70**	-0.53**	-0.55**
Upright Pull	-0.62**	-0.59**	-0.66**	0.77**	0.81**
Biceps Curl	-0.68**	-0.63**	-0.68**	0.77**	0.80**
SLJ[1]	-0.55**	-0.56**	-0.73**	0.64**	0.62**
Push-Up	0.57**	-0.51**	-0.66**	0.62**	0.51**
Resistance Pull	-0.51**	-0.50**	-0.55**	0.53**	0.60**
Powerball Throw	-0.67**	-0.63**	-0.70**	0.75**	0.84**
Sit-Up	-0.36**	-0.28**	-0.35**	0.27**	0.18*
Arm Ergometer	-0.65**	-0.66**	-0.68**	0.66**	0.74**
Handgrip (sum)	-0.60**	-0.57**	-0.61**	0.66**	0.77**
300m Sprint	0.63**	0.53**	0.73**	-0.56**	-0.58**
Squat Lift	-0.67**	-0.69**	-0.72**	0.81**	0.80**

**p<0.01; *p<0.05
[1]Standing Long Jump

Table 3.13. Regression Results of Full Predictive Models: Unstandardized Coefficients (13F)

	Best Model		**No Arm Ergometer** **Results in same model as No Calibrated Equipment**		**Stopwatch and Tape Measure Only**	
Tasks Excluded from Model			*Arm Ergometer*		*Arm Ergometer, Handgrip Upright Pull, Biceps Curl, Resistance Pull, Medicine Ball Put, Powerball Throw, Squat Lift*	
	ß	**Std. Error**	**ß**	**Std. Error**	**ß**	**Std. Error**
Constant	-7.327**	1.973**	-6.098**	2.102**	0.529	4.804
Squat Lift	0.039**	0.006**	0.042**	0.006**		
Powerball Throw	0.007**	0.002**	0.006**	0.002**		
300m Sprint	-7.742**	1.359**	-8.279**	1.381**	-9.539**	2.755**
Arm Ergometer	0.018**	0.005**				
Med Ball Put			0.006*	0.003*		
1-Minute Push-Up					0.106**	0.022**
SLJ[1]					0.45**	0.011**
1-Minute Sit-Up					-0.101*	0.046*
R-squared	**0.85**		**0.84**		**0.63**	
Adj. R-squared	**0.84**		**0.84**		**0.62**	
Std. Error of Measurement	**1.693**		**1.73**		**2.667**	

n=145; * p<0.05, ** p<0.01 for covariates.
p<0.01 for all full models.
Covariates not shown did not significantly contribute to any models.
[1]Arm Ergometer
[2]Standing Long Jump

Table 3.14. Regression Results of Predictive Models: Predictive Capabilities (13F)

		All Tests Combined Full Model Adj. R^2	Individual Test r				
			Foot March	Sandbag Carry	Move Under Fire	BFV Cas Evac	Casualty Drag
Best Model	Squat Lift + Powerball Throw + 300m Sprint + Arm Ergometer	**0.84**	0.76	0.74	0.83	0.83	0.88
No Arm Ergometer = No Calibrated Equipment	Squat Lift + Powerball Throw + 300m Sprint + Med. Ball Put	**0.84**	0.76	0.72	0.83	0.83	0.88
Stopwatch & Tape Measure Only	1-min Push-Up + SLJ[1] + 300m Sprint + 1-min Sit-Up	**0.62**	0.68	0.61	0.81	0.71	0.67

[1]Standing Long Jump

Table 3.15. Physical Domains of Current and Proposed Military Employment Testing Batteries

		Strength	Power	Muscular Endurance	Aerobic Capacity	Agility
Existing Test Batteries	**Australia** (3)	Box Lift and Place		Jerry Can Carry Weight Load Carry	Weight Load Carry	Fire and Movement
	Canada (6, 9)		Sandbag Drag	Sandbag Lift Intermittent Loaded Sandbags	Sandbag Lift Intermittent Loaded Sandbags	20m Rushes
	United Kingdom (5, 26, 27)	Static Lift		Jerry Can Carry 2-Minute Push-Up 2-Minute Sit-Up	1.5-Mile Run	
Proposed 13B Test Batteries	**Best Model**	Handgrip Upright Pull	300m Sprint Med Ball Put Powerball Throw			
	4-Predictor No Arm Ergometer	Handgrip	300m Sprint Med Ball Put Powerball Throw			
	Best 4-Predictor = No Calibrated Equipment	Squat Lift	300m Sprint Med Ball Put Powerball Throw			
	4 Predictor Stopwatch & Tape Measure		300m Sprint SLJ[1]	1-Min Push-Up		
Proposed 13F Test Batteries	**Best Model**	Squat Lift	300m Sprint Powerball Throw	2-Min AE[2]		
	No Arm Ergometer = No Calibrated Equipment	Squat Lift	300m Sprint Powerball Throw Med Ball Put			
	Stopwatch & Tape Measure		300m Sprint SLJ[1]	1-Min Push-Up 1-Min Sit-Up		

[1]Standing Long Jump
[2]Arm Ergometer

Figure 3.1. Schematic of the Illinois Agility Test

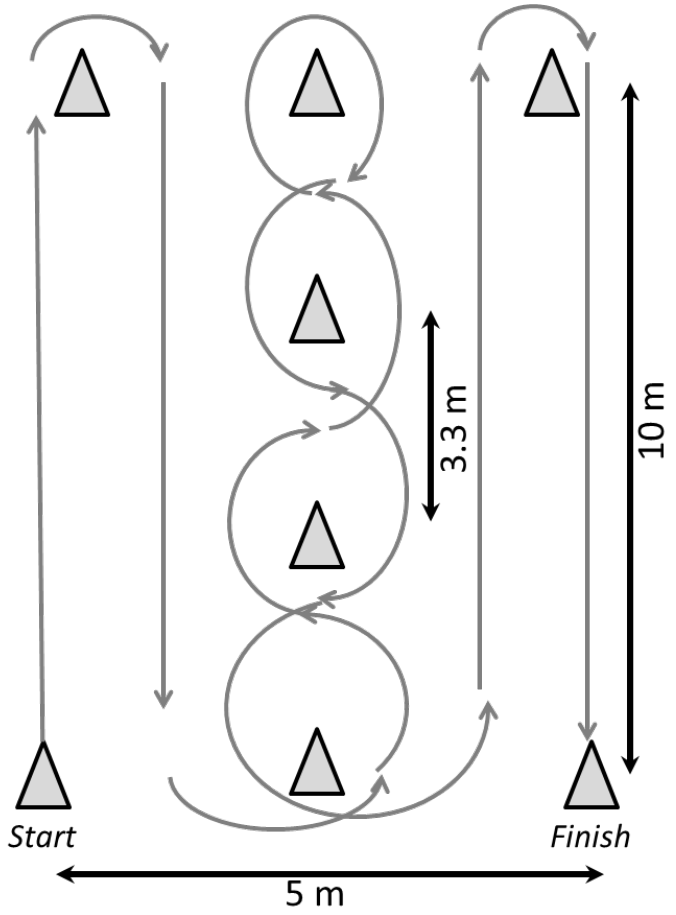


Figure 3.2. Image of Arm Ergometer Test

CONCLUSIONS

This set of 3 studies used best practices set out by Payne and Harvey to develop a physical testing battery for Field Artillery. Study 1 identified the most physical demanding tasks. Of the physically demanding tasks listed by SMEs for each MOS, two 13B tasks and five 13F tasks were identified as capturing the physical demands of the MOS. For the 13B, transfer ammunition with a FAASV captured both heavy lifting and repeated lift and carry tasks. The casualty drag captured the demands for heavy drags. For the 13F, the foot march captured load carriage; casualty evacuation captured heavy lifting; sandbag carry captured repeated lifting and carrying, the casualty drag captured heavy drags, and the move under fire captured agility. Following approval of the task selection by SMEs, task simulations were developed and reliability of the tasks was determined in Study 2. Finally, four 13B and three 13F models, using different sets of predictor tests, were developed for each MOS in Study 3.

The four models for 13B were (from best to worst predictive ability):

- 300m sprint, handgrip, medicine ball put, powerball throw, and upright pull
- 300m sprint, handgrip, medicine ball put, and powerball throw
- 300m sprint, medicine ball put, powerball throw, and the squat lift
- 300m sprint, 1-minute push-up, and standing long jump

The three models for 13F were (from best to worst predictive ability):

- 300m sprint, arm ergometer, powerball throw, and squat lift
- 300m sprint, medicine ball put, powerball throw, and squat lift
- 300m sprint, 1-minute push-up, standing long jump, and 1-minute sit-up

The models presented herein are developed specifically using information from the Field Artillery studies. Additional studies were or will be conducted using Soldiers from the Combat Engineers (12B), Infantry (11B, 11C), and Armor (19D, 19K). When these studies are compiled, one overarching test battery of five to seven tests to cover all seven Combat Arms MOSs will need to be developed in order to complete the tasking from TRADOC. This final model will provide a single testing battery able to identify candidates for each of the seven Combat Arms MOSs.

RECOMMENDATIONS

- The Field Artillery MOSs contains a number of physically demanding tasks. Given these high demands, a pre-enlistment test battery would be beneficial in preventing injuries and misclassifications.
- The Army should institute either one of the predictive test batteries presented herein, or wait until the completion of this study to institute a test battery common to all Combat Arms MOSs.
- Once a test battery is instituted, it will be necessary to perform short-term follow-up assessments to ensure the success of the models in preventing injuries and reclassifications of new Army recruits. Acceptable passing scores may need to be adjusted in order to optimize the model to prevent these negative outcomes.
- Periodic review of the physically demanding tasks of Field Artillery Soldiers. should be considered. If a new task is identified with greater physiological demands, or one of the currently identified criterion tasks is deemed no longer representative of the physical demands, redevelopment of the models should be considered.

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APPENDIX A. LIST OF PARTICIPANTS ON REVIEW PANEL FOR DEVELOPING TASK STANDARDS FOR FIELD ARTILLERY SOLDIERS

Peer Review Panel
MG Arthur Bartell
BG Brad Becker
COL(P) Wilson Shoffner
COL Ken Kamper
CSM Michael Giles
CSM Daniel Moriarty

FA Working Group
LTC Kelly Ivanoff
CPT Jose Cardenas
SGM Robert Norvell
MSG Mark Wallace
SFC Benjamin Schneider
SFC John Key
SFC Chris Dorsey
SFC Jeff Martin
SFC Jose Rivera
1SG (R) William Johnson

Deployed and Recently Deployed Battalion Commanders and NCOs:
LTC Dave Pierce
LTC Phil Raymond
LTC Don Paquin
SFC Jeffrey Wonser
SFC Richard Kolberg
SFC Joseph Will
SSG Jason Thompson

APPENDIX B. UNIFORM LOAD VARIANTS

Soldier Load

Uniform 12.4 lbs

Boots	5.00
ACU	3.20
Multi tool	0.50
Rigger Belt	0.50
Patches	0.49
Patrol Cap	0.48
ID Tags	0.38
Undershirt	0.35
Gloves	0.25

12.4 lbs

Eye Pro	0.25
Notebook	0.25
Drawers	0.20
Socks	0.20
Wrist Watch	0.19
Ear Plugs	0.13
Chapstick	0.01
ID Card	0.01

Personal Protective Equipment and Weapon (PPE) 63.03 to 77.60 lbs*

100 oz Hydration system (With Water)	7.10
Fighting Load Carrier	1.25
30 round magazine pouch (3 x 0.25)	0.75
Hand grenade pouch (2) with (2) M67 Fragmentation Grenades	1.86
Lensatic Compass w/case	0.27
Individual First Aid Kit (IFAK)	1.08
Mag light flashlight w/2 ea AA battery	0.24
Infrared signal beacon, PHOENIX w/Battery	0.70
Ballistic Knee/Elbow Pads	0.79
Visual/Language Translator Card	0.01
Casualty Feeder Report/ Witness Statement	0.01
Advanced Combat Helmet (ACH)	3.25
Helmet Cover w/camouflage cover band	0.28
Night Vision goggle mounting plate	0.20
Ballistic Protection Goggles (ESS)	0.15
M4 Carbine w/fully loaded magazine	7.50

M68- CCO w/ battery	0.71
3 point sling	0.30
Back-Up Iron Sight	0.32
M-4 RAS & Fwd Pistol Grip	1.55
5.56mm Magazine with 30 rounds each (6 ea)	6.42
Sure Fire light w/ battery	0.50
PAQ-4C w/batteries	0.90
	36.14
IOTV w/ neck/groin protector	11.69-19.63*
Enhanced Small Arms Protective Inserts	7.60-14.20*
Enhanced Side Ballistic Insert set with Side Plate Carrier	7.60
	63.03 to 77.57 lbs

Uniform 12.4 lbs + PPE 63.03 to 77.57 lbs*
= Fighting Load 75.43 to 89.97 lbs*

V1, 5 Sep 2013

* see slide 4, Weights for IOTV Gen II

Soldier Load - <24 hour Sustainment Load

Sustainment Load Carried in Assault Pack

Assault Pack w/ waist pack	4.2
2QT Canteen w/Cover and Sling w/water	4.15
Liner Poncho	1.14
Poncho	1.05
Improved Rain suit Top	1.7
Improved Rain suit Bottom	1.7
Neck Gaiter	1
Meal Ready To Eat 1 ea (1.50/0.68 kg)	1.5
Undershirt moisture wicking x 1 ea	0.35
Socks x 1 pr	0.2
Improved Cleaning Kit	1.6
Flexi Cuffs (4 large per soldier)	0.04
Chemlight (2per)	0.04
Water purification tablets	0.02
Camo Face Paint	0.02
VS17 Panel (small)	0.3
	19.0 lbs

Uniform	12.4
PPE	63.03 to 77.57 *
+ <24 Hr Sustainment Load	19.0
Approach March Load	94.43 to 108.97 lbs*

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* see slide 4, Weights for IOTV Gen II

APPENDIX C. TASK DESCRIPTION SLIDES PROVIDED BY TRADOC

Task 1: Conduct Tactical Movement
11B, 11C, 19D, 19K, 13F, 12B

Task: Conduct a 24 Kilometer Tactical Movement

Condition: Wearing / Carrying 94 – 109 lbs Evenly Distributed Across the Entire Body

Standard: Complete in not less than 22 or more than 24 hours; the entire distance should not be completed in one segment.

Conduct Tactical Movement
Carry minimum of 102 lbs evenly distributed over entire body and remain able to fight at conclusion of march of 24 kilometers per day.

Weight: 94-109 lbs Horizontal Distance: 24 km Vertical Distance: Terrain Dependant Time: 24 hours	Weight: 94-109 lbs is combined weight of Basic Soldier Uniform (12 lbs), PPE (63.03 to 77.57 lbs), and <24 hour sustainment load (19 lbs) Horizontal Distance: Army Standard for Tactical Movement is 3-4 km per hour. 24 km per day is representative of 2 Combat Patrols (6-8 km out and 6-8 km back twice a day) from Combat Outposts and Joint Security Sites Time: 22 to 24 hours

- This is not an individual event; however, all platoons and squads do not have to complete the event at the same time.

- Platoon/Squad Leaders may adjust the rate of movement as necessary while still maintaining the ability to complete the task in 22 to 24 hours.

- Soldiers who do not finish with their platoon/squad should be counted as No-GOs.

V1, 5 Sep 2013

Task 2: Employ Hand Grenades
11B, 11C, 19D, 19K, 13B, 13F, 12B

Task: Employ Hand Grenades

Condition: Wearing / Carrying 63.65 to 78.19** lbs Fighting Load(no weapon) and given two M69 Practice Hand Grenades

Standard: Throw at least one Hand Grenade 30 meters

Employ Hand Grenades
Throw hand grenade to engage enemy forces

Weight: 1 lb Horizontal Distance: 30 m Vertical Distance: N/A Time: N/A	Weight: M67 Fragmentation Grenade or M69 Practice Hand Grenade Horizontal Distance: Doctrinally, the Army considers 30 m to be hand grenade range, 30 m engages a 35 m target

*Weight range based on difference for sizes XS-4XL of uniform items & body armor
** 63.65 to 78.19 lbs is fighting load minus 11.78 lbs for M4 & items attached to the M4

V1, 5 Sep 2013

Task 3: Prepare a Fighting Position (Fill and Emplace Sandbags)
11B, 11C, 19D, 19K, 13B, 13F, 12B

Task: Fill Sandbags

Condition: Wearing / Carrying 63.65 to 78.19** lbs Fighting Load(-) (no weapon) and given entrenching tool, 26 empty sandbags, sufficient fill

Standard: 26 sandbags filled 55-60% full in 52 minutes

Fill Sandbags **Dig, lift, and shovel 11 lbs scoops of dirt in bent, stooped or kneeling position into sandbags.**	
Weight: 11 lbs Horizontal Distance: N/A Vertical Distance: 0.75 m Time: 52 minutes	Weight: 11 lbs is combined weight of e-tool and average weight of various soil compositions Vertical Distance: 0.75 meters is height of a sandbag, 3-5 scoops of dirt fill one sandbag One hasty fighting position (without overhead cover) uses 26 sand bags Time: 2 minute average to fill a sandbag

Task: Carry / Emplace Sandbags
Condition: Wearing / Carrying 64–80* lb Fighting Load(-) (no weapon) and given 26 sandbags (55-60% full)
Standard: Hasty fighting position (without overhead cover) built in 26 minutes 10 meters from the original position of the sandbags

Carry/Emplace Sandbags **Lift 30-40 lb sandbags waist to shoulder high, carry them 10 m and emplace**	
Weight: 30-40 lbs Horizontal Distance: 10 m Vertical Distance: 1 m to 1.5 m Time: 26 minutes	Weight: Based on soil composition and bags filled 55-60%, a sandbag weighs 30-40 lbs Horizontal Distance: 10 meters is farthest distance carried from fill point without a vehicle Vertical Distance: Waist to shoulder height Time: 1 minute to carry/emplace a sandbag

*Weight range based on difference for sizes XS-4XL of uniform items & body armor
** 63.65 to 78.19 lbs is fighting load minus 11.78 lbs for M4 & items attached to the M4

V1, 5 Sep 2013

Task 4a: Drag a Casualty to Immediate Safety (Dismounted)
11B, 11C, 19D, 19K, 13B, 13F, 12B

Task: Individually Drag a Casualty to Immediate Safety

Condition: Wearing / Carrying 75.43 to 89.97 lbs* Fighting Load and given a casualty (~188 lbs) with an 83 lbs Fighting Load for a total weight of ~271 lbs

Standard: Casualty dragged 15 meters.

Evaluator's Note: See Next Slide

Soldier on the Ground **Individually lift, drag, and carry a casualty to a safe location; casualty is in harm's way**	
Weight: ~271 lbs Horizontal Distance: 15 m Vertical Distance: 0.5-2 m Time: As quickly as possible	Weight: ~188 lbs incapacitated Soldier with an 83 lb Fighting Load Horizontal Distance: 15m is approximately half the distance a Soldier could move during a 3-5 second rush Vertical Distance: 0.5 - 2 m is height Soldier would carry or drag casualty.

V1, 5 Sep 2013

Task 4b: Remove a Casualty from a Vehicle* (Mounted)
11B, 19D, 13F, 12B

Task: Remove a Casualty from a Vehicle*; Three Soldier Task

Condition: See Next Slide

Standard: Casualty removed from Vehicle*

*** 11B, 19D, 13F:** BFV, Stryker
*** 12B:** BFV or Buffalo (Type of Unit Dependant)

Lift from the Inside of a Vehicle **Three Soldiers perform this task from a BFV, Stryker, or Buffalo**	
Weight: ~207 lbs (prorated ~103.5 ls) Horizontal Distance: 1-2 m Vertical Distance: 1.5 m Time: 2 Minutes	Weight: ~188 lbs incapacitated Soldier with 19 lbs of Vehicle Crewman Uniform and equipment Horizontal Distance: 1.5 m is the height from the commander's seat to the top of the turret Vertical Distance: To clear vehicle

Three Soldiers perform this task; two on the vehicle and one inside. The two Soldiers on the vehicle lift the vast majority of the casualty's weight. The Soldier in the vehicle primarily guides the casualty.

V1, 5 Sep 2013

Task 5: Maintain 25mm Gun on a BFV – Install the Barrel
11B, 19D, 13F, 12B

Task: Install an M242 25mm Barrel on the M242 Gun on a BFV; Two Soldier Task

Condition: Wearing / Carrying 75.43 to 89.97 lbs* Fighting Load and given a BFV with an M242 Gun and an M242 25mm Barrel

Standard: Barrel is carried 25 meters and lifted onto BFV hull

Armor Standard: Barrel is carried 3 meters and lifted onto BFV hull

Lift an M242 25mm Barrel onto the Deck of a BFV

- Removal of M242, 25mm barrel
- Required during maintenance and during remedial action misfire procedures

Lift 107 Pounds 1 Meter and Carry 3 Meters or 25 Meters as Part of a 2 Soldier Team	
Weight: 107 lbs (prorated 53.5 lbs) Horizontal Distance: 3 m or 25 m Vertical Distance: 1 m Time: n/a	Weight: Barrel weighs 107 lbs Horizontal Distance: Barrel to BFV Vertical Distance: BFV hull

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*Weight range based on difference for sizes XS-4XL of uniform items & body armor

Task 6: Maintain 25mm Gun on BFV – Remove Feeder Assembly
11B, 19D, 13F, 12B

Task: Remove the M242 Feeder Assembly from the M242 Gun on a BFV

Condition: Wearing / Carrying 30-44* lbs (IOTVC with ESAPI and ESBI, CVC/ACH Helmet) and given a BFV with an M242 Gun and an M242 Feeder Assembly

Standard: Feeder assembly properly removed

Remove the M242 Feeder Assembly

- Required during maintenance and during remedial action misfire procedure

Lift 59 Pounds 6 Inches and Carry 1 Meter While Seated	
Weight: 59 lbs Horizontal Distance: 1 m Vertical distance: 6 in Time: N/A	Weight: M242 Feeder Assembly weighs 59 lbs

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*Weight range based on difference for sizes XS-4XL of uniform items & body armor

Task 7: Load 25mm HEI-T Ammunition Can on BFV
11B, 19D, 13F, 12B

Task: Load 30 25mm High-Explosive Incendiary Tracer (H-EIT) Ammo Cans onto a BFV

Condition: Wearing / Carrying 63.65 to 78.19** lbs Fighting Load(-) (no weapon) and given a BFV and 30 Ammo Cans with 45 Rounds of H-EIT per can

Standard: 30 Ammunition Cans carried 15 meters and loaded onto BFV 75.43 to 89.97 lbs*

Lift 45 Pounds Waist High and Carry 5 or 15 Meters	
Weight: 45 lbs Horizontal Distance: 15 m Vertical distance: 1 m Time: N/A	Weight: One 25mm ammunition can weighs 45 lbs (contains 45 rounds) Basic Load (25mm) for a BFV is 900 rounds (30 ammunition cans) Horizontal Distance: 15 m is an estimated safe distance between the back of the BFV and the ammunition supply point or ammunition carrier Vertical Distance: 1 m is waist high

V1, 5 Sep 2013

*Weight range based on difference for sizes XS-4XL of uniform items & body armor
** 63.65 to 78.19 lbs is fighting load minus 11.78 lbs for M4 & items attached to the M4

Task 21: Transfer Ammo with an M992 Carrier Ammunition Tracked (CAT) 13B

Task: Transfer Ammunition with an M992 Carrier Ammunition Tracked (CAT). 2 Soldier Task (Performed by 2 Soldiers (1 on Ground, 1 in CAT). The 3 Soldier crew is authorized to rotate duties; 1 Soldier will perform security at all times).

Evaluated Physical Demand: Load M795 / M107 HE Rounds into the M992.

Conditions: Wearing mission specific personal protective equipment: ACH, IOTV with front and back plates, eye protection, and gloves, and given a M992 CAT and 90 x M795 / M107 HE Rounds 3 meters from CAT

Standard: 90 Rounds loaded onto CAT in 45 minutes

Load / Unload M795 / M107 HE Rounds Transfer Ammunition On / Off the M992 Carrier Track Vehicle	
Weight: 105 / 100 lbs Horizontal Distance: 3 m Vertical Distance: 1.6 m Time: 45 minutes - Performed 3-6 times per day	Weight: M795 (standard HE round) weighs 105 lbs; M107 HE weighs 100 lbs Horizontal Distance: Ammunition flat rack to M992 Vertical Distance: Upper bustle rack (from floor of CAT). - To provide the 223 rounds expected to be fired, the M992 crew would upload and download the CAT 3 complete times each day. - In a decisive action environment, a Soldier may handle between 45-90 rounds, 6 times a day. The Soldier will also handle the associated number of powder canisters (weight up to 51 lbs) during upload and download procedures. - M992 Crew is 3 Soldiers; one M992 supports one M109A6 Paladin Howitzer. Ammo Team Chief, Ammo Handler, and Driver rotate duties during operations. One Soldier will maintain security over watch at all times.

V1, 5 Sep 2013

Task 22: Emplace a 155mm Howitzer / Lift Wheel Arm Assembly 13B

Task: Emplace a 155mm Howitzer (Lift Wheel Arm Assembly); 2 Soldier Task

Condition: Wearing / Carrying 75.43 to 89.97 fighting load and given a 155mm Howitzer

Standard: Wheel Arm Assembly properly lifted to enable howitzer to meet the 6 minute emplacement standard

Lift the Wheel Arm Assembly Lift 135 Pounds as a Two Soldier Team	
Weight: 135 lbs (prorated 67.5 lbs) Horizontal Distance: 0.5 m Vertical Distance: 2 m Time: 6 minutes to ready to fire	Weight: Wheel arm assembly weighs 135 lbs Horizontal Distance: Max lift of Wheel Arm Assembly Vertical Distance: The range of motion for the wheel arm assembly is 2 m Time: 6 minut e is the howitzer emplacement standard - Performed simultaneously by 2 x 2 Soldier teams.

V1, 5 Sep 2013

*Weight range based on difference for sizes XS-4XL of uniform items & body armor

Task 23: Displace a 155mm Howitzer / Recover Spade Trail Arm and Blade 13B

Task: Displace a 155mm Howitzer (Recover Spade Trail Arm and Blade); 2 Soldier Task

Condition: Wearing / Carrying 75.43 to 89.97 Fighting Load and given a 155mm Howitzer

Standard: Spade Trail Arm properly recovered to enable howitzer to meet the 5 minute displacement standard which includes taking the howitzer out of firing configuration and putting it into travel configuration, connecting to prime mover, recovering mission essential equipment, and depart firing point.

Recover the Spade Trail Arm and Blade Lift 204 Pounds as a Two Soldier Team and Traverse to a New Azimuth of Fire or Displacing within 5 Minutes	
Weight: 204 lbs (prorated 102 lbs) Horizontal Distance: 0.5 m Vertical Distance: 2 m Time: 5 minutes per displacement	Weight: Spade trail arm and blade weighs 204 lbs Horizontal Distance: Max lift of trail arm and blade Vertical Distance: The range of motion for the trail arm and blade is 2 m Time: Displacement standard is 5 minutes to take howitzer out of firing configuration and into travel configuration, connect to prime mover, recover mission essential equipment, and depart firing point.

V1, 5 Sep 2013

*Weight range based on difference for sizes XS-4XL of uniform items & body armor

Task 25: Establish An Observation Point 13F

Task: Establish an Observation Point

Evaluated Physical Demand: Conduct a 24 Kilometer Dismounted Tactical Movement with supported maneuver unit, carry Forward Observer (FO) specific equipment to perform fire support tasks

Conditions: Wearing / Carrying 94.43 to 108.97* lbs (see below)

Standard: Complete in 24 hours; Soldiers do not have to complete the entire 24 kilometers at once.

Establish An OP Carry FO Specific Fighting Load, Evenly Distributed Over Entire Body During Dismounted Tactical Movement	
Weight: 94.43 to 108.97* lbs Horizontal Distance: up to 24 km (~15 miles) Vertical Distance: Terrain dependant Time: 22-24 Hours	Weight: - Basic Soldier Uniform (12 lbs) (as provided by Infantry Proponent) - PPE (63.03 to 77.57 lbs*) (as provided by Infantry Proponent) - Patrols remaining in the field overnight or for multiple days increase weight significantly (additional ammunition, food, water, mission essential equipment, etc.) Horizontal Distance: - This is not an individual event; however, all platoons and squads do not have to complete the event at the same time. - Platoon/Squad Leaders may adjust the rate of movement as necessary while still maintaining the ability to complete the task in 22 to 24 hours. - Soldiers who do not finish with their platoon/squad should be counted as No-GOs.

V1, 5 Sep 2013

*Weight range based on difference for sizes XS-4XL of uniform items & body armor

Task 26: Prepare an M1200 Armored Knight Vehicle For Operation 13F

Task: Prepare an M1200 Armored Knight Vehicle For Operation; Install and Uninstall the Fire Support Sensor System (FS3); 3 Soldier Task

Condition: Wearing / Carrying 75.43 to 89.97 lbs* Fighting Load and given an M1200 Armored Knight Vehicle and an FS3 located 3 meters from the Vehicle

Standard: FS3 properly installed and subsequently properly uninstalled

Install and Uninstall the Fire Support Sensor System (FS3) **Lift 120 Pounds 2 Meters and Carry 3 Meters as a 2 Soldier Team**	
Weight: 120 lbs (prorated 60 lbs) Horizontal Distance: 3 m Vertical Distance: 2 m Time: n/a	Weight: FS3 weighs 120 lbs Vertical Distance: 2 m to top of the M1200. - Lift is preformed by 2 Soldiers; 3rd Soldier stabilizes

V1, 5 Sep 2013

*Weight range based on difference for sizes XS-4XL of uniform items & body armor

APPENDIX D. PRE-TESTING TRAINING SCHEDULE FOR POTENTIAL STUDY 1 PARTICIPANTS

	20 NOV 2013	21 NOV 2013	25 NOV 2013	27 NOV 2013	3 DEC 2013	7 DEC 2013
	Day 1	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 5**
13B	Transfer Ammo with a FAASV	Transfer Ammo with a FAASV	Transfer Ammo with a FAASV	Transfer Ammo with a FAASV	Transfer Ammo with a FAASV	Transfer Ammo with a FAASV
	Lift Wheel Assembly	Lift Wheel Assembly	Lift Wheel Assembly	Lift Wheel Assembly	Lift Wheel Assembly	Lift Wheel Assembly
	Lift Spade Trail Arm and Blade	Lift Spade Trail Arm and Blade	Lift Spade Trail Arm and Blade	Lift Spade Trail Arm and Blade	Lift Spade Trail Arm and Blade	Lift Spade Trail Arm and Blade
	Install/ Remove FS3	Install/ Remove FS3	Install/ Remove FS3	Install/ Remove FS3	Install/ Remove FS3	Install/ Remove FS3
13F	Install 25mm Barrel	Install 25mm Barrel	Install 25mm Barrel	Install 25mm Barrel	Install 25mm Barrel	Install 25mm Barrel
	Feeder Assembly	Feeder Assembly	Feeder Assembly	Feeder Assembly	Feeder Assembly	Feeder Assembly

APPENDIX E. MINUTES OF THE FIELD ARTILLERY SUBJECT MATTER EXPERT BRIEFING FOR APPROVAL OF CRITERION TASKS

13B and 13F SME VTC
10/8/2014

Soldiers present
TRADOC G3/5/7
MAJ Richard Jones and Mr. Jack Myers

Field Artillery Proponency Office (FAPO):
LTC Robert Krieg, LTC Michael Mullins, MAJ Antonio Perez, CW3 Shannon Mowery, CSM Michael Moriarty, CSM Freddie Barbary, CSM Joseph James, MSG David Anderson, SFC Harry Hafalla, SFC James Joslin, SFC Nicholas Rivera, SFC Jason Gill, Mr. William Johnson, and Mr. John Schraffenberg

USARIEM Personnel:
Mrs. Marilyn Sharp, MAJ Bradley Warr, Dr. Jan Redmond, Dr. Stephen Foulis, and Mrs. Leila Walker

MAJ Jones stated the purpose of the meeting, which was to brief FAPO Subject Matter Experts (SMEs) on the FA task simulations and obtain the approval of the Field Artillery Commandment.

Mrs. Sharp provided a brief overview of the Physical Demands Study. The final outcome of the study was to provide a battery of physical predictor tests to identify recruits who possess the physical potential to succeed as Field Artillery Soldiers (13B/13F). The progress to date included the identification of the critical tasks and standards for these MOSs (FAPO in coordination with TRADOC), the verification of the tasks and standards (TRADOC), the conduct of Focus groups, and the measurement of the physiological demands of the task identified (USARIEM).

The following tasks were identified for the 13B MOS: Employ a Hand Grenade; Prepare a Fighting Position (Fill and Emplace Sandbags); Drag a Casualty to Immediate Safety (Dismounted); Transfer Ammunition with an M992 Carrier (Load M795 ME Rounds); Emplace 155mm Howitzer (Lift Wheel Assembly); and Displace 155mm Howitzer (Lift Spade Trail Arm and Blade).

The following tasks were identified for the 13F MOS: Conduct a Tactical Movement; Employ a Hand Grenade; Prepare a Fighting Position (Fill and Emplace Sandbags); Drag a Casualty to Immediate Safety (Dismounted); Remove a Casualty from a Vehicle (Mounted); Lift, Carry, and Install the Barrel of a 25mm gun on the Bradley Fighting Vehicle; Remove the Feeder Assembly of a 25mm gun on the Bradley Fighting Vehicle; Load 25mm HEI-T Ammunition Cans onto the Bradley Fighting Vehicle; Establish and

Observation Point (Carry AN/PED-1(LLDR)); and Install/Remove Fire Support Sensor System (FS3) on M1200.

USARIEM determined the hand grenade (13F/13B) and set up a gun laying position system (13B) were more skill-based rather than physical demanding. Therefore, these tasks were not included in the data analysis. Additionally, the Establish an Observation Point task (13F) was determined to be similar to the foot march task in terms of physical demands, so this task was not considered separately.

Physical effort from the Soldiers performing these tasks were measured (13B: 20 males and 10 females, 13F: 20 males and 11 females). These measurements included timing, pacing, rate of perceived exertion, heart rate, and physiological energy costs.

USARIEM initiated the task simulation process, but input from the SMEs were necessary in order to ensure the task simulations were reflective of the real tasks. It was also to ensure the most important tasks were represented and to set an entry level of performance on each of the simulations (i.e., time to completion, speed of movement, etc.)

The following considerations were essential in the development of the task simulations:

1. Test individual physical capabilities
2. Allow for a range of scores to show differences between people-cannot be a go/no-go
3. Measure unique physical capabilities.
4. Tests must not endanger Soldiers.
5. Require minimal, readily available equipment.
6. Be reliable (same person gets same score on different days).
7. Require minimal skill and practice.
8. Be time efficient.

Each task for both MOSs were grouped into categories. The SMEs were asked if they agreed with the categories and stated there was agreement. They also stated that the Casualty Drag (13B/13F) and Tactical Road Movement (13F) were important, unique capabilities that should be simulated and tested.

The following categories and tasks were assigned to the 13B MOS:

a. Heavy Lifting: Transfer M795 HE Rounds from an M992 Carrier, Lift the Wheel Arm Assembly of a 777 Howitzer, Recover the Spade Trail Arm and Blade of a 777 Howitzer.

b. Repetitive Lifting and Carrying: Transfer M795 HE Rounds from an M992 Carrier, Carry Sandbags to Prepare a Fighting Position.

c. Drag: Drag a Casualty to Immediate Safety.

The following categories and tasks were assigned to the 13F MOS:

a. Heavy Lifting: Evacuate a Casualty from a Bradley Fighting Vehicle (BFV), Install the Barrel of a 25mm Gun on a BFV, Remove the Feeder

Assembly on the BFV, and Install the Fire Support Sensor of an Armored Knight Vehicle

b. Repetitive Lifting and Carrying: Carry Sandbags to Prepare a Fighting Position, and Load 25mm Ammunition

c. Drag: Drag a Casualty to Immediate Safety

d. Load Carriage: Conduct a Tactical Movement

For the task categories with more than one task, the next step was to determine which task was the most physically demanding and/or the most mission critical. This would be the task selected to design a simulation. Based on the performance data collected, as well as practical considerations, USARIEM recommended tasks from each category. The FAPO personnel concurred with our recommendations and agreed that these tasks captured the critical physical demands of 13B and 13F Soldiers.

The following categories and tasks were selected for the 13B MOS:

a. Heavy Lifting: Transfer M795 HE Rounds from an M992 Carrier. This task was as heavy as the other two, conducted more frequently, is an individual task and could risk injury to self or others if the Soldier is not capable of performing the task.

b. Repetitive Lifting and Carrying: Transfer M795 HE Rounds from an M992 Carrier. This task is also the most demanding in this category. It is the heaviest load, is performed for a longer period of time, requires a high energy expenditure and is perceived by the Soldiers as one of the most difficult.

c. Drag: Drag a Casualty to Immediate Safety. This task is the only task in this category, and is considered both physically demanding and essential to the safety of the Soldier.

The following categories and tasks were selected for the 13F MOS:

a. Heavy Lifting: Evacuate a Casualty from a Bradley Fighting Vehicle. The weight of the casualty described in the task is equally heavy or even heavier than other items evaluated in this category. Additionally, evacuating a casualty is common to other MOSs, it can be tested individually, requires minimum skill, and is critical to the safety and success of the mission.

b. Repetitive Lifting and Carrying: Carry Sandbags to Prepare a Fighting Position. The described task utilizes a 40-lb sandbag (a weight similar to 25mm ammunition cans). Preparing a fighting position is also common to many MOSs, the equipment is readily available, and is physically demanding (high heart rate and energy cost). Additionally, a unique characteristic of carrying sandbags is the requirement for significant grip strength.

c. Drag: Drag a Casualty to Immediate Safety. This task is the only task in this category, and is considered both physically demanding and critical for Soldier safety.

d. Load Carriage: Conduct a Tactical Movement. This task is essential to the performance of a 13F and is the only task in this category.

The task simulations were described, and the SMEs provided their analysis and feedback. They agreed that the simulations captured the essential physical demands of the tasks. A short description of each task simulation follows:

Transfer Ammunition with an M992 Field Artillery Ammunition Supply Vehicle (FAASV) (M795 HE Rounds)
While wearing approximately 30 lb of mission specific personal protective equipment (ACH, IOTV with front and back plates, eye protection, and gloves) and heart rate monitor, Soldiers will have up to 20 minutes to move 30 M795 HE Rounds (approximately 100 lb each) from the floor of the FAASV into the designated locations on the ammunition rack inside the FAASV. Soldiers will work for 5-min, rest for 2.5-min, work 5-min, rest 2.5-min and finally work the last 5-min. The test is over as soon as the 30^{th} round is loaded or at the end of 20 minutes.

Drag a Casualty to Immediate Safety (Casualty Drag)
While wearing a fighting load with a weapon (approximately 83 lb), Soldiers will drag a simulated casualty (approximately 270 lb) up to 15 m as fast as possible in 60 seconds. If the Soldier fails to pull the casualty 15 m in 60 seconds, the distance the casualty was dragged will be measured.

Prepare a Fighting Position (Sandbag Carry)
While wearing a fighting load minus the weapon (approximately 71 lb), Soldiers will lift and carry a total of 16 sandbags weighing 40 lb, carry them 10 m, and place them on the floor as quickly as possible. Soldiers will be instrumented with heart rate monitors for the duration of this task. Soldiers will be timed.

Conduct a Tactical Movement
The Soldiers will complete a movement of four (4) miles, while wearing the basic Soldier uniform, personal protective equipment (to include weapon), and 24-hour sustainment load (approximately 103 lb). Soldiers will complete this task as quickly as possible while walking on a supervised course. Soldiers will not be allowed to run or do the airborne shuffle, but can take breaks as needed.

Remove a Casualty from a Vehicle (Casualty Evacuation)
This task will be simulated using a platform and a heavy bag. A heavy bag is a long bag with reinforced handles used for weight training. It is about the same length as the average torso and head of a Soldier. While wearing a fighting load minus the weapon (approximately 71 lb), a Soldier will squat, grasp the handles of the heavy bag level with the floor, then stand and pull the bag through the hole in the platform. The heavy bag will be placed onto the platform for successful task completion. The initial load of 50 lb will be used for familiarization and warm-up. With the successful completion of the lift,

the weight of the simulated casualty will be increased in 10-lb increments and the lift will be repeated until the participating Soldier reaches volitional fatigue or a max load of 210 lb, representing their maximal heavy lift ability for a casualty evacuation task. The final load will be recorded.

In December 2014, a study was conducted at Ft. Carson, CO to determine the reliability of two FA task simulations: Transfer M795 HE Rounds from an M992 Carrier and Conduct a Tactical Movement tasks. Reliability testings were previously completed for the Casualty Drag, Casualty Evacuation and Sandbag Carry at JB Lewis-McChord in May 2014. The two FA tasks were performed four (4) times over a two week period to determine if the scores change over repeated measurements.

In February 2015, a study was conducted at Ft. Carson, CO to identify simple physical fitness tests that could be used to predict performance on the task simulations. These predictor tests included assessments such as a standing long jump, a medicine ball put, and a 300m Sprint. The data from the predictor tests was used to create a predictive equation to predict Soldier performance on the task simulations.

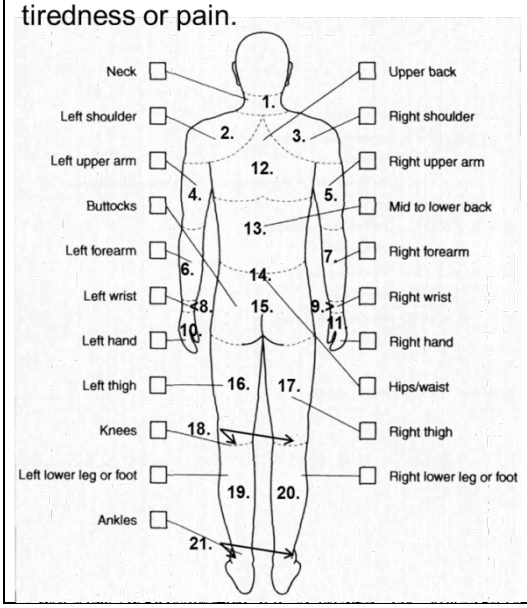
Prior to identifying suggested courses of action, SMEs determined the minimal level of acceptable performance on each of the task simulations. For example, what is the longest acceptable time to complete the sandbag carry, the casualty drag, the foot march or the CAT task simulations? Once these were agreed upon by the four Branch Proponents, the data was appropriately analyzed.

The FAPO was extremely generous with their time and provided us with important insights regarding our testing and task simulations.

APPENDIX F. SCALES USED DURING TESTING

Pain & Discomfort Scale ADAPTED FROM DIMOV ET AL *AIHAJ* 2000

The purpose of this scale is to identify the amount of discomfort you are experiencing in each region of your body. Discomfort includes any feelings of tiredness or pain.



Discomfort Scale

0: No Discomfort
1: Uncomfortable
2: Very Uncomfortable
3: Extremely Uncomfortable

Identify all regions in which you are currently feeling any discomfort and then rate that discomfort from 0-3.

If you are not experiencing any discomfort, you may skip that region.

Borg CR10 Scale

Brief Instruction: “During the job task, pay close attention to the exertion required for the physical work, which, should reflect your total amount of effort and fatigue. Don’t be concerned with any one factor (e.g., duration, leg pain, shortness of breath); concentrate on your total body feeling of exertion. It’s your own feeling that is important, not how it compares to other people or what other people think. Be as accurate as you can.”

Continue for Initial Instruction:

“The scale goes from, “0, nothing at all,” to “10, Extremely Hard,” which is the main anchor, and is the hardest effort most people have ever experienced.

0 “Nothing at all” You are lifting no weight.

3 “Moderate” Task is not especially hard or difficult. It feels fine.

7 “Very Hard” You have to push yourself very much.

10 “Extremely Hard” You are doing as much as you possibly can do.

(Adapted from: Adapted from 1998 Borg HK, ACSM’s Guidelines for Exercise Testing and Prescription 7th Edition, and Borg 1990 SJWEH - Psychophysical scaling with applications in physical work and the perception of Exertion)

0	Nothing at all
0.5	Extremely Light
1	Very Light
2	Light
3	Moderate
4	
5	Hard
6	
7	Very Hard
8	
9	
10	**Extremely Hard**

Borg 6-20 Scale

Brief Instruction: "During the job task, we want you to pay close attention to how hard you feel the physical work rate is. This feeling should reflect your total amount of exertion and fatigue, combining all sensations and feelings of physical stress, effort, and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity. It's your own feeling of effort and exertion that is important, not how it compares to other people or what other people think. Be as accurate as you can."

Continue for Initial Instruction:
"Look at this rating scale; we want you to use this scale from 6 to 20 where 6 means "no exertion at all," and 20 means "maximal exertion."

9 corresponds to "very light" exercise. For most healthy people it represents walking slowly at their own pace for several minutes.

13 corresponds to "somewhat hard" exertion, but it still feels OK to continue.

17 corresponds to "very hard" or difficult exercise. A healthy person can still go on but they really have to push themselves. It feels very strenuous and the person is very tired.

19 corresponds to very strenuous exercise. To most people it is the most strenuous exercise they have ever experienced.

Try to appraise your feeling of exertion as honestly as possible, without thinking about the actual job task or purpose of the task."

(Adapted from: Adapted from 1998 Borg HK, ACSM's Guidelines for Exercise Testing and Prescription 7th Edition, and Borg 1990 SJWEH - Psychophysical scaling with applications in physical work and the perception of Exertion)

6	No exertion at all
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

APPENDIX G. TASK INSTRUCTIONS FROM STUDY 1

1. Conduct a Tactical Movement (24-hour Sustainment Load and Weapon)

This task will allow us to measure the energy expenditure of Soldiers during a tactical road march. In this task, you will be asked to walk on a treadmill for 20 minutes at a speed of 2 mph while carrying about 103 lb of equipment. You need to check that your heart rate monitor is working. You will be outfitted with a face mask attached by a hose to a metabolic cart. The cart will allow us to measure your energy consumption during the task. Upon completion of the task, you will be asked to rate how hard you think you worked during the task on a scale from 6-20, with 6 being very easy and 20 being maximum effort. Your average oxygen consumption, heart rate, and your rate of perceived exertion will be recorded. It is important that you do your best throughout the task. If you feel dizzy or are worried you might fall, hold onto the side of the treadmill and step off the belt. You can also press the stop button if needed.

3. *Prepare a Fighting Position (Fill and Emplace Sandbags)*

In this task, you will work with a partner to fill and emplace 26 sandbags. You will be outfitted with a face mask attached to a small device worn on your back called an Oxycon. The Oxycon will allow us to measure your oxygen consumption. Once instrumented, you will fill each of these buckets 13 times up to the line indicated on the inside using an entrenchment tool for a total of 26 buckets. A test administrator will count the buckets and empty them after you fill them. After filling all 26 sandbags, you will be asked to rate how hard you think you worked during the task on a scale from 6-20, with 6 being very easy and 20 being maximum effort by pointing to a number on a scale. You will then lift and carry 26 sandbags a distance of 10 m where you will build a fighting position. A template is provided for the fighting position. The fighting position is three sided. Each side is three sandbags in length and three sandbags tall. Upon completion of the fighting position, you will be asked to rate how hard you worked during the task using the same scale as before. It is important that you do your best throughout the task, but this is not a race. Perform the task rapidly, as you would during a combat deployment and place, do not throw, the sandbags.

4a. *Drag a Casualty to Immediate Safety (Dismounted)*

In this task, you will be asked to drag a casualty to safety. You need to check that your heart rate monitor is working. Upon auditory signal, you will drag a casualty weighing approximately 270 lb a distance of 15 m as quickly as possible (from this line to the line over there). The test isn't over until the dummy's feet cross the line. Upon completion of the task, you will be asked to rate how hard you think you worked during the task on this scale (show copy of the scale) from 0-10, with 0 being no exertion at all and 10 being maximum effort. We will also ask you to read and call out your heart rate. The grader will also be walking next to you with an alternate heart rate watch. It is important that you do your best throughout the task, but this is not a race. Perform the task as you would during a combat deployment. Before we get started you should jog in place or do some jumping jacks to warm up. You will

be given an opportunity to drag the dummy a few feet prior to the real test, so that you get a feel for the weight.

4b. *Remove a Casualty from a Vehicle (Mounted)*

The purpose of this task is to measure your ability to remove a casualty from the BFV and to determine how difficult you think it is to do this. Upon auditory signal, you will pull a casualty weighing approximately 207 lb from the commander's seat of a BFV as quickly as possible. Two Soldiers will be on top of the BFV, while one soldier is inside. The two Soldiers on top will do most of the work of lifting the wounded soldier out of the turret. The Soldiers on top will kneel down and reach into the turret, grasping the straps of the heavy bag placed on the driver's seat. The person inside will help guide the wounded soldier out of the turret, but will only minimally assist with the lift. Upon completion of the task, you will be asked to rate how hard you think you worked during the task on a scale from 0-10, with 0 being no exertion at all and 10 being maximum effort. It is important that you do your best throughout the task, but this is not a race. Perform the task as you would during a combat deployment. Prior to beginning you will jog in place and stretch to warm up. Protecting your lower back is very important during this task. If you feel any pain or discomfort you should stop.

5. *Lift, Carry, and Install the Barrel of a 25mm Gun on the Bradley Fighting Vehicle (BFV)*

In this task, you and one other Soldier will carry the 107-lb barrel of a 25mm gun a distance of 25 m from a starting point to a BFV and lift it onto the hull of the BFV. One soldier will support the barrel while the second soldier climbs up onto the hull. The solider on the hull will stabilize the barrel while the second soldier climbs up. The barrel will be lifted and placed into the mount opening. Upon completion of the task, you will be asked to rate how hard you think you worked during the task on a scale from 0-10, with 0 being no exertion at all and 10 being maximum effort (show appropriate RPE scale). The time it takes you to carry and install the barrel and your rate of perceived exertion will be recorded. It is important that you do your best throughout the task, but this is not a race. Perform the task as you would during a combat deployment and be careful with the equipment.

6. *Remove the Feeder Assembly of a 25mm Gun on the Bradley Fighting Vehicle (BFV)*

In this task, you will remove the 59-lb M242 feeder assembly from the gun on the BFV and place it on the floor in the rear of the vehicle as quickly as possible. Upon completion of the task, you will be asked to rate how hard you think you worked during the task on a scale from 0-10, with 0 being no exertion at all and 10 being maximum effort (familiarize soldier with the scale). The time it takes you to remove the feeder assembly and your rate of perceived exertion will be recorded. It is important that you do your best throughout the task, but this is not a race. Perform the task as you would during a combat deployment and be careful with the equipment.

7. *Load 25mm HEI-T Ammunition Cans onto the Bradley Fighting Vehicle*

The purpose of this test is to measure your energy expenditure during the loading of 25mm ammo cans onto a BFV. In this task, you will be asked to load 30 ammunition cans onto a shelf the height of the tailgate of the Bradley Fighting Vehicle. You will be outfitted with a face mask attached to a small device worn on your back called an Oxycon. The Oxycon will allow us to measure your oxygen consumption. Upon auditory signal, you will lift a 45-lb can of 25mm ammunition, carry it 15 m and place it onto the platform. You will repeat this at your own pace until 30 cans have been moved. You may carry two cans at a time if you wish. Treat these cans as if they were live ammunition. The cans should be placed onto the platform, not thrown. Upon completion of the task, you will be asked to rate how hard you think you worked during the task on a scale from 6-20, with 6 being very easy and 20 being maximum effort. The time it takes you to complete the task as well as your maximum oxygen consumption, maximum heart rate, and your rate of perceived exertion will be recorded. It is important that you do your best to work quickly throughout the task, but this is not a race. Perform the task as you would during a combat deployment. Prior to starting you should jog or do jumping jacks to warm up. In addition, make sure you stretch and move your arms, back and legs through a full range of motion.

21. Transfer Ammunition with an M992 Field Artillery Ammunition Supply Vehicle (M795 HE Rounds)

While wearing approximately 30 lb of mission specific personal protective equipment (ACH, IOTV with front and back plates, eye protection, and gloves), heart rate monitor, and oxygen measuring device Soldiers will complete two subtasks in order to test the individual demands of loading the Field Artillery Ammunition Supply Vehicle (FAASV). These subtasks are outlined as 21a and 21b. Soldiers will have a 15-minute break between completions of the subtasks. They will be asked to rate their perceived exertion using the CR10 scale (14) at the completion of each subtask.

> ***21a.*** Soldiers will move 30-M795 HE Rounds (roughly 100 lb each) from a pallet into the M992 FAASV or a simulated platform. They will have 15 minutes to complete this subtask.
>
> ***21b*****.** Soldiers will move 30 rounds from the floor of the FAASV into the designated locations on the ammunition rack inside the FAASV. They will have 15 minutes to complete this subtask.

22. Emplace 155mm Howitzer (Lift Wheel Assembly)

As part of a two-Soldier team, each wearing a fighting load (approximately 83 lb), lift the wheel arm assembly of a 155mm Howitzer (135 lb, prorated 67.5 lb) from the ground to the emplacement position (height=1 meter, distance=0.5 meter). Soldiers

will rate their perceived exertion using the CR10 scale (14) at the completion of the task.

23. Displace 155mm Howitzer (Lift Spade Trail Arm and Blade)

As part of a two-Soldier team, each wearing a fighting load (approximately 83 lb), lift the spade trail arm and blade of a 155mm Howitzer (204 lb, prorated 102 lb/Soldier) to the displacement position (height=2 m , distance=0.5 meter). Soldiers will rate their perceived exertion using the CR10 scale (14) at the completion of the task.

26. Install/Remove Fire Support Sensor System (FS3) on M1200

As part of a two-Soldier team, each wearing a fighting load (approximately 83 lb), Soldiers will lift, carry (3 m), and install the Fire Support Sensor System (FS3) (120 lb, prorated 60 lb/Soldier) onto the M1200 Armored Knight Vehicle and then remove it. A third Soldier will be present to provide stability to the FS3 once it is lifted onto the M1200. Soldiers will rate their perceived exertion using the CR10 scale at the completion of the task.

APPENDIX H. QUESTIONNAIRES, SURVEYS, AND DATA SHEETS FROM STUDY 1

Physical Performance Standards Study

Ft Bliss, TX Dec. 2013

Demographics Sheet

(To be filled out by investigator)
Height (in)
_____
Unloaded (lbs)
_____
Fighting Load (lbs)
_____
Fighting Load minus Weapon (lbs)
_____
Approach March Load (lbs)
_____

Subject ID_____

Age _____ Date of Birth: _____

Sex _____ Race _____

MOS _____ Rank _____

Last Army Physical Fitness Test Score (total) _____

Push-ups (reps) _____

Sit-ups (reps) _____

2-Mile Run Time (min:sec) _____

MOS – 13B

Demographic Data: Please complete the following items.

Subject ID_____

Total time of military service (years) _____

Total time in current MOS (years) _____

Total time deployed in current MOS (months) _____

Deployment locations:_____ _____ _____

Directions: Please indicate whether you have performed these tasks in training or while deployed and the number of times you have performed them in each.

		Performed During				
Task		*Training (Y/N)*	*# of times*	*Deployed (Y/N)*	*# of times*	*# of times you performed this task to prepare for the study.*
2	*Employ hand grenades*					
3	*Prepare a fighting position*					
4a	*Drag casualty to safety (dismounted)*					
21	*Transfer ammunition with an M992 Carrier (load M795 HE rounds)*					
22	*Emplace 155mm Howitzer (lift wheel assembly)*					
23	*Displace 155mm Howitzer(recover spade trail arm and blade)*					
24	*Set up Gun Laying Positioning System (GLPS)*					

MOS – 13F

Demographic Data: Please complete the following items.

Subject ID_____

Total time of military service (years) _____

Total time in current MOS (years) _____

Total time deployed in current MOS (months) _____

Deployment locations:_____ _____ _____

Directions: Please indicate whether you have performed these tasks in training or while deployed and the number of times you have performed them in each setting.

		Performed During				
Task		*Training (Y/N)*	*# of times*	*Deployed (Y/N)*	*# of times*	*# of times you performed this task to prepare for the study.*
1	*Conduct a tactical movement*					
2	*Employ hand grenades*					
3	*Prepare a fighting position*					
4a	*Drag casualty to safety (dismounted)*					
4b	*Remove a casualty from a wheeled vehicle (mounted)*					
5	*Lift, carry, and install the barrel of a 25mm gun*					
6	*Remove the feeder assembly of a 25mm gun*					
7	*Load 25mm H-EIT tracer ammunition cans*					
25	*Establish observation point [carry AN/PED-1 (LLDR)]*					
26	*PrepareM1200 Armored Knight Vehicle for operation [Install Fire Support Sensor System (FSS)]*					

13F Day # _____

USARIEM MOS Physical Performance Standards Study

Task 1- Conduct a Tactical Movement

Subject ID: _____

Date: _____

Parvo Cart Number: _____

First Day Approach March Load Weight (lbs): _____

	Task	*Loaded Weight (lbs)*	*Final RPE (6-20)*	*Pre HR (bpm)*	*Final HR (bpm)*	*Time of Day*
1	**Conduct a Tactical Movement (Approach March Load) *Weight within ± 3 lbs of First day Approach March Load**					

***If Soldier is unable to complete the task, please indicate why in the comments section.**

Minute	Treadmill Grade	RPE (6-20)	HR (bpm)
0-3	1%		
3-6	3%		
6-9	1%		
9-12	5%		
12-15	1%		
15-18	3%		
18-20	1%		

Comments:

Test Administrator's Initials _____

13B Day # _____

USARIEM MOS Physical Performance Standards Study

Task 3- Prepare Fighting Position

Subject ID_____

Date: _____

Oxycon Device Number: _____

First Day Fighting Load minus Weapon Weight (lbs): _____

	Task	*Loaded Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (6-20)*	*Pre HR (bpm)*	*Post HR (bpm)*	*Time of Day*
3	**Filling Sandbags (Fighting Load minus weapon) *Weight within ± 3 lbs of First Day Fighting Load minus Weapon**		____ : ____				

Comments:

	Task	*Loaded Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (6-20)*	*Pre HR (bpm)*	*Post HR (bpm)*	*Time of Day*
3	**Carrying Sandbags (Fighting Load minus Weapon) * Weight within ± 3 lbs of First Day Fighting Load minus Weapon**		____ : ____				

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

13B Day # _____

USARIEM MOS Physical Performance Standards Study

Task 4a- Drag a Casualty to Immediate Safety

Subject ID:_____

Date: _____

First Day Fighting Load Weight (lbs): _____

	Task	*Loaded Weight (lbs)*	*Time (Min:Sec)*	*RPE (0-10)*	*Pre HR (bpm)*	*Post HR (bpm)*	*Time of Day*
4a	**Drag a Casualty to Immediate Safety (Fighting Load) *Weight with ± 3 lbs of first day Fighting Load**		____ : ____				

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Comments:

Test Administrator's Initials _____

13F Day # _____

USARIEM MOS Physical Performance Standards Study

Task 4b- Remove a Casualty from a Wheeled Vehicle (mounted)

Subject ID: _____

Date: _____

First Day Fighting Load minus Weapon Weight (lbs): _____

Team (circle one): Male-Male / Male-Female

Teammate Subject ID: _____

	Task	*Loaded Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (0-10)*	*Time of Day*
4b	**Two Soldier Team** **(Fighting Load minus Weapon)** ***Weight within ± 3 lbs of first day Fighting Load Minus Weapon**		____ : ____		

Comments:

	Task	*Loaded Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (0-10)*	*Time of Day*
4b	**Individually** **(Fighting Load minus Weapon)** ***Weight within ± 3 lbs of first day Fighting Load minus Weapon**		____ : ____		

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

13F Day # _____

USARIEM MOS Physical Performance Standards Study

Task 5- Lift, Carry and Install the Barrel of a 25mm Gun

Subject ID: _____

Date: _____

First Day Fighting Load (lbs):_____

Team (circle one): Male-Male / Male-Female

Teammate Subject ID: _____

	Task	*Loaded Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (0-10)*	*Time of Day*
5	**Lift, Carry and Install the Barrel of a 25mm Gun (Fighting Load)** ***Weight within ± 3 lbs of first day Fighting Load**		____ : ____		

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

13F Day # _____

USARIEM MOS Physical Performance Standards Study

Task 6- Remove the Feeder Assembly of a 25mm Gun

Subject ID_____

Date: _____

First Day Body Weight (lbs): _____

	Task	*Loaded Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (0-10)*	*Time of Day*
6	**Remove the Feeder Assembly of a 25mm Gun (First Day Body Weight + 39lbs of Task Specific PPE: IOTVC with ESAPI and ESBI, CVC/ACH Helmet)**		____ : ____		

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Comments:

Test Administrator's Initials _____

13F Day # _____

USARIEM MOS Physical Performance Standards Study

Task 7- Load 25mm H-EIT Tracer Ammunition Cans onto BFV

Subject ID: _____

Date: _____

Oxycon Device Number: _____

First Day Fighting Load minus Weapon Weight (lbs):_____

	Task	*Loaded Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (6-20)*	*Pre HR (bpm)*	*Final HR (bpm)*	*Time of Day*
7	**Load 25mm H-EIT Tracer Ammunition Cans onto BFV (Fighting Load minus Weapon) *Weight within ± 3 lbs of first day Fighting Load minus Weapon**		____ : ____				

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

13B Day # _____

USARIEM MOS Physical Performance Standards Study

Task 21a- Transfer Ammo with an M992 Carrier Ammunition Tracked (CAT)

Subject ID: _____

Date: _____

Oxycon Device Number: _____

Team (circle one): Male-Male / Male-Female

Teammate Subject ID:_____

	Task	*Loaded Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (6-20)*	*Pre HR (bpm)*	*Final HR (bpm)*	*Time of Day*
21a	**Ammo pad to CAT** (Uniform Weight + Mission specific PPE: ACH, IOTV with front and back plates, eye protection and gloves)		____ : ____				

Comments:

	Task	*Loaded Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (6-20)*	*Pre HR (bpm)*	*Final HR (bpm)*	*Time of Day*
21b	**CAT to Bustle Rack** (Uniform Weight + Mission specific PPE: ACH, IOTV with front and back plates, eye protection and gloves)		____ : ____				

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

13B Day # _____

USARIEM MOS Physical Performance Standards Study

Task 22- Emplace 155mm Howitzer/Lift Wheel Assembly

Subject ID: _____

Date: _____

First Day Fighting Load Weight (lbs): _____

Team (circle one): Male-Male / Male-Female

Teammate Subject ID:_____

	Task	*Loaded Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (0-10)*	*Time of Day*
22	**Emplace 155mm Howitzer/ Lift Wheel Assembly (Fighting Load) *Weight within ± 3 lbs of the first day Fighting Load**		____ : ____		

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Comments:

Test Administrator's Initials _____

13B Day # _____

USARIEM MOS Physical Performance Standards Study

Task 23- Displace 155mm Howitzer/Recover Spade Trail Arm and Blade

Subject ID: _____

Date: _____

First Day Fighting Load Weight (lbs): _____

Team (circle one): Male-Male / Male-Female

Teammate Subject ID_____

	Task	*Loaded Weight (lbs)*	*Time to Finish (Min:Sec)*	*RPE (0-10)*	*Time of Day*
23	**Displace 155mm Howitzer/Recover Spade Trail Arm and Blade (Fighting Load) *Weight within ± 3 lbs of the first day Fighting Load**		____ : ____		

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Comments:

Test Administrator's Initials _____

13F Day # _____

USARIEM MOS Physical Performance Standards Study

Task 26- Prepare M1200 Armored Knight Vehicle for Operation

Subject ID: _____

Date: _____

First Day Fighting Load Weight (lbs): _____

Team (circle one): Male-Male / Male-Female

Teammate Subject ID:_____

	Task	*Loaded Weight (lbs)*	*Time to Finish (Min:Sec)*	*Pre HR (bpm)*	*Post HR (bpm)*	*RPE (0-10)*	*Time of Day*
26	**Install** **(Fighting Load)** ***Weight within ± 3 lbs of first day Fighting Load**		____ : ____				

Comments:

	Task	*Loaded Weight (lbs)*	*Time to Finish (Min:Sec)*	*Pre HR (bpm)*	*Post HR (bpm)*	*RPE (0-10)*	*Time of Day*
26	**Uninstall** **(Fighting Load)** ***Weight within ± 3 lbs of first day Fighting Load**		____ : ____				

Comments:

***If Soldier is unable to complete the task, please indicate why in the comments sections.**

Test Administrator's Initials _____

APPENDIX I. TASK INSTRUCTIONS FROM STUDY 2

4-Mile Road March Simulation

The purpose of this task is to assess the reliability of completing a 4-mile road march. You will walk as quickly as you can for 4 miles while carrying total load of 103 lb. While this task should be completed quickly, do not run. Choose a pace that you can maintain and that would allow you to maintain situational awareness to complete a mission. You may take any rest time that you need, but try to finish as quickly as you can.

At the start, you will be asked your HR and current level of discomfort (show discomfort scale and read instructions). You will then place the SPORTident stick in the clear station followed by the start station. When it beeps, your time will begin. At the midpoint, there will be a tester who will ask your HR and RPE (using the 6-20 scale, read instructions if necessary). Respond as quickly as possible, then check out using the other control station and continue on the course. There will be a cone and a stake at the end of each ½ mile. Please walk between the two. Your SPORTident stick will beep as you pass between the marker and the cone. Do not rest within 50 feet of these markers, because the system will record multiple times.

At the end of the course, you will place your SPORTident stick in to the finish station to stop your time. You will then again be asked your HR, RPE and discomfort. We will then record your weight and you will return your testing equipment and any additional weight you were given.

There will be medics and support staff along the course if you require assistance. Your safety and well-being is of utmost importance to us. If you are injured, stop and see a medic. If you choose to discontinue the march for any reason other than a medical emergency, please return to the finish line to checkout. We need to determine your reason for stopping, the distance you completed, and collect the equipment from you.

Again, please walk as quickly as you can, but remember, you should be able to complete your mission at the end of the four miles. Do not jog or do the airborne shuffle. Do you have any questions?

Prepare a Fighting Position (Emplace Sandbags)

Participant Instructions:

The purpose of this task is to determine the reliability of carrying and emplacing 16 filled sandbags, as quickly as possible. Before we get started, make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch. When I say go, you will carry a total of 16 sandbags 10 m where you will build a fighting position that is 4 sandbags wide, 2 sandbags deep, and two sandbags tall. You may carry no more than 2 sandbags at a time, and you must properly place the sandbags you are carrying within the marked outline before returning for the next bag. Upon completion of the task, you will rate how hard you worked using the scale from 6-20 (show scale, read instructions). You should move as quickly as you can complete the task while maintaining your safety. If at any point you feel you are unable to continue, the test will be terminated. Do you have any questions?

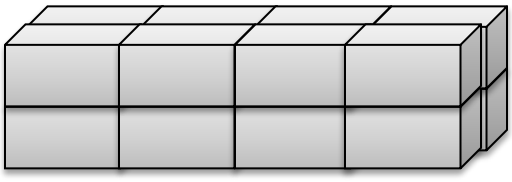


Figure A. Design of fighting position.

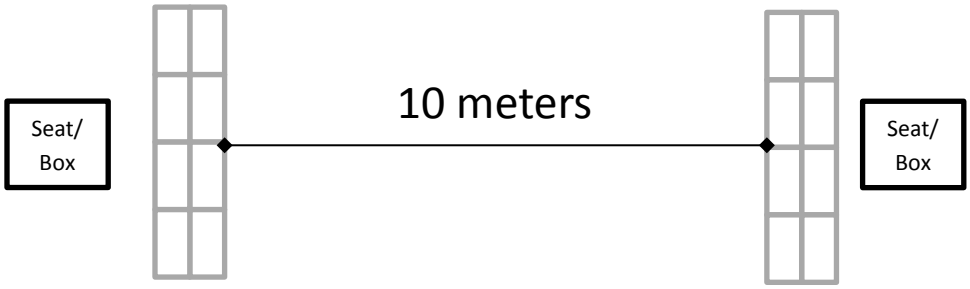


Figure B. Overhead layout.

Drag a Casualty to Safety

The purpose of this task is to determine reliability of quickly dragging a 271-lb casualty a distance of 15 m. Before we get started, make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch. When told to begin, you will grasp the harness on the dummy with one or two hands and drag it as quickly as possible past the 2nd set of cones. The feet of the dummy must cross the line before you stop, so don't stop until I tell you to. You will have 30 seconds to complete this task and I will count down the last 5 seconds and say 'stop'. If you cross the finish line within 30 seconds, I'll tell you when to stop. If you do not cross the finish line when I count down and say 'stop', stop right where you are and wait until I tell you to release the dummy. I will measure how far you dragged it. Upon completion of the task, we will record your heart rate and you will rate how hard you worked during the task on a scale from 0-10 (show scale, read instructions).

You should perform the task as quickly as you can while maintaining your safety. If at any point you feel you are unable to continue, the test will be terminated. Before we start the test, you will drag the dummy a few feet to get a feel for the weight. Do you have any questions?

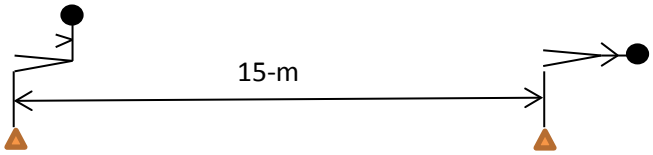


Figure A. If completed task (Record 15-m and actual completion time)

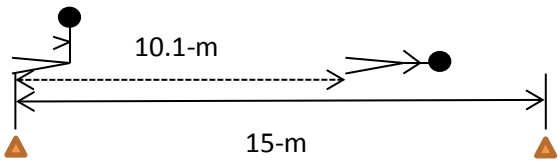


Figure B. If task not completed (Record 30 seconds and Distance to feet)

Remove a Casualty from a Vehicle

Participant Instructions:

The purpose of this test is to determine the reliability of a maximal heavy lift test designed to mimic removing a casualty from a vehicle turret. The weight of the bag will begin at 50 lb. You will squat, grasp the shoulder straps and pull the bag out through the hole simulating the commander's hatch. You must lift the bag up and place it beside the hatch (either upright or on its side) for it to be considered successful. Everyone will complete this weight so that we can ensure you are using the proper lifting technique. After everyone has completed the first weight, an additional 10 lb will be added to the bag, and we will cycle through everyone again. You may choose to skip up to 2 consecutive weight increments if you feel confident you can complete it; however, the tester may ask you to perform the weight anyway. The maximum lift for this test is 210 lb.

Make sure you are wearing gloves. Prior to starting we will review proper lifting technique using a set of kettlebells. You will be required to use good technique to protect your lower back. If you show poor lifting technique, we will stop you and you will not receive credit for that weight. If you feel any pain or discomfort, you should release the bag and stop performing the task.

Upon completion of each lift, you will be asked to rate how hard you worked during the task on a scale from 0-10 (show scale, review instructions before test begins). Your rating should reflect only your effort for that particular weight.

Do you have any questions?

PROPER LIFTING TECHNIQUE: ***Demonstrate and check before testing***

Starting position:

- Place feet at edge of the opening, shoulder width apart
- Knees in line with toes
- Bend at the hips, sticking your butt back so that your *back is flat or slightly arched*
- Head up
- Grip the bag with arms fully extended.

Motion:

- Pull the bag straight up by extending the knees and hips at the same time. The bag should stay as close to your legs as possible.
- Arms should remain extended until knees and hips are fully extended.
- Extend your knees and hips fully before you use your arms to lift and tilt the bag out of the opening. Once upright, you are allowed to bend your knees again to finish the lift if necessary

If you do not use correct form, the test will be stopped. Poor form includes:

- Arching or rounding your back during the lift
- Holding your breath. You should exhale while lifting

Transfer Ammunition with an M992 Field Artillery Ammunition Support Vehicle (Transfer Ammo with a FAASV)

The purpose of this test is to determine the relationship between loading 30 rounds into the FAASV and simple predictor tests. Before beginning, make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch (check now). Also, make sure your gloves are on.

This task requires you to lift the rounds from the back of the FAASV and place them in the ammunition rack in the specified slots. Prior to testing, we will check your height in the FAASV, since you will only be required to fill up to shoulder height. You must carry the rounds; you may not roll them. You will have up to 20 minutes to move up to 30 rounds. The time will be split into three work shifts of 5 minutes, with a mandatory 2 ½-minute rest in between each shift. I will provide warnings when time is running out in each shift. When I alert you that each shift is up, you must safely place the shell down at your current position. When the rest is over, you will resume from the position you left off.

You should perform the task as quickly as possible while maintaining your safety, but choose a pace at which you can complete the task. You can stop and rest as necessary. If you are unable to continue even after a break, tell the administrator, and we will terminate the test.

Upon completion of the task, you will be asked for your heart rate. You will also rate your physical effort on a scale from 6-20. This feeling should reflect your total amount of exertion, combining all sensations and feelings of physical stress and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity. It's your own feeling that is important, not how it compares to other people. Be as accurate as you can (show scale). Look at this rating scale: 6 means "no exertion at all," and 20 means "maximal exertion."

9 corresponds to "very light" exercise. For most healthy people it represents walking slowly at their own pace for several minutes.

13 corresponds to "somewhat hard" exertion, but it still feels OK to continue.

17 corresponds to "very hard" or difficult exercise. A healthy person can still go on but they really have to push themselves. It feels very strenuous and the person is very tired.

19 corresponds to very strenuous exercise. To most people it is the most strenuous exercise they have ever experienced.

Try to rate your feeling of exertion as honestly as possible, without thinking about the actual job task or purpose of the task. Do you have any questions?

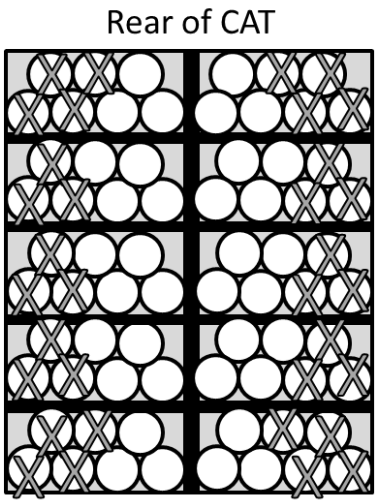


Figure A. Design of FAASV layout

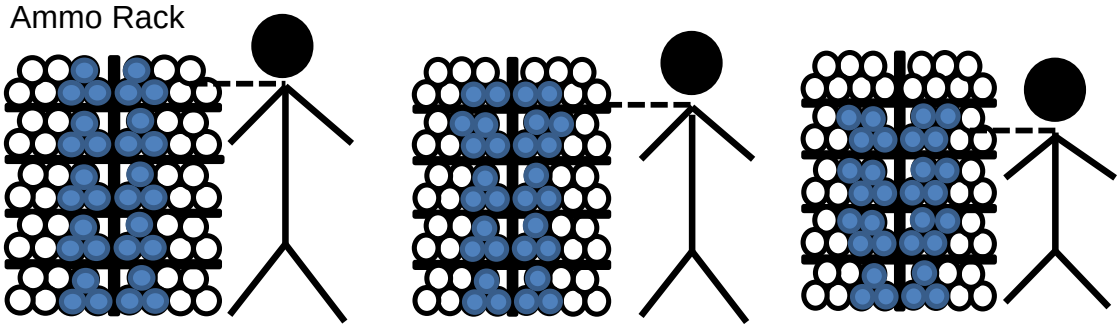


Figure B. Ammo rack loaded to shoulder height. Filled circles represent spaces a Soldier of a given height would be expected to load.

APPENDIX J. QUESTIONNAIRES AND SURVEYS FROM STUDY 2

Physical Performance Standards Study

Demographics Sheet

(To be filled out by investigator)
Height (in)
_____
ACU Unloaded (lbs)
_____
Fighting Load minus Weapon (lbs)
_____
Fighting Load (lbs)
_____
Approach March Load (lbs)
_____

Subject ID_____

Sex _____

Age _____

Date of Birth: _____

Race (circle one):

Caucasian African American Hispanic Asian

MOS _____ Rank _____

Last Army Physical Fitness Test Score (total) _____

Push-ups (reps) _____

Sit-ups (reps) _____

2-Mile Run Time (min:sec) _____

Subject ID: _____ **Date/Time:** _____

USARIEM MOS Physical Performance Standards Study
Reliability Phase

Sandbag Carry

Test Repetition Number: **1** **2** **3** **4**
(Circle one)

Soldier Weight
***Fighting Load NO WEAPON* (lbs):** _____

Stopwatch Number: _____ **Stopwatch Record #:** _____

Time to Finish (Min:Sec)	*RPE (6-20)*	*Pre HR (bpm)*	*Post HR (bpm)*
____ : ____			

Bag Number	*Time (min:sec)*
1	**:**
2	**:**
3	**:**
4	**:**
5	**:**
6	**:**
7	**:**
8	**:**

Bag Number	*Time (min:sec)*
9	**:**
10	**:**
11	**:**
12	**:**
13	**:**
14	**:**
15	**:**
16	**:**

Comments:

Test Administrator's Initials _____

Subject ID: _____ **Date/Time:** _____

USARIEM MOS Physical Performance Standards Study
Reliability Phase

Casualty Drag

Test Repetition Number: **1** **2** **3** **4**
(Circle one)

Soldier Weight
***Fighting Load WITH WEAPON* (lbs):** _____

Distance (m)	*Time (sec)*	*Velocity (m/s)*

RPE (0-10)	*Pre HR (bpm)*	*Final HR (bpm)*

Comments:

Test Administrator's Initials _____

Subject ID: _____ **Date/Time:** _____

USARIEM MOS Physical Performance Standards Study
Reliability Phase

Casualty Extraction

Test Repetition Number: **1** **2** **3** **4**
(Circle one)

Soldier Weight
***Fighting Load NO WEAPON* (lbs):** _____

Rep	*Bag Weight (lbs)*	*Completed (Y/N)*	*RPE (0-10)*
1			
2			
3			
4			
5			
6			
7			

Comments:

Test Administrator's Initials _____

Subject ID: _____ Date: 12/____/ 2014 Time: _____

Investigators Last Name (Printed): _____

USARIEM MOS Physical Demands Study
Reliability Phase

Move Under Direct Fire

Test Repetition Number: 1 2 3 4
(Circle one)

Soldier Weight *Fighting Load With WEAPON* (lbs): _____

Stopwatch Number: _____ **Stopwatch Record #:** _____

	Time to Finish (Min:Sec)	*RPE (6-20)*	*HR (bpm)*
Baseline			
Finish	:		

STAPLE STOPWATCH PRINTOUT TO STOPWATCH SHEET. NOTE ANY ISSUES WITH PRINTOUT BELOW.

Comments:

Subject ID: _____ **Date: 12/_____/ 2014** **Time:** _____

Investigators Last Name (Printed): _____

USARIEM MOS Physical Demands Study
Reliability Phase

Transfer Ammo with an M992 Carrier Ammunition Tracked (CAT) (30 Rounds)

Test Repetition Number: **1** **2** **3** **4**
(Circle one)

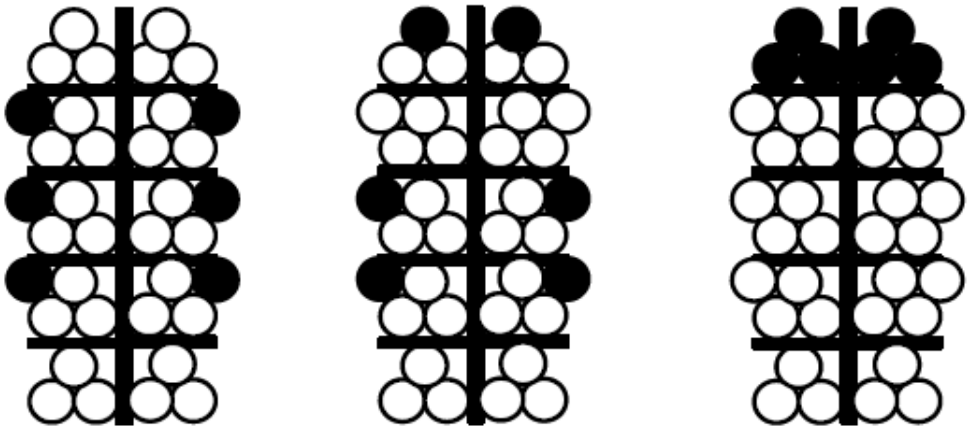
Soldier Weight in *Mission Specific PPE* (lbs): _____

Stopwatch Number: _____ **Stopwatch Record #:** _____

	Time (min:sec) in Shift *Up to 5:00*	*Total* Rounds Completed	RPE (6-20)	HR (bpm)
Baseline				
Shift 1 (0:00-5:00)	:			
Shift 2 (7:30-12:30)	:			
Shift 3 (15:00-20:00)	:			

Mark filling pattern. If all 30 shells not Loaded Mark with an X which slots were filled

☐ *Filled to Top* ☐ *Second Row* ☐ *Third Row*



STAPLE STOPWATCH PRINTOUT TO STOPWATCH SHEET. NOTE ANY COMMENTS OR ISSUES WITH PRINTOUT ON BACK OF THIS SHEET.

CARSON RELIABILITY Last Revised 03SEP2015

Date: ____________ Data Collector: ______________

Test Repetition Number: 1 2 3 4

USARIEM MOS Physical Performance Standards Study

Tactical Road March: Start Data Sheet

Subject #	Start Time	HR
	:	
	:	
	:	
	:	
	:	
	:	
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	:	
	:	
	:	

Page ___ of ___

Date: ____________ Data Collector: ______________

Test Repetition Number: 1 2 3 4

USARIEM MOS Physical Performance Standards Study

Tactical Road March: Finish Data Sheet

Subject #	Finish Time	RPE	HR
	:		
	:		
	:		
	:		
	:		
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Page ___ of ___

Date: ____________ Data Collector: ______________

Test Repetition Number: 1 2 3 4

USARIEM MOS Physical Performance Standards Study

Tactical Road March: Checkpoint Data Sheet

Subject #	Check-in Time	RPE	HR
	:		
	:		
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Page ___ of ___

USARIEM MOS Physical Performance Standards Study
Tactical Road March: Start Discomfort Scale

Date: _____ **Data Collector:** _____

Test Repetition Number: 1 2 3 4

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Subject ID	Neck	Left Shoulder	Right Shoulder	Left Upper Arm	Right Upper Arm	Left Forearm	Right Forearm	Left Wrist	Right Wrist	Left Hand	Right Hand	Upper Back	Mid/Lower Back	Hips/Waist	Buttocks	Left Thigh	Right Thigh	Knees	Left Leg/Foot	Right Leg/Foot	Ankles

Page ____ of ____

USARIEM MOS Physical Performance Standards Study
Tactical Road March: Finish Discomfort Scale

Date: _____ **Data Collector:** _____

Test Repetition Number: 1 2 3 4

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Subject ID	Neck	Left Shoulder	Right Shoulder	Left Upper Arm	Right Upper Arm	Left Forearm	Right Forearm	Left Wrist	Right Wrist	Left Hand	Right Hand	Upper Back	Mid/Lower Back	Hips/Waist	Buttocks	Left Thigh	Right Thigh	Knees	Left Leg/Foot	Right Leg/Foot	Ankles

Page ____ of ____

APPENDIX K. TASK INSTRUCTIONS FROM STUDY 3

Tactical Movement:

The purpose of this task is to determine the relationship between performance on a 4-mile road march and simple predictor tests. You will walk as quickly as you can for 4 miles while carrying total load of 103 lb. While this task should be completed quickly, do not run. Choose a pace that you can maintain and that would allow you to maintain situational awareness to complete a mission. You may take any rest time that you need, but try to finish as quickly as you can.

At the start, you will be asked your HR and current level of discomfort (show discomfort scale and read instructions). You will then place the SPORTident stick in the clear station followed by the start station. When it beeps, your time will begin. At the midpoint, there will be a tester who will ask your HR and RPE (using the 6-20 scale, read instructions if necessary). Respond as quickly as possible, then check out using the other control station and continue on the course. There will be a cone and a stake at the end of each ½ mile. Please walk between the two. Your SPORTident stick will beep as you pass between the marker and the cone. Do not rest within 50 feet of these markers, because the system will record multiple times.

At the end of the course, you will place your SPORTident stick in to the finish station to stop your time. You will then again be asked your HR, RPE and discomfort. We will then record your weight and you will return your testing equipment and any additional weight you were given.

There will be medics and support staff along the course if you require assistance. Your safety and well-being is of utmost importance to us. If you are injured, stop and see a medic. If you choose to discontinue the march for any reason other than a medical emergency, please return to the finish line to checkout. We need to determine your reason for stopping, the distance you completed, and collect the equipment from you.

Again, please walk as quickly as you can, but remember, you should be able to complete your mission at the end of the four miles. Do not jog or do the airborne shuffle. Do you have any questions?

Sandbag Carry

The purpose of this task is to determine the relationship between performance of carrying and emplacing 16 filled sandbags as quickly as possible and simple predictor tests. Before we get started, make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch. When I say go, you will carry a total of 16 sandbags 10 m where you will build a fighting position that is 4 sandbags wide, 2 sandbags deep, and two sandbags tall. You may carry no more than 2 sandbags at a time, and you must properly place the sandbags you are carrying within the marked outline before returning for the next bag. Upon completion of the task, you will rate how hard you worked using the scale from 6-20 (show scale, read instructions). You should move as quickly as you can complete the task while maintaining your safety. If at any point you feel you are unable to continue, the test will be terminated. Do you have any questions?

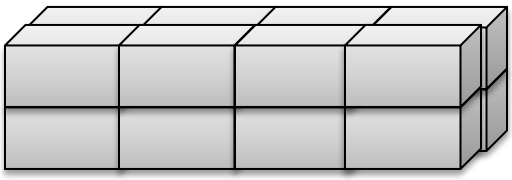


Figure A. Design of fighting position.

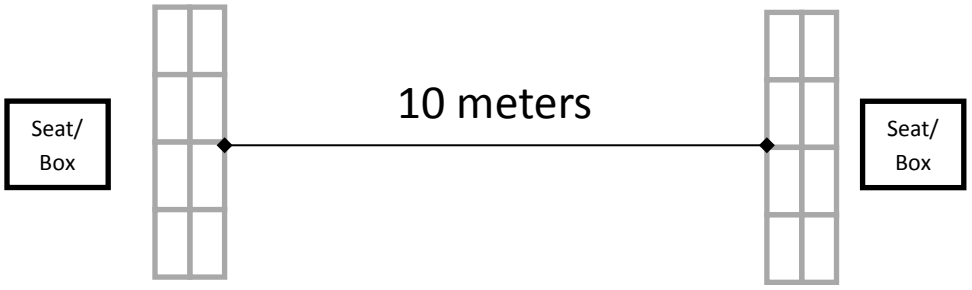


Figure B. Overhead layout.

Casualty Drag

The purpose of this task is to determine the relationship between performance of dragging a 270-lb casualty a distance of 15 m and simple predictor tests. Before we get started, make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch. When told to begin, you will grasp the harness on the dummy with one or two hands and drag it as quickly as possible past the 2nd set of cones. The feet of the dummy must cross the line before you stop, so don't stop until I tell you to. You will have 30 seconds to complete this task, and I will count down the last 5 seconds and say 'stop'. If you cross the finish line within 30 seconds, I'll tell you when to stop. If you do not cross the finish line when I count down and say 'stop', stop right where you are and wait until I tell you to release the dummy. I will measure how far you dragged it. Upon completion of the task, we will record your heart rate and you will rate how hard you worked during the task on a scale from 0-10 (show scale, read instructions).

You should perform the task as quickly as you can while maintaining your safety. If at any point you feel you are unable to continue, the test will be terminated. Before we start the test, you will drag the dummy a few feet to get a feel for the weight. Do you have any questions?

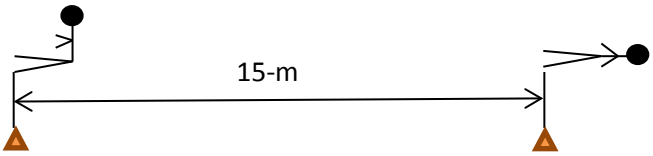


Figure A. If completed task (Record 15-m and actual completion time)

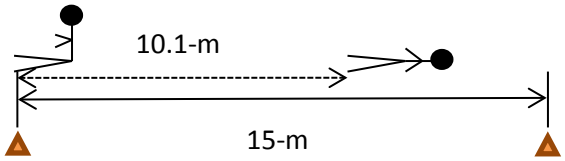


Figure B. If task not completed (Record 30 seconds and distance to feet)

Casualty Evacuation

The purpose of this task is to determine the relationship between performance of a maximal heavy lift test designed to mimic removing a casualty from a vehicle turret, and simple predictive tests. The weight of the bag will begin at 50 lb. You will squat, grasp the shoulder straps and pull the bag out through the hole simulating the commander's hatch. You must lift the bag up and place it beside the hatch (either upright or on its side) for it to be considered successful. Everyone will complete this weight so that we can ensure you are using the proper lifting technique. After everyone has completed the first weight, an additional 10 lb will be added to the bag, and we will cycle through everyone again. You may choose to skip up to 2 consecutive weight increments if you feel confident you can complete it; however, the tester may ask you to perform the weight anyway. The maximum lift for this test is 210 lb.

Make sure you are wearing gloves. Prior to starting we will review proper lifting technique using a set of kettlebells. You will be required to use good technique to protect your lower back. If you show poor lifting technique, we will stop you and you will not receive credit for that weight. If you feel any pain or discomfort, you should release the bag and stop performing the task.

Upon completion of each lift, you will be asked to rate how hard you worked during the task on a scale from 0-10 (show scale, review instructions before test begins). Your rating should reflect only your effort for that particular weight. Do you have any questions?

PROPER LIFTING TECHNIQUE: ***Demonstrate and check before testing***

Starting position:

- Place feet at edge of the opening, shoulder width apart
- Knees in line with toes
- Bend at the hips, sticking your butt back so that your *back is flat or slightly arched*
- Head up
- Grip the bag with arms fully extended.

Motion:

- Pull the bag straight up by extending the knees and hips at the same time. The bag should stay as close to your legs as possible.
- Arms should remain extended until knees and hips are fully extended.
- Extend your knees and hips fully before you use your arms to lift and tilt the bag out of the opening. Once upright, you are allowed to bend your knees again to finish the lift if necessary
- If you do not use correct form, the test will be stopped.

Poor form includes:

- Arching or rounding your back during the lift
- Holding your breath. You should exhale while lifting

Transfer Ammunition with an M992 Field Artillery Ammunition Support Vehicle (Transfer Ammo with a FAASV)

The purpose of this test is to determine the relationship between loading 30 rounds into the FAASV and simple predictor tests. Before beginning, make sure the chest strap of your heart rate monitor is tight and that your heart rate is displayed on the watch (check now). Also, make sure your gloves are on.

This task requires you to lift the rounds from the back of the FAASV and place them in the ammunition rack in the specified slots. Prior to testing, we will check your height in the FAASV, since you will only be required to fill up to shoulder height. You must carry the rounds; you may not roll them. You will have up to 20 minutes to move up to 30 rounds. The time will be split into three work shifts of 5 minutes, with a mandatory 2 ½-minute rest in between each shift. I will provide warnings when time is running out in each shift. When I alert you that each shift is up, you must safely place the shell down at your current position. When the rest is over, you will resume from the position you left off.

You should perform the task as quickly as possible while maintaining your safety, but choose a pace at which you can complete the task. You can stop and rest as necessary. If you are unable to continue even after a break, tell the administrator, and we will terminate the test.

Upon completion of the task, you will be asked for your heart rate. You will also rate your physical effort on a scale from 6-20. This feeling should reflect your total amount of exertion, combining all sensations and feelings of physical stress and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity. It's your own feeling that is important, not how it compares to other people. Be as accurate as you can (show scale). Look at this rating scale: 6 means "no exertion at all," and 20 means "maximal exertion."

9 corresponds to "very light" exercise. For most healthy people it represents walking slowly at their own pace for several minutes.

13 corresponds to "somewhat hard" exertion, but it still feels OK to continue.

17 corresponds to "very hard" or difficult exercise. A healthy person can still go on but they really have to push themselves. It feels very strenuous and the person is very tired.

19 corresponds to very strenuous exercise. To most people it is the most strenuous exercise they have ever experienced.

Try to rate your feeling of exertion as honestly as possible, without thinking about the actual job task or purpose of the task. Do you have any questions?

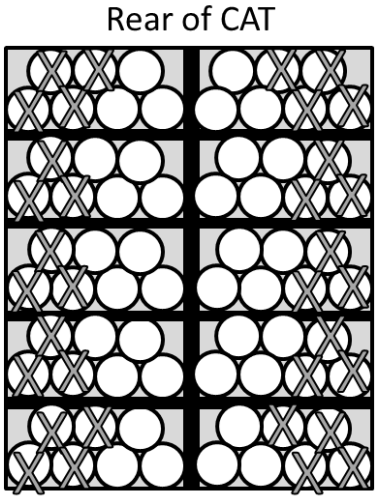


Figure A. Design of FAASV layout

Move Under Direct Fire

The purpose of this task is to determine the relationship between performance of a test designed to simulate moving 100 m under direct fire and simple predictor tests. Make sure the chest strap of your heart rate monitor is tight and your heart rate is displayed on the watch (check now). You will begin the test lying in an unsupported prone fighting position.

When told to begin, you will rise and sprint to the first marker. Get right next to the marker and assume a kneeling fighting position. After 5 seconds, we will cue you to run to the next marker. You will sprint, get right next to the 2nd marker, and again assume a kneeling fighting position. You will continue sprinting between markers in a similar manner, cycling between 1 prone, and 2 kneeling positions, until you have completed the entire course. The signs next to each cone will instruct you whether to kneel or get prone. When getting up, you may not use the barrel of the gun for support. On the final sprint, run straight through the finish line.

You should perform the task as quickly as possible while maintaining your safety, but choose a pace at which you can complete the task. Once you start the test, do not stop unless it is an emergency. You should continue even if you stumble, as you may not be allowed to restart. Upon completion of the task, you will be asked for your heart rate. You will also be asked to rate your physical effort on a scale from 6-20. This feeling should reflect your total amount of exertion, combining all sensations and feelings of physical stress and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity. It's your own feeling that is important, not how it compares to other people. Be as accurate as you can (show scale). Look at this rating scale: 6 means "no exertion at all," and 20 means "maximal exertion."

> 9 corresponds to "very light" exercise. For most healthy people it represents walking slowly at their own pace for several minutes.
>
> 13 corresponds to "somewhat hard" exertion, but it still feels OK to continue.
>
> 17 corresponds to "very hard" or difficult exercise. A healthy person can still go on but they really have to push themselves. It feels very strenuous and the person is very tired.
>
> 19 corresponds to very strenuous exercise. To most people it is the most strenuous exercise they have ever experienced.

Try to rate your feeling of exertion as honestly as possible, without thinking about the actual job task or purpose of the task. Do you have any questions?

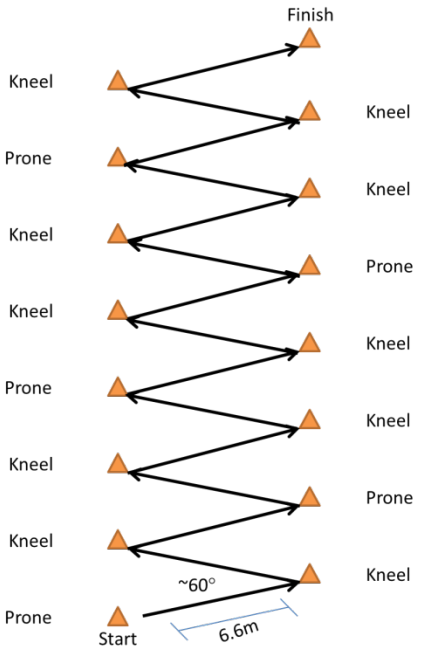


Figure A. Course Diagram Option 1

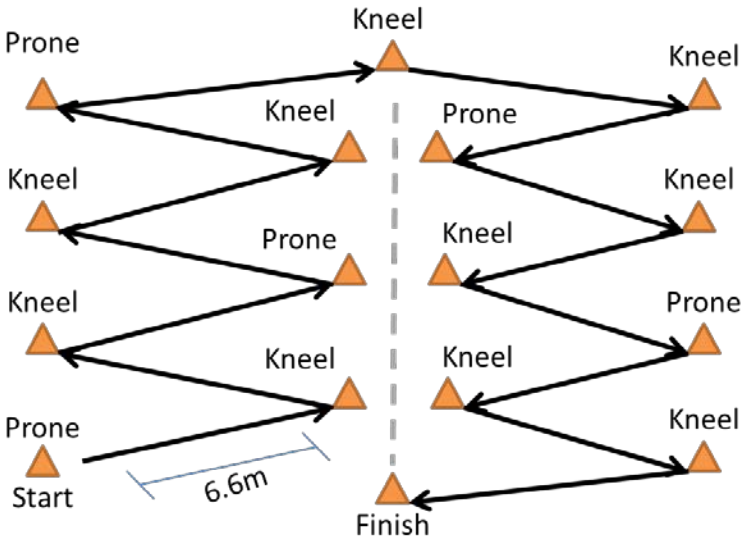


Figure B. Course Diagram Option 2

Beep Test

The purpose of this task is to determine the ability of the beep test to predict performance of the physically demanding tasks of a 13B and 13F. You will jog, run, and then sprint continuously between the two lines 20 m apart in time to recorded beeps. This test will require that you push yourself to your maximal ability and you should be winded at the end of the test. The audio recording will tell you when to begin. The test start begins with a slow warmup. The beeps will increase in speed every level, which is about every minute. This will be indicated on the audio recording with a different sound. Each shuttle within a level is at the same speed.

You must cross the opposite line before the beep occurs and you cannot leave the line until the beep sounds. If you do not make it to the line before the beep, I will call out your ID number and give you a warning (Example: "352 Warning #1"; "352 Warning #2"). When you miss 3 beeps *in a row*, you will be informed by the investigator that the test is over ("352 you're done!"). At any point, you may choose to stop on your own if you do not feel like you can continue.

After completing, an investigator will ask you to read your heart rate off of your heart rate monitor. Do you have any questions?

Standing Long Jump

The purpose of this task is to determine the ability of the standing long jump to predict performance of the physically demanding tasks of a 13B and 13F. You will stand behind the line with your feet slightly apart. You will jump as far as possible with a two foot take-off and landing. You are allowed to swing your arms and bend your knees to provide forward push. If you fall, we will ask you to repeat the attempt. You will be given two practice jumps and then you will perform three maximal effort jumps that will be recorded. Do you have any questions?

Upright Pull at 38 cm

The purpose of this task is to determine the ability of an upright pull to predict performance of the physically demanding tasks of a 13B and 13F. You will stand with your feet about 50 cm apart, and squat down flexing at the knees and hips. You will grasp the handles with the palms facing in opposite direction approximately equidistant from the center of the handle. Then place your buttocks against the wall to the rear, and straighten your back and look straight ahead. I will give you a "ready-three-two-one-pull," without jerking build up to your maximal force in about 2 seconds, maximally pull for about 3 more seconds and then relax. You will perform the test three times, if you improperly performed the test you will be asked to take a short rest and repeat the attempt. Do you have any questions?

Isometric Biceps Curl

The purpose of this task is to determine the ability of an isometric biceps curl to predict performance of the physically demanding tasks of a 13B and 13F. You will stand holding onto a bar with palms facing up, elbows at right angle and forearms parallel to the floor. I will adjust the instrument to fit you. You will stand with your feet hip width apart without bending your knees or hips. I will give you a "ready-three-two-one-pull," without jerking or leaning back, build up to your maximal force in about 2 seconds, pull for about 3 more seconds and then relax. You will perform the test three times, if you improperly performed the test you will be asked to take a short rest and repeat the attempt. Do you have any questions?

2-Minute Arm Ergometer

The purpose of this task is to determine the ability of an arm ergometer test to predict performance of the physically demanding tasks of a 13B and 13F. The test involves cranking an Arm Ergometer, as fast as possible, for two minutes. You will kneel in front of the arm ergometer and I will adjust the handles to fit you. After, you will perform ten revolutions to familiarize yourself with the test and to provide a warm up. When you are ready I will say "ready-three-two-one-GO," you will then have two minutes to perform as many revolutions as possible. We will inform you when you are half way, and when you have 30 and 15 seconds left. We will record the number of revolutions at 2 minutes. Do you have any questions?

Handgrip

The purpose of this task is to determine the ability of handgrip strength to predict performance of the physically demanding tasks of a 13B and 13F. The base of the handle will be set so it rests on the heel of the palm and the handle will rest on the middle of the four fingers. You will then hold it so that your elbow is flexed to 90 degrees, the device is oriented up and down, and your shoulder and wrist are in a relaxed position. When I say go, you will squeeze your hand as tight as possible, while avoiding use of any other part of the body. If I see that you are using other muscles, you will be asked to repeat the measure. You repeat this 3 times in each hand, alternating hands. Do you have any questions?

1-Minute Sit-Up

The purpose of this task is to determine the ability of using a 1-minute sit-up score to predict performance of the physically demanding tasks of a 13B and 13F. You will begin by lying down in the proper sit-up position. You should be lying on your back with your knees bent at a 90-degree angle. Place your feet under the tables at the end of the mat. During the test, your fingers must be interlocked behind your head and the backs of your hands must touch the ground. On the command "go" you should begin raising your upper body forward to the vertical position. After reaching the vertical position, you should lower-body until the bottom of your shoulder blades touch the ground. You must use proper sit-up technique for the repetition to count. If you need to rest, you may do so only in the up position without resting your arms on your legs to

hold yourself up. You may not rest in the down position. You will have 1-minute to complete as many as possible.

You should perform the task as long as you can while maintaining your safety. If at any point you feel you are unable to continue, the test will be terminated. Do you have any questions?

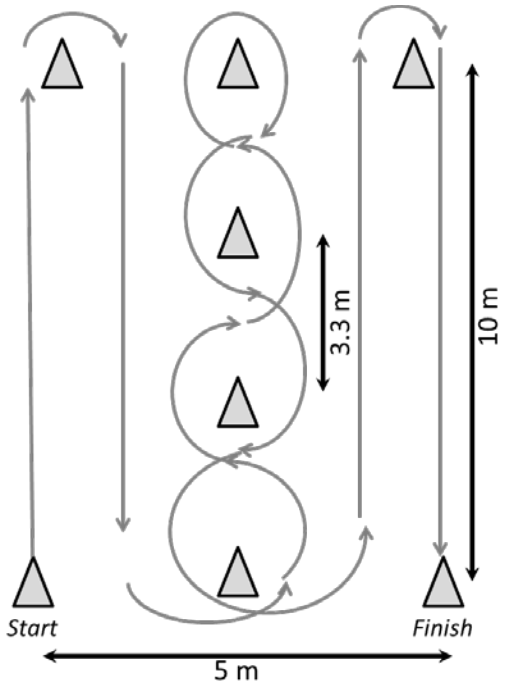
1-Minute Push-Up

The purpose of this task is to determine the ability of using a 1-minute push-up score to predict performance of the physically demanding tasks of a 13B and 13F. You will begin by assuming a front-leaning rest position by placing your hands shoulder-width apart, with your feet together or up to 12 inches apart. When I say "go", you should begin the push-up by bending your elbows and lowering your entire body as a single unit until your upper arms are at least parallel to the ground. Then, you should return to the starting position by raising your entire body until your arms are fully extended. At the end of each repetition, the scorer will state the number of push-ups correctly performed. Push-ups in which the arms are not parallel to the ground or the elbows are not fully locked at the end of a repetition will not be scored. You may rest at any time, however during rest breaks your hands and feet must not break contact with the ground. You will have 1-minute to complete as many as possible.

You should perform the task as long as you can while maintaining your safety. If at any point you feel you are unable to continue, the test will be terminated. Do you have any questions?

Illinois Agility Test

The purpose of this test is to assess the ability of the Illinois agility test to predict performance of the physically demanding tasks of a 13B and 13F. During this test, you will run through a series of cones (*show Soldiers Figure below, and point out the course as you explain the next section*). You will start the test lying on your stomach with your hands in a push-up position and facing the first far cone. I will give you a "Three-Two-One-Go" and you will sprint the far cone, then sprint back to this middle cone (point to it). Do a zig-zag up and back in the center cones. Sprint to the far cone (point to it) and then sprint back through the finish line (point to it). During the test, run through the course as fast as you can, while maintaining safety and without knocking over the cones. If at any point you feel you are unable to continue, the test will be terminated. If you make a mistake during the test we will ask you to stop and repeat the attempt. Do you have any questions? If you wouldn't mind following me, I will walk you through the course before we begin.



300m Sprint

The purpose of this test is to assess the ability of the 300 meter sprint test to predict performance of the physically demanding tasks of a 13B and 13F. You will start the test with the toes of one foot on the starting line, and the other foot either even with or behind the line. When I say 'go', you will run 300 m. The test is complete when you cross the finish line. Run the 300 m as fast as you can, while maintaining safety. If at any point you feel you are unable to continue, the test will be terminated. Do you have any questions?

Resistance Pull

The purpose of this test is to assess the ability of the resistance pull test to predict performance of the physically demanding tasks of a 13B and 13F. You will be asked to run backwards 20-m while holding a 24-kg kettlebell attached to a rope providing resistance.

You will begin with your back facing the direction you will be running. When ready, you will pick up the kettlebell with two hands side by side, and I will give you a "3, 2, 1, Go" countdown. On the "go" command, run backwards as fast as you can while maintaining your safety. I will let you know when you cross the finish line. Time stops when the sled crosses the line, not your body. If you don't cross the line in 90 seconds, I will give you a "5, 4, 3, 2, 1, stop" countdown. On the "stop" command, stop where you are, and I will measure how far you ran. If you fall during the test, attempt to get up and

keep going. If at any point you feel you are unable to continue, the test can be terminated. Do you have any questions?

Powerball Throw

The purpose of this test is to assess the ability of the powerball throw test to predict performance of the physically demanding tasks of a 13B and 13F. During the test, you will be standing with your back facing the direction you will be throwing. Your feet should be shoulder width apart with your heels on the "zero"/ start line.

(Demonstrate while describing motion) You will begin the throw with the ball in both hands, held over your head. While keeping your arms extended, swing the ball down between your legs while flexing your knees, hips and trunk. After you have reached a squatting position, thrust your hips forward, extend your knees and trunk, flex your shoulders, while in one motion, throw the ball back overhead.

You will be given two practice throws. After the practice throws you will be asked to complete three throws for record. If at any point you feel you are unable to continue, the test will be terminated. Do you have any questions?

Squat Lift

The purpose of this task is to determine the ability of a dumbbell squat test to predict performance of the physically demanding tasks of a 13B and 13F. Beginning with a pair of 25-lb dumbbells, you will squat, grasp handles, and complete a set of 3 to 5 squat lifts.

Prior to testing, make sure you are wearing gloves. (Demonstrate while explaining) You will begin by placing feet between the dumbbells about shoulder width apart. Make sure your knees are in line with toes. On the "set" command, bend at the hips and knees, sticking your butt back so that your back is flat or slightly arched. Keep your head up, and grip the dumbbells at your sides with your arms fully extended. When given the "lift" command, lift the dumbbells straight up by extending your knees and hips at the same time. Keep your head angled up. The dumbbells should stay as close to your legs as possible, and your arms should remain extended. When you are standing with your hips and knees fully straight, the test administrator will say "good" and you will squat back down and release the weights in their stands in a safe and controlled manner. If you show poor lifting technique or you drop the weights, we will stop you and you will not receive credit for that lift.

After you have completed the first weight, you will be given a short rest and then you'll be asked to lift a pair of dumbbells 10 lb heavier. The maximum lift for this test is a pair of 110-lb dumbbells for a total load of 220 lb. If you fail to lift a load, you may try one more time after a brief rest.

Don't overexert yourself trying to lift a weight that is too heavy. If you feel any pain or discomfort, you should put the dumbbell down and stop performing the task. Do you have any questions?

Medicine Ball Throw

The purpose of this test is to assess the ability of the Medicine Ball Throw test to predict performance of the physically demanding tasks of a 13B and 13F. During the test, you will sit in the chair with your back against the back rest and both feet on the ground. During throw and follow through your back must stay in contact with the chair. You will hold the medicine ball with both hands. When I say Go, you will touch the medicine ball to your chest and then push/throw it as far forward as possible. It is recommended that you throw it up at a 45° angle to get maximum distance. The distance between the front of the chair and the landing point of the medicine ball will be measured. You will be given two practice throws. After the practice throws you will be asked to complete three throws for record. While throwing the medicine ball, you must keep your back against the chair. If you fail to maintain contact with the back of the chair you will be asked to repeat the throw. If at any point you feel you are unable to continue, the test will be terminated. Do you have any questions?

APPENDIX L. QUESTIONNAIRES AND SURVEYS FROM STUDY 3

Physical Performance Standards Study

Ft Carson, CO February 2015

Demographics Sheet

Subject ID_____

Sex _____

Age _____ Date of Birth: _____

Race (circle one):

Caucasian African American Hispanic Asian

MOS _____ Rank _____

Date of Last Army Physical Fitness Test_____

APFT Total Score _____

Push-ups (reps) _____

Sit-ups (reps) _____

2-Mile Run Time (min:sec) _____

MOS – 13B

Demographic Data: Please complete the following items.

Subject ID_____

Total time of military service (years) _____

Total time in current MOS (years) _____

Total time deployed in current MOS (months) _____

Deployment locations:_____ _____ _____

Directions: Please indicate whether you have performed these tasks in training or while deployed and the number of times you have performed them in each.

		Performed During			
Master Task Number/Master Task		*Training (Y/N)*	*# of times*	*Deployed (Y/N)*	*# of times*
2	*Employ hand grenades*				
3	*Prepare a fighting position (Fill and Emplace Sandbags)*				
4a	*Drag casualty to safety (dismounted)*				
21	*Transfer ammunition with an M992 Carrier (load M795 HE rounds)*				
22	*Emplace 155mm Howitzer (lift wheel assembly)*				
23	*Displace 155mm Howitzer(recover spade trail arm and blade)*				
24	*Set up Gun Laying Positioning System (GLPS)*				

MOS – 13F

Demographic Data: Please complete the following items.

Subject ID_____

Total time of military service (years) _____

Total time in current MOS (years) _____

Total time deployed in current MOS (months) _____

Deployment locations:_____ _____ _____

Directions: Please indicate whether you have performed these tasks in training or while deployed and the number of times you have performed them in each setting.

		Performed During			
Master Task Number/Master Task		*Training (Y/N)*	*# of times*	*Deployed (Y/N)*	*# of times*
1	*Conduct a Roadmarch of at least 4 miles wearing a fighting load*				
2	*Employ hand grenades*				
3	*Prepare a fighting position (Fill and Emplace Sandbags)*				
4a	*Drag casualty to safety (dismounted)*				
4b	*Remove a casualty from a vehicle (mounted)*				
5	*Lift, carry, and install the barrel of a 25mm gun*				
6	*Remove the feeder assembly of a 25mm gun*				
7	*Load 25mm H-EIT tracer ammunition cans*				
25	*Establish observation point [carry AN/PED-1 (LLDR)]*				
26	*PrepareM1200 Armored Knight Vehicle for operation [Install Fire Support Sensor System (FSS)]*				

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study
13 Series Criterion Tasks

Sandbag Carry

Soldier Weight
***Fighting Load NO WEAPON* (lbs): _____**

Stopwatch Number: _____ Stopwatch Record #: _____

Time to Finish (Min:Sec)	*RPE (6-20)*	*Pre HR (bpm)*	*Post HR (bpm)*
___ : ___			

STAPLE STOPWATCH PRINTOUT TO STOPWATCH SHEET. NOTE ANY ISSUES WITH PRINTOUT BELOW.

Comments:

Move Under Direct Fire

Soldier Weight
***Fighting Load WITH WEAPON* (lbs): _____**

Stopwatch Number: _____ Stopwatch Record #: _____

	Time to Finish (min:sec)	*RPE (6-20)*	*HR (bpm)*
Baseline			
Finish	:		

Comments:

Last Revised 31AUG2015

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study
13 Series Criterion Tasks

Casualty Extraction

Soldier Weight
***Fighting Load NO WEAPON* (lbs): _____**

Rep	*Bag Weight (lbs)*	*Completed (Y/N)*	*RPE (0-10)*
1			
2			
3			
4			
5			
6			
7			

Comments:

Casualty Drag

Soldier Weight
***Fighting Load WITH WEAPON* (lbs): _____**

	Distance (m)	*Time to Finish (sec, up to 60)*	*RPE (0-10)*	*HR (bpm)*
Baseline				
Finish		:		

Comments:

Last Revised 31AUG2015

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study
13 Series Criterion Tasks

Transfer Ammo with an M992 Carrier Ammunition Tracked (CAT) (30 Rounds)

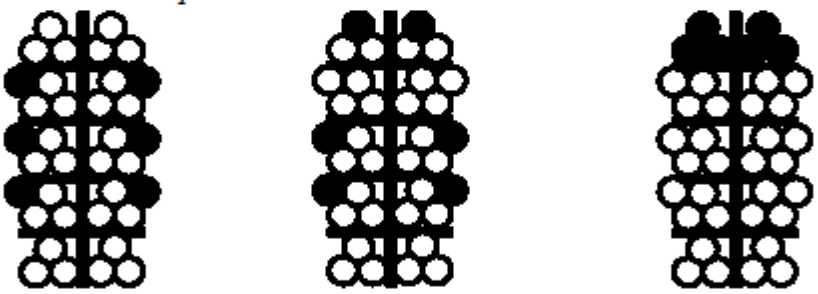
Soldier Weight in *Mission Specific PPE* (lbs): _____

Stopwatch Number: _____ Stopwatch Record #: _____

	Time (min:sec) in Shift *Up to 5:00*	*Total* Rounds Completed	RPE (6-20)	HR (bpm)
Baseline				
Shift 1 (0:00-5:00)	:			
Shift 2 (7:30-12:30)	:			
Shift 3 (15:00-20:00)	:			

Mark filling pattern. If all 30 shells not Loaded Mark with an X which slots were filled

☐ *Filled to Top* ☐ *Second Row* ☐ *Third Row*



STAPLE STOPWATCH PRINTOUT TO STOPWATCH SHEET. NOTE ANY COMMENTS OR ISSUES BELOW.

Comments:

Last Revised 31AUG2015

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study
13 Series Predictive Tasks

Weight in PT Uniform: _____

Beep Test

Check as Shuttle Completed

Level #	Shuttle # 1	2	3	4	5	6	7	8	9	10	11	12	13
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													

Beep Test	*Level #*	*Shuttle #*	*Heart Rate (bpm)*
Baseline			
Finish			

Comments:

Last Revised 07AUG2015

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study
13 Series Predictive Tasks

				If Necessary	
	Trial 1	*Trial 2*	*Trial 3*	*Trial 4*	*Trial 5*
Medicine Ball Put (cm)					
Illinois Agility (min:sec)	:				

Comments:

				If Necessary	
	Trial 1	*Trial 2*	*Trial 3*	*Trial 4*	*Trial 5*
Upright Pull (lbs)					
Isometric Bicep Curl (lbs)					

Comments:

				If Necessary	
	Trial 1	*Trial 2*	*Trial 3*	*Trial 4*	*Trial 5*
Standing Broad Jump (m)					
One Minute Push Ups (#)					

Comments:

Resistance Pull Test	*Time* (min:sec)	*Distance (m)* *(if not completed)*	*Heart Rate (bpm)*
Baseline			
Finish			

Comments:

Last Revised 31AUG2015

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study
13 Series Predictive Tasks

				If Necessary	
	Trial 1	*Trial 2*	*Trial 3*	*Trial 4*	*Trial 5*
Power Ball Throw (cm)					
One Minute Sit-Ups (#)					

Comments:

Arm Endurance	*Revolutions (#)*	*Heart Rate (bpm)*
Baseline		
Minute 1 (Halfway)		
Minute 2 (Finish)		

				If Necessary	
	Left 1	*Left 2*	*Left 3*	*Left 4*	*Left 5*
Handgrip (kg)					
	Right 1	*Right 2*	*Right 3*	*Right 4*	*Right 5*

Comments:

	Timer 1 (Start Line)	*Timer 2 (Finish Line)*
300 Meter Run (min:sec)	:	:

Comments:

Last Revised 31AUG2015

Subject ID: _____ Date: _____

USARIEM MOS Physical Performance Standards Study
13 Series Predictive Tasks

Squat Lift (lbs)	*Completed (Y/N)*	*RPE (0-10)*
50		
60		
80		
100		
120		
140		
160		
180		
200		
220		

Comments:

Last Revised 31AUG2015

Date: _____ Data Collector: _____

USARIEM MOS Physical Performance Standards Study

Tactical Road March: Start Data Sheet

Subject #	Start Time	HR
	:	
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Page ___ of ___

Date: _____ Data Collector: _____

USARIEM MOS Physical Performance Standards Study

Tactical Road March: Finish Data Sheet

Subject #	Finish Time	RPE	HR
	:		
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Page ___ of ___

USARIEM MOS Physical Performance Standards Study
Tactical Road March: Start Discomfort Scale

Date: _____ **Data Collector:** _____

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Subject ID	Neck	Left Shoulder	Right Shoulder	Left Upper Arm	Right Upper Arm	Left Forearm	Right Forearm	Left Wrist	Right Wrist	Left Hand	Right Hand	Upper Back	Mid/Lower Back	Hips/Waist	Buttocks	Left Thigh	Right Thigh	Knees	Left Leg/Foot	Right Leg/Foot	Ankles

Page ____ of ____

USARIEM MOS Physical Performance Standards Study
Tactical Road March: Finish Discomfort Scale

Date: _____ **Data Collector:** _____

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Subject ID	Neck	Left Shoulder	Right Shoulder	Left Upper Arm	Right Upper Arm	Left Forearm	Right Forearm	Left Wrist	Right Wrist	Left Hand	Right Hand	Upper Back	Mid/Lower Back	Hips/Waist	Buttocks	Left Thigh	Right Thigh	Knees	Left Leg/Foot	Right Leg/Foot	Ankles

Page ____ of ____

APPENDIX M. ADDITIONAL STATISTICAL ANALYSIS

13B Predictor Tests among other Predictor Tests

		Beep Test (#)	Med Ball Put (cm)	Illinois Agility (min)	Upright Pull (lb)	Biceps Curl (lb)	SLJ[1] (cm)	Push-up (#)
Beep Test (#)	r	—	0.49**	-0.50**	0.47**	0.49**	0.60**	0.61**
	n	—	196	196	196	196	196	196
Med Ball Put (cm)	r	0.49**	—	-0.53**	0.85**	0.82**	0.69**	0.59**
	n	196	—	196	196	196	196	196
Illinois Agility (min)	r	-0.50**	-0.53**	—	-0.53**	-0.55**	-0.70**	-0.53**
	n	196	196	—	196	196	196	196
Upright Pull (lb)	r	0.47**	0.85**	-0.53**	—	0.89**	0.70**	0.64**
	n	196	196	196	—	197	197	197
Biceps Curl (lb)	r	0.49**	0.82**	-0.55**	0.89**	—	0.69**	0.69**
	n	196	196	196	197	—	197	197
SLJ[1] (cm)	r	0.60**	0.69**	-0.70**	0.70**	0.69**	—	0.63**
	n	196	196	196	197	197	—	197
Push-up (#)	r	0.61**	0.59**	-0.53**	0.64**	0.69**	0.63**	—
	n	196	196	196	197	197	197	—
Resist Pull (m/sec)	r	0.31**	0.38**	-0.16*	0.42**	0.41**	0.35**	0.31**
	n	182	182	182	183	183	183	183
Powerball (cm)	r	0.50**	0.89**	-0.57**	0.87**	0.85**	0.77**	0.62**
	n	196	196	196	197	197	197	197
Sit-up (#)	r	0.47**	0.29**	-0.32**	0.29**	0.30**	0.40**	0.50**
	n	195	195	195	196	196	196	196
ArmErg (RP2m)	r	0.56**	0.80**	-0.50**	0.78**	0.76**	0.59**	0.61**
	n	196	196	196	197	197	197	197
Handgrip (lb)	r	0.46**	0.76**	-0.49**	0.79**	0.75**	0.58**	0.55**
	n	194	194	194	195	195	195	195
300m Sprint (m)	r	-0.73**	-0.58**	0.61**	-0.59**	-0.60**	-0.75**	-0.66**
	n	196	196	196	196	196	196	196
Squat Lift (lb)	r	0.54**	0.80**	-0.49**	0.84**	0.81**	0.68**	0.67**
	n	196	196	196	197	197	197	197

**p<0.01; *p<0.05

[1] Standing Long Jump

13B Predictor Tests among other Predictor Tests (continued)

		Resist. Pull (m/sec)	Power-ball Throw (cm)	Sit-up (#)	ArmErg RP2m	Hand-grip (lb)	300m Sprint (min)	Squat Lift (lb)
Beep Test (#)	r	0.31**	0.50**	0.47**	0.56**	0.46**	-0.73**	0.54**
	n	182	196	195	196	194	196	196
Med Ball Put (cm)	r	0.38**	0.89**	0.29**	0.80**	0.76**	-0.58**	0.80**
	n	182	196	195	196	194	196	196
Illinois Agility (min)	r	-0.16**	-0.57**	-0.32**	-0.50**	-0.49**	0.61**	-0.489**
	n	182	196	195	196	194	196	196
Upright Pull (lb)	r	0.42**	0.87**	0.29**	0.78**	0.79**	-0.59**	0.84**
	n	183	197	196	197	195	196	197
Biceps Curl (lb)	r	0.41**	0.85**	0.30**	0.76**	0.75**	-0.60**	0.81**
	n	183	197	196	197	195	196	197
SLJ[1] (cm)	r	0.35**	0.77**	0.40**	0.59**	0.58**	-0.75**	0.68**
	n	183	197	196	197	195	196	197
Push-up (#)	r	0.31**	0.62**	0.50**	0.61**	0.55**	-0.66**	0.67**
	n	183	197	196	197	195	196	197
Resist Pull (m/sec)	r	---	0.44**	0.16**	0.43**	0.45**	-0.33**	0.44**
	n	---	183	182	183	181	182	183
Powerball (cm)	r	0.44**	---	0.30**	0.77**	0.75**	-0.59**	0.81**
	n	183	---	196	197	195	196	197
Sit-up (#)	r	0.16*	0.30**	---	0.32**	0.28**	-0.44**	0.29**
	n	182	196	---	196	194	195	196
ArmErg (RP2m)	r	0.43**	0.77**	0.32**	---	0.73**	-0.57**	0.75**
	n	183	197	196	---	195	196	197
Handgrip (lb)	r	0.45**	0.75**	0.28**	0.73**	---	-0.53**	0.73**
	n	181	195	194	195	---	194	195
300m Sprint (m)	r	-0.33**	-0.59**	-0.44**	-0.57**	-0.53**	---	-0.65**
	n	182	196	195	196	194	---	196
Squat Lift (lb)	r	0.44**	0.81**	0.29**	0.75**	0.73**	-0.65**	---
	n	183	197	196	197	195	196	---

**p<0.01; *p<0.05

[1] Standing Long Jump

13F Predictor Tests among other Predictor Tests

		Beep Test (#)	Med Ball Put (cm)	Illinois Agility (min)	Upright Pull (lb)	Biceps Curl (lb)	SLJ[1] (cm)	Push-up (#)
Beep	r	---	0.40**	-0.61**	0.39**	0.41**	0.62**	0.53**
Test (#)	n	---	142	142	142	142	142	142
Med Ball	r	0.40**	---	-0.59**	0.84**	0.85**	0.66**	0.57**
Put (cm)	n	142	---	144	144	144	144	144
Illinois	r	-0.61**	-0.59**	---	-0.54**	-0.57**	-0.78**	-0.60**
Agility (min)	n	142	144	---	144	144	144	144
Upright	r	0.39**	0.84**	-0.54**	---	0.88**	0.65**	0.52**
Pull (lb)	n	142	144	144	---	145	145	145
Biceps	r	0.41**	0.85**	-0.57**	0.88**	---	0.63**	0.63**
Curl (lb)	n	142	144	144	145	---	145	145
SLJ[1]	r	0.62**	0.66**	-0.78**	0.65**	0.63**	---	0.62**
(cm)	n	142	144	144	145	145	---	145
Push-up	r	0.53**	0.57**	-0.60**	0.52**	0.63**	0.62**	---
(#)	n	142	144	144	145	145	145	---
Resist Pull	r	0.40**	0.60**	-0.46**	0.58**	0.58**	0.50**	0.37**
(m/sec)	n	141	143	143	144	144	144	144
Powerball	r	0.42**	0.89**	-0.60**	0.87**	0.87**	0.72**	0.59**
(cm)	n	142	144	144	145	145	145	145
Sit-up	r	0.45**	0.25**	-0.43**	0.19*	0.26**	0.48**	0.50**
(#)	n	141	143	143	144	144	144	144
ArmErg	r	0.51**	0.78**	-0.56**	0.75**	0.75**	0.55**	0.54**
(RP2m)	n	142	144	144	145	145	145	145
Handgrip	r	0.40**	0.79**	-0.55**	0.81**	0.77**	0.56**	0.47**
(lb)	n	142	144	144	145	145	145	145
300m	r	-0.72**	-0.57**	0.74**	-0.51**	-0.56**	-0.77**	-0.61**
Sprint (m)	n	142	144	144	144	144	144	144
Squat	r	0.43**	0.80**	-0.53**	0.82**	0.83**	0.64**	0.59**
Lift (lb)	n	142	144	144	145	145	145	145

**p<0.01; *p<0.05

[1] Standing Long Jump

13F Predictor Tests among other Predictor Tests (cont.)

		Resist. Pull (m/sec)	Power-ball Throw (cm)	Sit-up (#)	ArmErg RP2m	Hand-grip (lb)	300m Sprint (min)	Squat Lift (lb)
Beep	r	0.40**	0.42**	0.45**	0.51**	0.40**	-0.72**	0.43**
Test (#)	n	141	142	141	142	142	142	142
Med Ball	r	0.60**	0.89**	0.25**	0.78**	0.79**	-0.57**	0.80**
Put (cm)	n	143	144	143	144	144	144	144
Illinois	r	-0.46**	-0.60**	-0.43**	-0.56**	-0.55**	0.74**	-0.53**
Agility (min)	n	143	144	143	144	144	144	144
Upright	r	0.58**	0.87**	0.19*	0.75**	0.81**	-0.51**	0.82**
Pull (lb)	n	144	145	144	145	145	144	145
Biceps	r	0.58**	0.87**	0.26**	0.75**	0.77**	-0.56**	0.83**
Curl (lb)	n	144	145	144	145	145	144	145
SLJ[1]	r	0.50**	0.72**	0.48**	0.55**	0.56**	-0.77**	0.64**
(cm)	n	144	145	144	145	145	144	145
Push-up	r	0.37**	0.59**	0.50**	0.54**	0.47**	-0.61**	0.59**
(#)	n	144	145	144	145	145	144	145
Resist Pull	r	---	0.60**	0.15	0.60**	0.51**	-0.45**	0.63**
(m/sec)	n	---	144	143	144	144	143	144
Powerball	r	0.60**	---	0.29**	0.74**	0.76**	-0.57**	0.80**
(cm)	n	144	---	144	145	145	144	145
Sit-up	r	0.15	0.29**	---	0.24**	0.24**	-0.48**	0.23**
(#)	n	143	144	---	144	144	143	144
ArmErg	r	0.60**	0.74**	0.24**	---	0.72**	-0.56**	0.75**
(RP2m)	n	144	145	144	---	145	144	145
Handgrip	r	0.51**	0.76**	0.24**	0.72**	---	-0.50**	0.72**
(lb)	n	144	145	144	145	---	144	145
300m	r	-0.45**	-0.57**	-0.48**	-0.56**	-0.50**	---	-0.57**
Sprint (m)	n	143	144	143	144	144	---	144
Squat	r	0.63**	0.80**	0.23**	0.75**	0.72**	-0.57**	---
Lift (lb)	n	144	145	144	145	145	144	---

**p<0.01; *p<0.05

[1] Standing Long Jump

13B Criterion Tasks among other Criterion Tasks

		Cas Drag (m/sec)	FAASV (round/min)
Cas Drag (m/sec)	r	---	0.75**
	n	---	197
FAASV (round/min)	r	0.75**	---
	n	197	---

**p<0.01; *p<0.05

13F Criterion Tasks among other Criterion Tasks

		Foot March (min)	Sandbag (min)	Move Under Fire (min)	Cas Evac (lb)	Cas Drag (m/sec)
Foot March (min)	r	---	0.64**	0.69**	-0.64**	-0.68**
	n	---	145	145	145	145
Sandbag (min)	r	0.64**	---	0.68**	-0.59**	-0.66**
	n	145	---	145	145	145
Move Under Fire (min)	r	0.69**	0.68**	---	-0.75**	-0.70**
	n	145	145	---	145	145
Cas Evac (lb)	r	-0.64**	-0.59**	-0.75**	---	0.75**
	n	145	145	145	---	145
Cas Drag (m/sec)	r	-0.68**	-0.66**	-0.70**	0.75**	---
	n	145	145	145	145	---

**p<0.01; *p<0.05

APPENDIX N. SME EVALUATION SHEETS OF SOLDIER PERFORMANCE AND RESULTS OF EVALUATIONS ON CRITERION TASKS FROM STUDY 3

SME Task Rating – TACTICAL MOVEMENT

Rate the soldier on his/her pace to complete the 4-Mile Tactical Movement and the likelihood that the Soldier will reach the objective on time with enough physical reserve to conduct the mission. Use the definitions for Certain, Very Likely, Likely, Unlikely, and Very Unlikely listed on the rating form.

Volunteer Number	Certain Pace was much faster than needed to reach objective on time and with ample physical reserve to conduct the mission [Top 10% soldiers]	Very Likely Pace was faster than needed to reach objective on time and with more than adequate physical reserve to conduct the mission	Likely Pace was adequate to reach objective on time with adequate physical reserve to conduct the mission [Mid-level soldiers]	Unlikely Pace was slower than needed to reach objective on time and with less than adequate physical reserve to conduct the mission	Very Unlikely Pace was inadequate to reach objective on time and with no physical reserve to conduct the mission; mission failed [Bottom 5% of soldiers]

SME Task Rating - SANDBAG CARRY

INSTRUCTIONS: Record the helmet number in the section titled "Volunteer Number" then rate the Soldier based on his or her performance by checking your level of agreement for the following statement:

Pace: This Soldier is performing this task at a pace that is likely to allow for completion of an emplacement in the time allotted for preparation for protection from and engagement with the enemy.

Ability: This Soldier is performing this task with technique that will create effective bunker and does not risk injury to themselves.

	Pace					Ability				
Volunteer Number	Certain Pace was much faster than needed and emplacement would be completed far ahead of schedule [Top 10% soldiers]	Very Likely Pace was faster than needed and emplacement would be completed ahead of schedule	Likely Pace was adequate to complete emplacement and emplacement would be completed on schedule [Mid-level soldiers]	Unlikely Pace was slower than needed and emplacement would be completed behind schedule	Very Unlikely Pace was inadequate and assistance would be needed to complete emplacement [Bottom 5% of soldiers]	Maintained proper technique to create bunker to standard and mitigate injury throughout all of the task	Maintained proper technique most of the time to create bunker to standard and mitigate injury during the task	Maintained proper technique half of the time to create bunker to standard and mitigate injury during the task	Occasionally maintained proper technique to create effective bunker and mitigate injury during the task	Rarely maintained proper technique to create effective bunker and mitigate injury during the task

SME Task rating - CASUALTY DRAG

INSTRUCTIONS:

Record the helmet number in the section titled "Volunteer Number." Rate the soldier on his/her pace to complete the casualty drag under fire and the likelihood that the victim and Soldier will survive. Use the definitions for Certain, Very Likely, Likely, Unlikely, and Very Unlikely listed on the rating form.

	Pace					Ability				
Volunteer Number	Certain Pace was much faster than needed to rescue the victim [Top 10% soldiers]	Very Likely Pace was faster than needed to rescue the victim	Likely Pace was adequate to rescue the victim [Mid-level soldiers]	Unlikely Pace was slower than needed to rescue victim under fire, but adequate not under fire	Very Unlikely Pace was inadequate to rescue victim [Bottom 5% of soldiers]	Maintained proper technique to rescue the victim and mitigate injury throughout all of the task	Maintained proper technique most of the time to rescue the victim and mitigate injury during the task	Maintained proper technique half of the time to rescue the victim and mitigate injury during the task	Occasionally maintained proper technique to rescue the victim and mitigate injury during the task	Rarely maintained proper technique to rescue the victim and mitigate injury during the task

SME Task Rating – Move Under Fire

INSTRUCTIONS: Record the helmet number in the section titled "Volunteer Number" then rate the Soldier based on his or her performance by checking your level of agreement for the following statement:

Pace: This Soldier is performing this task at a pace that is likely to provide them adequate protection from enemy fire and still maintain adequate physical reserve to engage the enemy.

Ability: This Soldier is performing this task with technique that does not risk injury to themselves.

	Pace					Ability				
Volunteer Number	Certain Pace was much faster than needed and soldier would be at much reduced risk of being shot/killed [Top 10% soldiers]	Very Likely Pace was faster than needed and soldier be at reduced risk of being shot/killed	Likely Pace was adequate and Soldier would be at average risk of being shot/killed [Mid-level soldiers]	Unlikely Pace was slower than needed and Soldier would be at somewhat higher risk of being shot/killed	Very Unlikely Pace was inadequate and Soldier would be at very high risk of being shot/killed [Bottom 5% of soldiers]	Maintained proper technique to mitigate injury throughout all of the task	Maintained proper technique most of the time to mitigate injury during the task	Maintained proper technique half of the time to mitigate injury during the task	Occasionally maintained proper technique to mitigate injury during the task	Rarely maintained proper technique to mitigate injury during the task

SME Task Rating – Evacuate a Casualty from a Vehicle Turret

INSTRUCTIONS: Record the helmet number in the section titled "Volunteer Number" then rate the Soldier based on his or her performance by checking your level of agreement for the following statement:

Ability: This Soldier is performing this task with technique that does not risk injury to themselves and would result in removal of the casualty.

	Ability				
Volunteer Number	Maintained proper technique to mitigate injury to self and casualty **throughout all of the task**	Maintained proper technique **most of the time** to mitigate injury to self and casualty during the task	Maintained proper technique **half of the time** to mitigate injury to self and casualty during the task	**Maintained minimally acceptable** technique to mitigate injury to self and casualty less than half the time	Technique would **likely result in injury** to self and inability to remove casualty

SME Task Rating – Load the CAT task

INSTRUCTIONS: Record the helmet number in the section titled "Volunteer Number" then rate the Soldier based on his or her performance by checking your level of agreement for the following statement:

Pace: This Soldier is performing this task at a pace that is likely to allow for completion of the loading task without risking unnecessary exposure to the enemy.

Ability: This Soldier is performing this task with technique that does not risk injury to themselves.

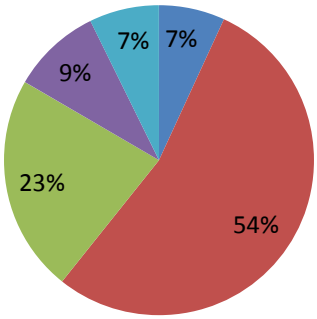
	Pace					Ability				
Volunteer Number	**Certain** Pace was much faster than needed and reload would be completed far above the time standard [Top 10% soldiers]	**Very Likely** Pace was faster than needed and reload would be completed above the time standard	**Likely** Pace was adequate to complete emplacement and reload would be completed to the time standard [Mid-level soldiers]	**Unlikely** Pace was slower than needed and reload would be completed below the time standard	**Very Unlikely** Pace was inadequate and assistance would be needed to complete reload [Bottom 5% of soldiers]	Maintained proper technique to mitigate injury **throughout the task**	Maintained proper technique to mitigate injury during **most of the task**	Maintained proper technique to mitigate injury during about **half of the task**	**Occasionally** maintained proper technique to mitigate injury during the task	**Rarely** maintained proper technique to mitigate injury during the task

Pace

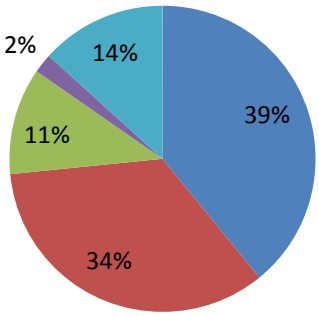
This Soldier is performing this task at a pace that is likely to (complete the task) and still maintain adequate physical reserve to engage the enemy.

- **Certain**: [Top 10% Soldiers]
- **Very Likely**:
- **Likely**: [Mid-level Soldiers]
- **Unlikely**:
- **Very Unlikely**: [Bottom 5% of Soldiers]

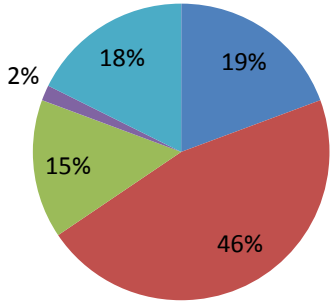
Sandbags



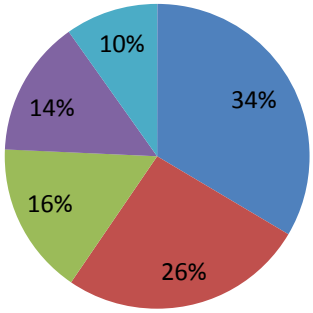
Casualty Drag



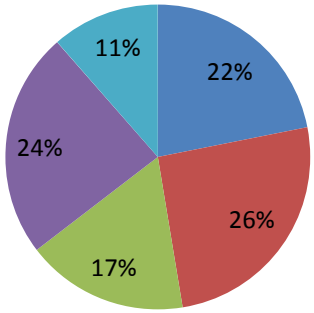
Casualty Evacuation



Move Under Fire



Load the FAASV

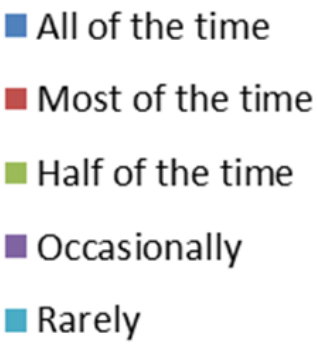


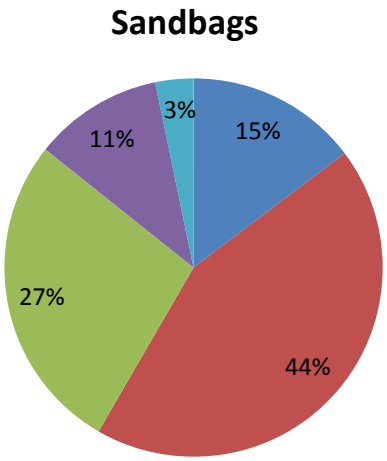
*Data includes the 13B, 13F and female Soldiers

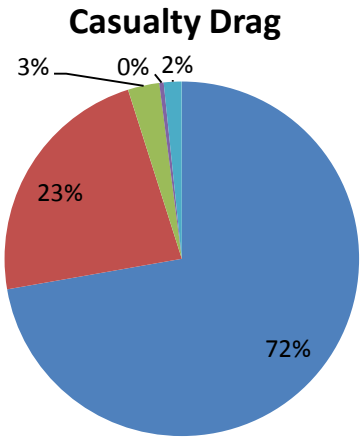
Ability

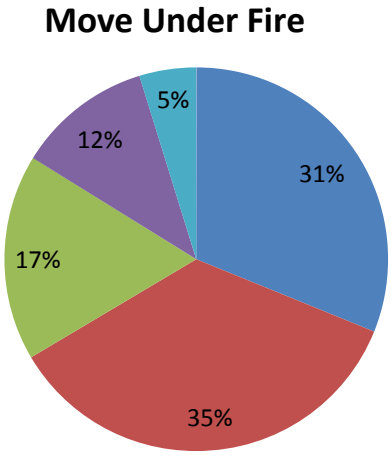
This Soldier is performing this task with technique that will (complete the task) and does not risk injury to themselves.

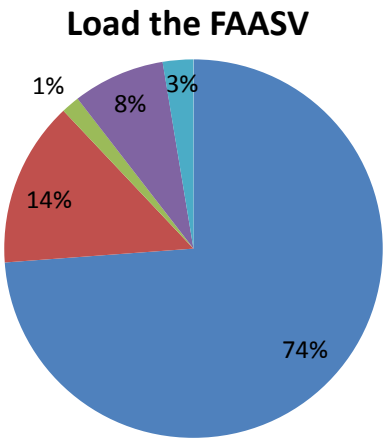
- **All of the task**
- **Most of the time**
- **Half of the time**
- **Occasionally**
- **Rarely**











*Data includes the 13B, 13F and female Soldiers