NATO STANDARD

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LOAD EFFECTS ASSESSMENT PROGRAM (LEAP)

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NORTH ATLANTIC TREATY ORGANIZATION

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NORTH ATLANTIC TREATY ORGANIZATION (NATO)

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NATO LETTER OF PROMULGATION

5 December 2019

1. The enclosed Allied Engineering Publication AEP-4821, Edition A, Version 1, LOAD EFFECTS ASSESSMENT PROGRAM (LEAP), which has been approved by the nations in the AC/225 NATO ARMY ARMAMENTS GROUP, is promulgated herewith. The agreement of nations to use this publication is recorded in STANREC 4821.

2. AEP-4821, Edition A, Version 1, is effective upon receipt.

4. This publication shall be handled in accordance with C-M(2002)60.

Zoltán GULYÁS
Brigadier General, HUNAF
Director, NATO Standardization Office

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RECORD OF RESERVATIONS

CHAPTER	RECORD OF RESERVATION BY NATIONS
Note: The reservations listed on this page include only those that were recorded at time of promulgation and may not be complete. Refer to the NATO Standardization Document Database for the complete list of existing reservations.	

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RECORD OF SPECIFIC RESERVATIONS

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CHAPTER 1 INTRODUCTION

1.1 Purpose of the document.

The purpose of this document is to provide recommendations in the development and execution of a Load Effects Assessment Program (LEAP) to measure Warfighter mobility and assist in the development, acquisition and evaluation of the impact of Dismounted Soldier Systems (DSS) equipment on Warfighter mobility. It will be of use to the materiel acquisition community, those involved in setting requirements for DSS equipment, and in the research and development, testing and evaluation DSS equipment and Warfighter performance. It will also provide a common platform for the comparison of the effects of new DSS equipment between NATO member nations. Furthermore the purpose is to establish the principles for the design of individual load-carrying equipment for combat soldiers of the NATO land forces and of those elements of the NATO naval and air forces who fight in a ground role. The nations are recommended to apply the principles below when measuring the impact of load on mobility.

1.2 Load Effects Assessment Program Obstacle Course and Hike.

Load Effects Assessment Program (LEAP) is built up on two trials; Obstacle Course and Hike. The Obstacle Course trial is established to stress the effect of equipment over a short period. While the Hike trial stress the equipment over a longer period and gives the ability to test other equipment not suitable for an obstacle course. Obstacle Course can be a standalone trial, while Hike is a supplement for better understanding and better coverage of soldier mobility.

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CHAPTER 2 DEFINITIONS

The following term and its definitions are used for the purpose of this agreement.

2.1. Timing Gates.

Each obstacle will have two timing gates, one before the start of the obstacle, and one after. This provides the markers at which the recording of the time taken to negotiate the obstacle starts and ends.

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CHAPTER 3. DEFINITIONS

Specified principles governing the establishment and execution of the Load Effects Assessment Program.

3.1 Test Protocol.

The Load Effects Assessment Program is used to definitively determine the impact of new DSS equipment on a soldier's mobility and performance. This is done through comparing a participant's performance using the current set of equipment, against the performance when using the new piece of equipment. Test protocols must be kept consistent between these two tests.

3.2 Overview of the LEAP Obstacle Course.

The Load Effects Assessment Program (LEAP) course is composed of eleven obstacles, three human performance stations, range of motion and anthropometry measurements, and a non-live fire shooting station. The course fits into a 50 by 30 meter area. Most personnel can complete the 11 obstacles in under ten minutes so it is a short duration, high intensity physical activity.

3.3 Description of the LEAP Obstacle Course.

The LEAP obstacle course is depicted in (Figure 1). LEAP comprises a series of combat movements, rifle shooting, and load handling activities derived by subject matter experts as critical movement and task components of dismounted combat mobility. The LEAP Obstacle Course will serve as the methodology to characterize weight, bulk and stiffness of a participant's equipment suite and provide a metric for the participant's mobility on the battlefield. LEAP will provide a unique ability to measure the effects of changing equipment in a participant's load by measuring the effect of their burden through multiple combat related tasks that collect data on the participant's movement mechanics, time to complete events, physical performance attributes, observed performance, and after action reviews for each iteration of the event. The LEAP's purpose is to provide a repeatable evaluation standard for assessing the effects of various combat loads, various integration designs, and various items of equipment in development and procurement.

3.4 Assumptions.

Test procedures and data collection systems will improve over time as the amount of testing conducted increases. It is envisioned the Load Effects Assessment Program procedures and data collection equipment will also be refined over time resulting in improved revisions of this enclosure.

3.5 Measurements.

Time: The LEAP can measure performance time needed to complete the entire circuit while simultaneously measuring the time it takes to traverse singular obstacles within the circuit itself.

Distance: A vertical jump test will record the time duration off the mat jumped by each participant as an indicator of leg power.

Load Handling Speed: The time to transfer horizontal loads and vertical load lifts will be recorded.

Shooting Performance: Using the engagement system, the time to engage targets and shot accuracy and consistency (i.e. grouping) will be recorded.

Subjective Ratings: A series of questions will be used in which participants will respond immediately after the course. Questions will require participants to rate the acceptability of each burden condition for flexibility, bulk, weight and their performance in terms of agility, speed, mobility and overall fatigue. Percentage of Body Weight: Percentage of body weight to load carried in relation to performance decrement will be recorded/calculated in order to define/update published standards. Movement times will be automatically measured and recorded for each combat activity and for the entire course through a timing system. An optical rifle target scoring system will be shooting performance following the effects of the movement activities in the LEAP Course. Three sensor pad stations will measure vertical leap, vertical load lifting, and horizontal load transfer handling performance. Finally, a survey will be used to record participants' self-assessment scores for mobility, speed, agility, maneuverability in confined space, exertion, and physical comfort.

During LEAP events, the following background information, anthropometry measurements, and range of motion will be collected for participants.

- Age
- Gender
- Rank
- Pre-existing Injury (- ies)
- Years of Service
- Billet
- # of Deployments
- Self-reported equipment size data
- Military Occupation Specialty

The following anthropometric measurements should be taken:

- Height
- Waist Circumference
- Weight
- Chest Circumference
- Torso Length
- Iliocristale Height
- Cervical Height
- 2nd Thoracic Height

To evaluate increased loads against flexibility, range of motion measurements will be taken during each test condition including the unencumbered baseline (boots, t-shirt & uniform). Measurements will be taken using a combination of a goniometer, a Wells

and Dillon Sit and Reach apparatus, inclinometer, and a digital level. The following ranges of motion will be measured:

• Trunk Forward Flexion.
• Trunk Lateral Flexion (Standing).
• Trunk Rotation.

All equipment and weapons are measured and used in the analyses of collected data.

3.6 Initial Briefing.

Prior to data collection, participants will be provided an in-brief and background information on the LEAP, a safety brief, and a LEAP orientation of the obstacle course and its accessory test stands.

3.7 Practice Runs.

Following the initial briefings, the participants will walk through the LEAP Course with a staff demonstrator and will be given movement instructions and safety instructions for each station. Participants will then be given time to practice obstacles on the course. Training runs are not required when executing the course for purposes of physical training where data collection is not the objective. Participants will be checked and measured after being equipped to ensure their diameter does not exceed the safe dimensions for traverse of the tunnel. If an equipped participant exceeds the safe clearance for executing the tunnel obstacle, the tunnel will be bypassed from the course run for that specific equipment configuration.

3.8 Evaluation Runs.

Participants will traverse the LEAP Course while wearing operational gear and equipment. The events should be conducted several times with different gear configurations and order.

Between each course run-through, the participant will be given at a minimum 45 minutes of sedentary rest time in order for the cardiovascular system to adequately recover from the previous run and return to resting heart rate. A commercial heart rate monitor may be used to record heart rate through the course in order to determine exertion levels and ensure return to resting heart rate based on a Participant’s desire to capture this information for use for themselves or as part of the obstacle staff.

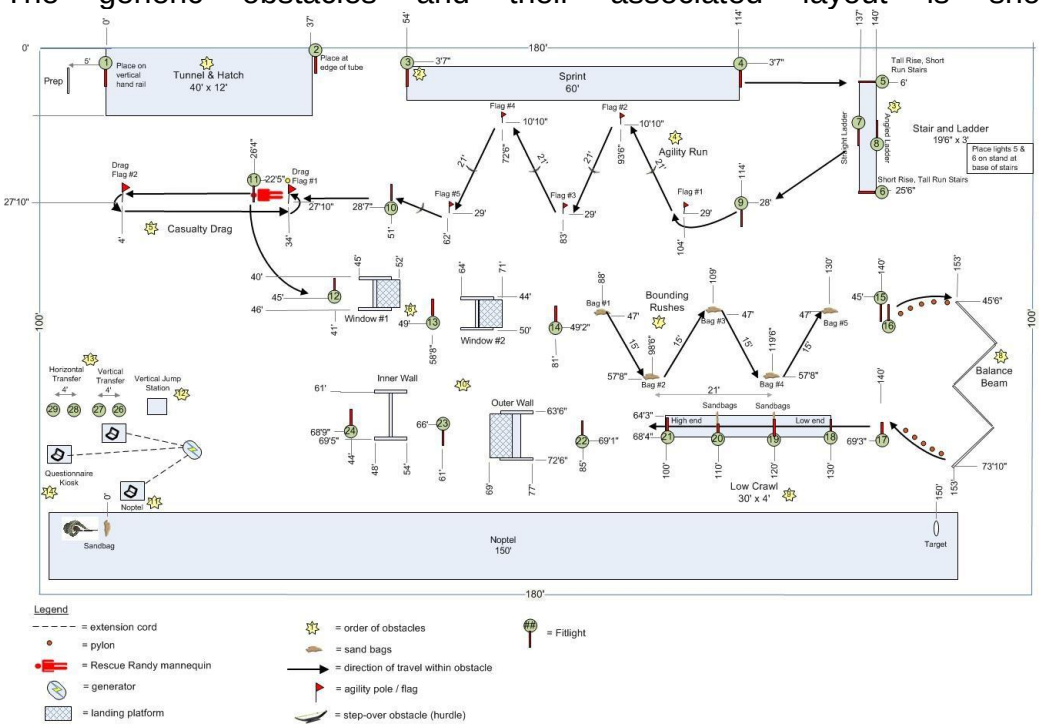
For every participant on the course there should be one obstacle staff member running along beside him or her to provide reminders of the correct course path, proper procedure, ensure timing gates activate, observe the Participant and their equipment, observe the Participant for any signs of unsafe levels of fatigue or exhaustion, and to watch for any safety concerns. No more than 2 participant should be permitted to run on the course at any one time. This will prevent the participant from passing/colliding

into one another as well as prevent the attention of researchers and safety monitors from becoming divided.

3.9 Course Layout.

While wearing the designated load condition, the participants will traverse the LEAP stations in the following order and manner.

The generic obstacles and their associated layout is shown below:



Station 1: Tunnel and Hatch.

The Participant approaches the stair portion of the tunnel and hatch obstacle (Figure 4) and climbs up the stairs one step at a time.

Figure 4. Tunnel and Hatch.

The Participant then lowers himself (feet first) into the vehicle hatch opening (Figure 5, left).

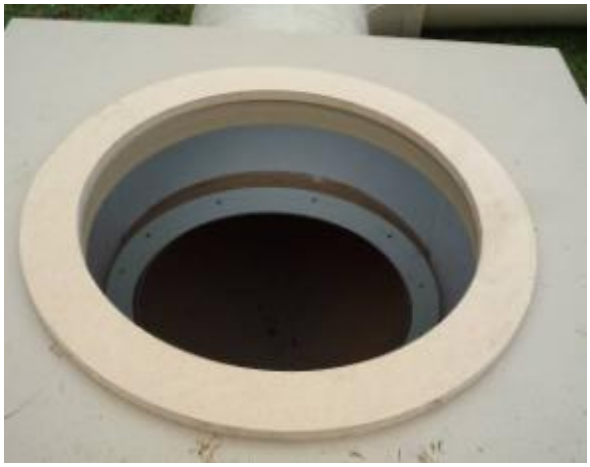


Figure 5. Hatch Opening. Figure 5. Tunnel Opening.

Next, the Participant crouches and enters the opening of the tunnel (Figure 5, right). The Participant will continue traversing through the tunnel until the Participant emerges out the other end. If the Participant has any difficulty in the tunnel, the sections can be separated with buckle release mechanisms.

Upon completing the length of the tunnel, the Participant quickly returns to a standing position and runs past the timing gate.

Station 2: Sprint.

Figure 6. Sprint Lane.

The Sprint station starts once the Participant passes the timing gate (Figure 6). The Participant sprints as fast as possible for 20 meters. The sprint ends when the next timing gate is crossed.

Station 3: Stairs and Ladders.

Figure 7. Stairs and Ladders.

The Participant will run to the stair and ladder obstacle (Figure 7) and progress through this obstacle in the following order:

Run to the base of the high rise stairs.
Climb up the high rise stairs; down the low rise stairs.
Climb up low rise stairs; down high rise stairs.

Climb up the angled ladder; then down the straight ladder.
Climb up straight ladder; then down angled ladder.

The Participant finishes this obstacle by passing the timing gate at the bottom of the angled ladder.

Station 4: Agility Run.

The Participant runs towards the first flag (Figure 8). The Participant makes a tight cut around the outside of the flag and heads back in the opposite direction towards the second

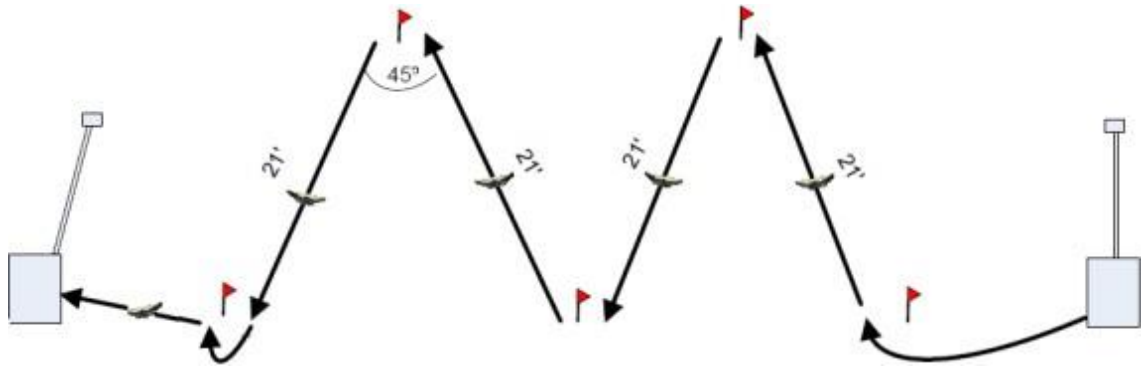


Figure 8: Agility Run.

flag, jumping over hurdle obstacles along the way and continues this sequence for the set of five (5) flags and five (5) hurdles (Figure 8). This segment is completed when the Participant crosses past the timing gate after the fifth hurdle.

Station 5: Casualty Drag.

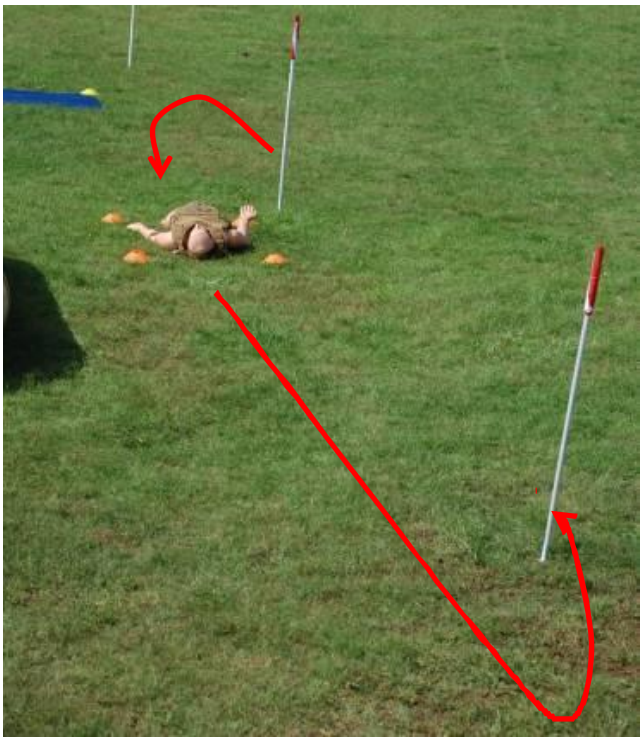


Figure 9. Casualty Drag Path.

Using the casualty strap on the Plate Carrier, the Participant will drag the mannequin (Figure 9) out to the turn-around point and back to the original position at which the mannequin was located.

Station 6: Window Obstacle.

To complete the window obstacles, the Participant must first go through the window opening of Window 1 (Figure 10, left). The Participant is free to choose whether or not he/she wants to use toe holds to assist him in climbing up the wall. After landing on the platform, the Participant runs to Window 2 (Figure 10, right) and climbs through the window opening.


Figure 10. Window Stations.

Station 7: Bounding Rushes.

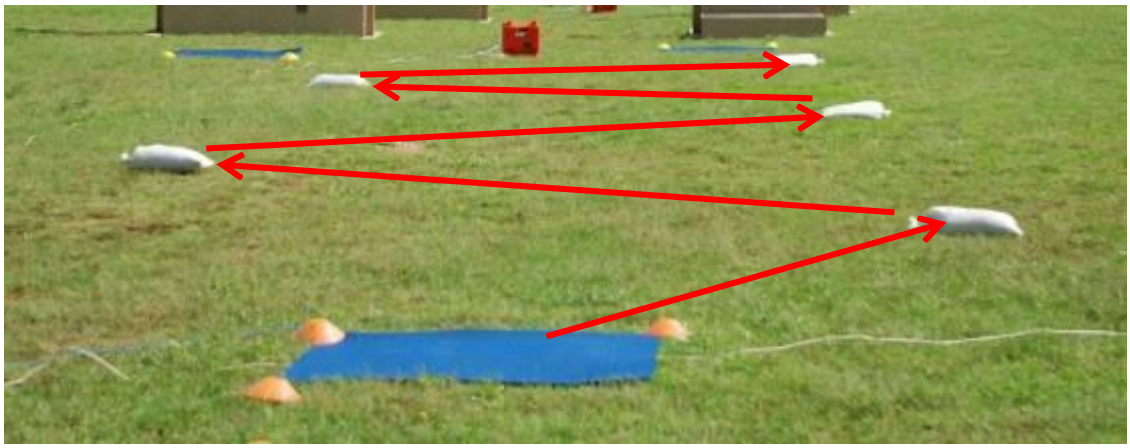


Figure 11. Bounding Rushes Path.

The Participant runs to the first pile of sandbags (Figure 11). Upon arriving at the first set of sandbags, the Participant assumes a prone position, acquires a sight picture, then leaps up to a running position. The Participant then sprints to the next (staggered) pile of sandbags and assumes another prone position. This cycle repeats until all piles of sandbags have been reached. This segment ends when the Participant runs past the final timing gate.

Station 8: Balance Beam.

Figure 12. Balance Beam.

For the balance beam obstacle, the Participant keeps to the outside of the line of cones (Figure 12) and steps up onto the beam from the left end. Jumping up onto the beam from the side is not permitted. The Participant carefully walks across the balance beam while stepping over padded box-shaped obstacles. Stepping on top of the box obstacles is not permitted. The Participant must exit the balance beam by stepping off the end (not the side) and then keeping to the outside of the line of cones, run towards the next timing gate. If a Participant falls off the balance beam, the Participant gets on where he or she fell off.

Station 9: Low Crawl.

Figure 13. Low Crawl.

The Participant begins by passing the timing gate and then low crawls underneath the canvas as fast as he/she can (Figure 13). At the 1/3 mark there will be a row of sandbags where the Participant will flip over and crawl on his or her back or side until reaching the next row of bags (2/3 mark). The Participant will flip over and perform a high crawl for the remainder. The Participant then runs past the timing gate thus completing this section.

Station 10: Inner and Outer Courtyard Walls.

The wall obstacle is comprised of an inner and outer courtyard wall set in a staggered formation. The Participant begins by traversing over the outer courtyard wall (foreground, Figure 14).

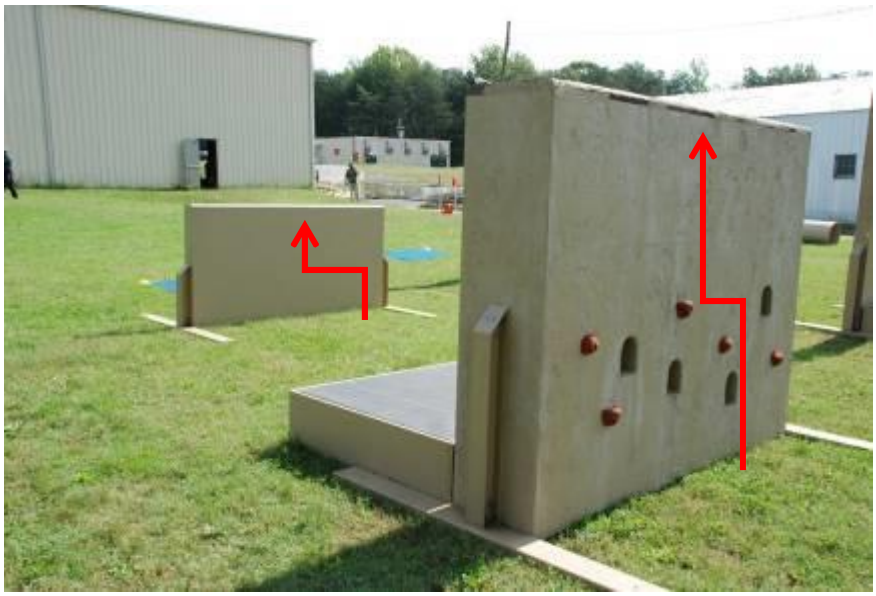


Figure 14. Outer (foreground) and Inner Courtyard Walls.

as quickly as possible. Any manner of traversing is permitted, and the Participant may use the foot holds to assist him if he/she wishes. After traversing the outer courtyard wall, the Participant sprints to the inner courtyard wall and crosses over it as fast as possible, passing the final timing gate.

Station 11: Firing Accuracy.

Firing Accuracy will be recorded. Firing positions and ranges can be varied but must be kept consistent between evaluations.

Figure 15. Example Targets.

To execute, the Participant will be instructed to pick up the weapon system and approach the firing line and take an unsupported kneeling position. Upon the command “Fire” , the Participant is given 15 seconds in which to complete 5 shots. He/she must aim for the center of the target. After 15 seconds has elapsed, if the 5 shots have not been taken the researcher will command “Cease Fire” and no further shots will be permitted.

Station 12: Vertical Jump.

The jump station (Figure 16, left) consists of a rubber mat with an embedded sensor (Figure 16, right) attached to a laptop computer. A set of 6 differently colored markers suspended from a rope serve as targets to facilitate goal setting for each jump. When the Participant jumps, the sensor measures the time off the mat, and computer software converts that time to a jump height and lower limb power. In order for this calculation to occur, the participant’s body mass (body weight + clothing + gear) will be taken and entered prior to the jump testing.

Figure 16. Jump Station.

The Participant will perform a series of three maximal-effort jumps. After the conducting staff member clicks “Start” on the laptop, the Participant will be instructed to make each

maximal vertical jump, with each jump measured. The maximum jump, and average height across the three jumps should be identified.

Station 13: Weight Transfer.

The weight transfer station is used to measure the Participant's ability to quickly transfer a weight from one platform to another within each of the test conditions. There are two components to the weight transfer station: horizontal transfer (Figure 17, left) and vertical transfer (Figure 17, right).

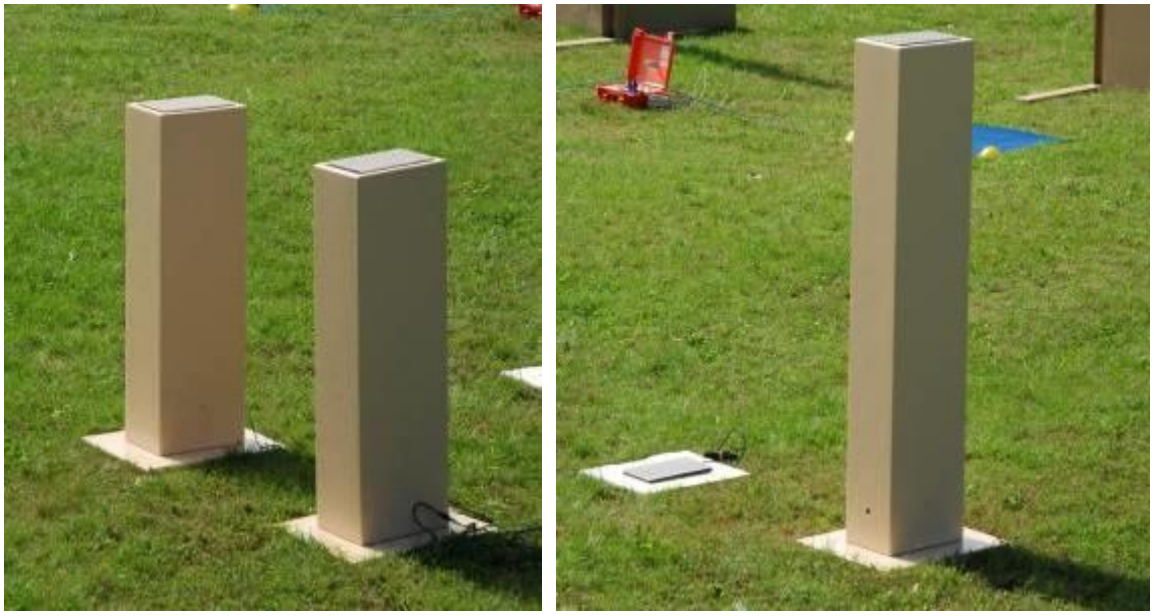


Figure 17. Horizontal (left) and Vertical Transfer (right) Stations.

The horizontal lift platforms are 120 cm from the ground, and a 14 kg ammunition can is used as the lifting load. The vertical platform is 170 cm from the ground and a 14 kg ammunition can will be used as the lifting load for the vertical transfer. For both the horizontal and vertical transfers, six lifts (with back and forth being considered one lift) are to be performed, and the time it takes to complete this set of six lifts is recorded.

Station 14: Subjective Rating Questionnaire.

The questionnaire consists of a one-page questionnaire. The questionnaire collects subjective data regarding the Participant's acceptability rating of various parameters of their test condition. The Participant will be presented with the questionnaire in Figure 18. He/she must fill in his participant number and condition, as well as an answer for each of the seven questions.

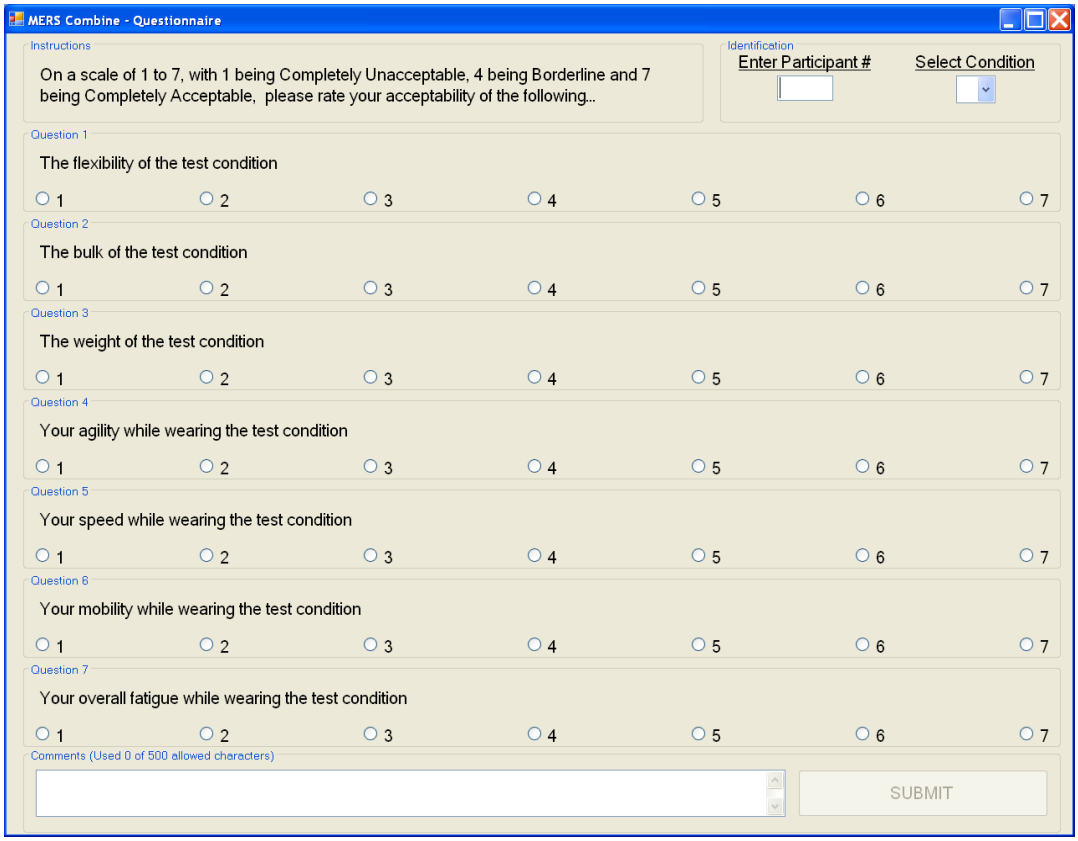


Figure 18. Subjective Questionnaire (sample).

3.10 Risk and discomfort to Participants.

Risk to Participants: Limited to what is expected when traversing any obstacle or endurance course when/while wearing combat loads (e.g. slips, trips, falls, dehydration, and musculoskeletal injury).

How will Risks be Minimized: Risks will be minimized according to each Nations safety regulations.

CHAPTER 4. LOAD EFFECTS ASSESSMENT PROGRAM HIKE.

4.1 Hike Assessment.

The Hike Assessment provides a long duration equipment wear event with various exertion levels. The purpose of the hike is to determine the load condition effects on the Participant, and collect data, observations and perceived effects in order to quantify the mobility implications for an equipment item as part of the complete system.

4.2 Hike Parameters.

Distance – 12-20 kilometers at a pace of 4 kilometers per hour.
Terrain – improved and unimproved roads with minimal to mild terrain relief.
Controlled Rate of March with constant speed in order to achieve a constant level of effort from the participants. Hydration is at individual's desired rate but will record fluid intake. Water is the only fluid intake.

4.3 Instrumentation.

Timing Devices/Stop Watch- Time recording in distance increments.
Physiological Status Monitor - Core temperature, heart rate, respiration rate, and skin temperature.
Inertial Measurement/Unit Trunk Angle Measurement - Identifies center of gravity shift and indicator of mechanical issues.
Contact Pressure Point Measurement - Identifies actual pressures primarily for shoulder area.

4.4 Measured Metrics.

Time variations to the prescribed rate of march.
Metabolic work rates differences within subjects' configurations from PSM.
Gait and pace changes.
Trunk Angle changes.
Survey.
Comfort and Perceived Exertion surveys.
Body Mapping Survey - pressure points and hot spots.
General equipment questions.

4.5 Hike Baseline Test Configuration.

Assault Load Configuration from LEAP Obstacle Course configurations.
Assault Load and contents.
Approach march load and contents.
Hike speed and distance - Longer than 12 km and less than 20 km.
Has to be repeated with rest recovery periods in between hike equipment configuration.

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