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ASSESSING THE IMPACT OF DISMOUNTED INFANTRY SMALL UNIT PROFICIENCY ON QUANTITATIVE MEASURES OF COLLECTIVE MILITARY PERFORMANCE PART 1: RECOMMENDED TEST METHODOLOGIES

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EXECUTIVE SUMMARY

Quantifying collective small unit performance in operational settings remains a significant challenge to both Army Science & Technology researchers and military communities to this day. This is due in large part to the overwhelming complexity of the operational environment as well as the high degree of variability found in mission sets, equipment capabilities, and desired operational outcomes. While the rise in commercially available wearable sensors has increased the capacity to record and measure large amounts of data from in-field settings, interpretation and usage of those data are still severely hampered by a lack of understanding about what aspects of performance are meaningful to quantify in a combat setting. Until quantitative performance metrics are developed that reflect and correlate directly to mission execution quality and operational outcomes, wearable data interpretation and data-to-decision models will remain severely limited for the dismounted infantry community. To that end, research activities focused on dismounted infantry performance were undertaken by the U.S. Army Combat Capabilities Development Command Soldier Center (DEVCOM SC) in support of the Measuring and Advancing Soldier Tactical Readiness and Effectiveness (MASTR-E) Program's Small Unit Performance Analytics (SUPRA) effort which began in October of 2019. The SUPRA integrated field test scenario, to date, has successfully tested 16 dismounted infantry squads (approximately 130 soldiers). Using best practices and lessons learned from the previously executed SUPRA experimentation work, the goal of this report is to two-fold: (1) provide test methodology recommendations for the measurement of dismounted infantry squad performance in operationally realistic settings and (2) provide recommendations on the development of metrics of collective small unit performance that correlate directly with operational outcomes.

This report first outlines the methodology for the operational scenario used and best practices for executing that scenario. The scenario focused predominantly on the infantry squad echelon and on execution of Battle Drill 2A and Battle Drill 6. These drills were selected based on the need for having collective, lethal action undertaken by a squad while simultaneously reducing operational variability. While the testing procedures for these two battle drills are the focus of this report, the authors believe that the general approaches and methods outlined here will provide the basis for assessment of small units executing other essential tasks and battle drills as applicable. Throughout the testing, data were collected utilizing the following techniques:

- Analysis of squad characteristics including (but not limited to) basic demographics and anthropometrics, military demographics, and baseline marksmanship ability
- Kinematic data collection through inertial measurement units (IMUs) and 3-D motion capture (MOCAP)
- Relative positional and gross movement tracking via global positioning systems (GPS)
- Physiological demand and stress response through physiological status monitoring (PSM) and blood- and saliva-biomarker analysis
- Analysis of squad mission outcomes via a) observational and video imaging analysis, b) auditory and communications analysis, and c) subjective military expert observation

This report also outlines recommendations on the development of collective performance metrics for the squad echelon and beyond. It is important to note that there are many instances during battle drill execution in which it is difficult to differentiate what constitutes team performance and what is simply the result of an aggregate of individual performances. Both *interactive* (individual duties are collaborative and involve joint action) and *coactive* (group productivity is a function of separate, but coordinated, individual efforts) [17] are discussed in this report, meaning that – in some cases – measures of individual performance were also taken throughout the testing and analyzed in the context of the collective small unit’s overall performance.

This report, by focusing on collective outcomes from squad-level battle drill execution, provides a substantial improvement in methodology and a significant step forward in establishing data-driven techniques that can be used to assess both proficiency and intervention effects on military small units as a whole.

ASSESSING THE IMPACT OF DISMOUNTED INFANTRY SMALL UNIT PROFICIENCY ON QUANTITATIVE MEASURES OF COLLECTIVE MILITARY PERFORMANCE

PART I: RECOMMENDED TEST METHODOLOGIES

1.0 INTRODUCTION

1.1 Background

The foundational building block of the infantry is the infantry squad. As stated by Col. (Ret.) Keith Nightingale,

[The] squad has been the basis of our Infantry success since time immemorial. The squad is the bottom firm foundation of our fighting forces and the ultimate determinate of our force projection...The squad is the most important and the most neglected of all military organizations. Its composition and significance is noted but rarely supported to the level deserved. It suffers from choices made by vastly higher decision makers. Tanks, planes, ships, and exotic emerging combat systems win in the allocation of time and money. Yet, despite the deficit, this lowest of all elements on the battlefield, the squad somehow manages to clear the village, take the hill, and hold the ground-or not [1].

However, quantifying squad or small unit performance at the collective or team level in operational environments remains a challenge to this day. Much of the previous work on small unit and squad performance has either focused purely on individuals within the unit (as opposed to the small unit team as a whole) [2-4], on individual injury risk and reduction [5-9], on subjective assessments of unit cohesion [10-11], or on assessments of fitness training interventions – again typically tracked at the individual level [5,12-15]. To the best of the authors' knowledge, only two studies have been published that utilized research-grade instrumentation to make inferences about collective performance during operationally relevant military activities [16, 20-21]. Silk et al. (2013) demonstrated significant differences in performance ($p < 0.05$) among patrol roles (also referred to as squad positions) for external load carried, heart rate response, bound duration, and distance covered. Movement velocity was not found to be significantly different ($p > 0.05$) across patrol roles. These significant findings were reported with a sample size of $N=23$ participants across three squads. Each squad conducted a total of three assaults similar to the proposed methodology laid out in the Operational Test Events portion of this report (see Section 3.0 Operational Test Events). Patton et al. (2018) examined the effectiveness of targeted training interventions on team performance utilizing heart rate variability measures collected via research-grade heart rate monitors across participating squads. Patton et al. (2018) found that targeted training interventions appeared to reduce training-induced stress during live-fire exercises.

The closest analog to the quantitative assessment of collective teaming performance in challenging, dynamic environments are those most commonly used in professional athletics applications. The proliferation of wearable technologies has allowed for detailed information on player and team dynamics during in-field play as well as improved access to large data archives for sports, which have resulted in increased opportunities to address critical sports problems utilizing both established and novel statistical methods [18]. Basic statistical approaches have been used to measure National Football League (NFL) team strength from historical game results as well as to estimate team strength as a whole. These basic models can be extended to account for the possibility of team strengths evolving over time [18] and take into account measures and metrics of the team's collective performance. However, there are significant limitations when attempting to draw direct parallels between the application of statistics in sport to military small units. Professional athletics analysis benefits from consistent game play, environments, scoring mechanisms, equipment usage, and large historical data sets. By contrast, the military small unit and dismounted infantry squad operates in a range of environments, across a wide variety of mission sets, utilizing varying equipment capabilities, and very little mission outcome data are stored in a readily accessible, centralized location.

In order to allow for the application of established analytical techniques such as those mentioned previously, care has therefore been taken in the procedures recommended in this report to allow for consistent measurement and execution of common infantry squad operational tasks in a training environment without fully compromising the operational validity of the tasks and outcomes. This is by no means the first time militarily relevant tasks have been systematically evaluated for research purposes; however, previous studies frequently reported individual performance outcomes for tasks such as PT tests, obstacle course navigation, or individual marksmanship ability [5-15]. While many of the aspects of individual proficiency may be generalized to groups, teams, or units, the literature on military collective operational performance measurement and quantification is sparse [17].

Despite this, the Army has long recognized that performance of integrated crews, teams, and units is essential to overall mission success [17&19] and improvement of operational teaming performance has long been a high-level Army objective. However, in order to improve in-field performance, one must first be able to measure and quantify it. To that end, research activities focused on dismounted infantry performance were undertaken by the U.S. Army Combat Capabilities Development Command Soldier Center (DEVCOM SC) in support of the Measuring and Advancing Soldier Tactical Readiness and Effectiveness (MASTR-E) Program's Small Unit Performance Analytics (SUPRA) effort which began in October of 2019.

1.2 Objectives

The U.S. Army DEVCOM SC established the MASTR-E Program's SUPRA effort to: (1) develop novel, small unit metrics of operational performance, (2) determine the baseline characteristics of Soldiers and small units that best predict operational performance at the collective level, and (3) determine the baseline characteristics and small unit performance

metrics that best discriminate between high and low performing squads. “Performance” (or small unit performance) in this context was defined as the quality of execution of a subset of common operational tasks including movement to contact, react to contact, squad attack, and precision room clearing. This research sought to provide the ability to monitor and quantify close combat performance and lethality at the small-unit level through instrumentation and analysis. Specifically, the SUPRA work sought to leverage analytical techniques commonly used within the professional athletic fields of study (sports analytics) and apply those techniques to data collected directly from military small units performing in operationally relevant settings. To that end, an integrated field test scenario was developed and successfully used to test dismounted nine-man infantry squads of varying proficiencies and experience levels. The SUPRA integrated field test scenario to date has successfully tested 16 dismounted infantry squads (approximately 130 soldiers) across two different active-duty infantry units. It is anticipated that the test methods and procedures highlighted in this report will be used to test a further 17 dismounted infantry squads over the next 12 months (April 2022 – April 2023).

Using best practices and lessons learned from the previously executed SUPRA experimentation work, the goal of this report is to two-fold:

- (1) Provide test methodology recommendations for the measurement of dismounted infantry squad performance in operationally realistic settings
- (2) Provide recommendations on the development of metrics of collective small unit performance that correlate directly with operational outcomes

This report, by focusing on collective outcomes from squad-level battle drill execution, provides a substantial improvement in methodology and a significant step forward in establishing techniques that can be used to assess effects on military small units as a whole.

1.3 Approach

As stated, there are many challenges associated with translating or implementing current sports analytics and wearables best practices to the military small unit. Professional athletics analysis benefits from consistent game play, environments, scoring mechanisms, and equipment usage. By contrast, the military small unit and dismounted infantry operate in a range of environments, across a wide variety of mission sets, utilizing varying equipment capabilities, with differing or evolving mission outcome requirements depending on the task at hand. In order to apply research-based approaches and methods to the measurement and quantification of collective small unit performance, a test paradigm had to be developed that would constrain or reduce some of this operational variability without compromising operational validity.

Battle drills are standardized collective military actions made in response to common battlefield occurrences [28]. They are designed for rapid reaction situations without the application of a deliberate higher echelon decision-making process. According to the U.S. Army Ft. Benning

Maneuver Center of Excellence (MCOE), there are approximately 15 essential Infantry battle drills that small units must train on to ensure operational success [28]. By focusing on these essential battle drills as the basis for testing dismounted infantry small unit performance, testers and evaluators are able to ensure the following: operational relevancy, task standardization, repeatability, and generalizability of findings. This is in comparison to a custom military scenario design approach, which may increase operational relevancy to a specific unit or mission set while reducing standardization, repeatability, and generalizability of findings.

The SUPRA effort focused on the squad-level echelon as it is considered the foundational building block of the infantry small unit. The SUPRA effort also focused on the U.S. Army's 15 essential Infantry battle drills to design its test paradigm and further down-selected to 2 critical drills:

- (1) Battle Drill 2A - a movement to contact and squad attack within an instrumented squad situational training exercise (STX) lane
- (2) Battle Drill 6 - a close quarters combat room clearing task within an instrumented shoot house (SH)

These drills were selected as they included direct, lethal action against an enemy force and are undertaken by the small unit as a collective – which was of highest interest to key effort stakeholders including the Army Futures Command (AFC) Soldier Lethality Cross Functional Team (SL CFT) and the Program Executive Office (PEO) – Soldier. Each drill-set was scored by a team of military experts to allow for multivariate correlations of small unit performance metrics to quality of execution and mission outcomes. Each drill was repeated up to three times over the course of the testing (see Sections 1.4 and 1.5 for the Overall Test Schedule and Operational Concept of Operations (CONOP). Drills were repeated in order to better understand and develop measures that were sensitive to changes in small unit performance over time. While the testing procedures for these two battle drills are the focus of this report, the authors believe that the general approaches and methods outlined here will provide the basis for assessment of small units executing other essential battle drills as applicable.

To date, a total of $N = 15$ dismounted infantry squads (approximately 120 Soldiers total) from two different infantry units have been tested through the full, recommended testing paradigm. A further $N = 18$ dismounted infantry squads (approximately 160 Soldiers total) have completed sub-sets of the recommended testing. This report outlines the methodology for the operational scenario used and best practices for executing that scenario. Throughout the testing, performance data were collected utilizing the following techniques:

- Analysis of squad characteristics including (but not limited to) basic demographics and anthropometry, military demographics, and baseline marksmanship ability
- Kinematic data collection through inertial measurement units (IMUs) and 3-D motion capture (MOCAP)

- Relative positional and gross movement tracking via global positioning systems (GPS)
- Physiological demand and stress response through PSM and blood- and saliva-biomarker analysis
- Analysis of squad operational performance via a) observational and video imaging analysis, b) auditory and communications analysis, and c) subjective military expert observation

It is important to note that while the primary goal of this work is to develop quantifiable metrics of small unit performance, there are many instances during battle drill execution in which it is difficult to differentiate what constitutes team performance and what is simply the result of an aggregate of individual performances. Both *interactive* and *coactive* [17] performance will be discussed in later portions of this report meaning that – in some cases – measures of individual performance will also be taken and analyzed in the context of the collective small unit’s overall performance (see Section 5.2 on Approaches to Developing In-Field Performance Measures for an expanded discussion).

The previously executed SUPRA testing was treated as a mixed-model design. The experimental design for both Battle Drill 2A within Task Set (1) and Battle Drill 6 within Task Set (2) were of the form: Squads (1 to N) by Iteration (1st, 2nd, 3rd) within Skill Group (see Section 1.4 Test Event Order and Schedule).

1.4 Test Event Order and Schedule

To collect all components of the data called for under this recommended methodology, test procedures were focused on two operational task sets: Task Set (1) – which focused primarily on the Battle Drill 2A movement to contact and squad attack within an instrumented squad situational training exercise (STX) lane, and Task Set (2) – which focused primarily on the Battle Drill 6 close quarters combat room clearing task within an instrumented shoot house (SH). For Task Set (1) of the previously executed SUPRA testing, participants were asked to complete: one Pre-Test Data Collection Session, one STX Lane Data Collection Session, and one Post-Execution Data Collection Session. For Task Set (2) of the previously executed SUPRA testing, participants were asked to complete one Pre-Test Data Collection Session, one Shoot-house Data Collection Session, and one Post- Execution Data Collection Session. Prior to data collection, all participants completed an Orientation Session and a Marksmanship Baseline Session. An outline of these recommended testing components is provided below:

I. Supporting Test Events (x1 per Small Unit Tested):

- i. Orientation Session
- ii. Marksmanship Baseline Session

II. Operational Test Events (x3 per Small Unit Tested):

- i. Task Set (1)
 - a. Pre-Test Data Collection
 - b. STX Lane Data Collection (Battle Drill 2A)
 - c. Post-Test Data Collection
- ii. Task Set (2)
 - a. Pre-Test Data Collection
 - b. Shoot-house Data Collection (Battle Drill 6)
 - c. Post-Test Data Collection

Participants repeated each task set three times over the course of the testing. A sample test schematic is given in Figure 1 below. Figure 1 is a sample schematic of the recommended order of testing for a single infantry squad. As stated previously, all proposed testing includes: one Orientation Session (“Orientation,” Navy Blue), one Marksmanship Baseline Session (“MXB,” Navy Blue), six Pre-Test Data Collection Sessions (“Pre,” Tan), six Post-Test Data Collection Sessions (“Pst,” Orange), three STX Lane Data Collection Sessions (“STX,” Grey), three Shoot House Data Collection Sessions (“SH,” Purple), and a Make-up Day as shown. Table 1 gives the recommended testing schedule for use in testing two squads simultaneously. This recommended schedule is based on having only one instrumented STX Lane and one instrumented Shoot-house available for test and evaluation, but could be expanded if multiple study sites and support teams were utilized or if multiple battle drills beyond Battle Drill 2A and Battle Drill 6 were under consideration.

	Orientation	Day 1			Day 2			Day 3			Makeup Day
AM	Orientation	Pre	SH	Pst	Pre	SH	Pst	Pre	SH	Pst	TBD
PM	MXB	Pre	STX	Pst	Pre	STX	Pst	Pre	STX	Pst	TBD

Figure 1: A sample schematic of the recommended order of testing for a single infantry squad including a Makeup Session as needed.

Table 1: A recommended testing schedule for use in testing two squads simultaneously through three iterations of both Task Set (1) and Task Set (2)

			Hours to Complete
Day 1	morning	Orientation Session Squad 1	3-6
	afternoon	Orientation Session Squad 2	3-6
Day 2	morning	Squad 1: Task Set 1 (1 st iteration) Squad 2: Task Set 2 (1 st iteration)	2-4
	afternoon	Squad 2: Task Set 1 (1 st iteration) Squad 1: Task Set 2 (1 st iteration)	2-4
Day 3	morning	Squad 1: Task Set 1 (2 nd iteration) Squad 2: Task Set 2 (2 nd iteration)	2-4
	afternoon	Squad 2: Task Set 1 (2 nd iteration) Squad 1: Task Set 2 (2 nd iteration)	2-4
Day 4	morning	Squad 1: Task Set 1 (3 rd iteration) Squad 2: Task Set 2 (3 rd iteration)	2-4
	afternoon	Squad 2: Task Set 1 (3 rd iteration) Squad 1: Task Set 2 (3 rd iteration)	2-4
Day 5	morning	Make Up Window	
	afternoon	Make Up Window	
Total Study Time			18 - 36

Detailed descriptions of all aspects of the Supporting Test Events and the Operational Test Events, including key tasks and testing activities, an overview of the battle drills, key test instruments used, and lessons learned from previous testing are given in the subsequent sections of this report.

1.5 Operational Scenario and CONOP

The operational test events for the previously executed SUPRA testing focused predominantly on the execution of Battle Drill 2A (Squad Attack) and Battle Drill 6 (Room Clearing). An important consideration for any collective performance testing that wishes to compare operational performance between varying small units is that each participating group be given

the same mission parameters when executing the testing. To that end, and in order to ensure consistency in the distribution of mission critical information, the same CONOP and fragmentary order (FRAGO) were issued to each participating squad that executed the SUPRA testing. The complete CONOP and FRAGO used for the previously executed SUPRA testing can be found in Appendix E of this report. In general, regardless of the echelon being tested or the battle drills of interest, the following recommendations are provided for the development of a consistent CONOP:

- Ensure that if force-on-force activities are to be included, any information regarding enemy position, numbers, or capabilities are kept consistent across all units tested.
- Ensure all visual information provided (maps, charts, keys, etc.) are kept consistent across all participating units.
- If possible, ensure that the execution of the battle drills of interest occurs in similar environments (i.e. not heavily forested vs. sandy dunes) and at similar times of day. It is not recommended that nighttime operations be directly compared to daytime operations in terms of performance metric development.
- Participating units should be provided similar step-off times, similar mission completion timelines, and enemy activity and behavior should be made as consistent as possible between testing iterations.

2.0 SUPPORTING TEST EVENTS

Supporting Test Events include those non-Battle-Drill-related testing activities, which occur only once throughout the event and are generally recommended to occur prior to initiation of any operational testing. As stated previously, for the procedures recommended as part of this report, supporting test events include:

I. Supporting Test Events (x1 per Small Unit Tested):

- i. Orientation Session
- ii. Marksmanship Baseline Session

An overview of these recommended test activities as well as the key test instruments proposed for each are described in detail below. Because a significant focus of these procedures is on small unit performance, it is recommended that participants be tested in groups of 7 – 13 at a time to represent dismounted infantry squads. It is further recommended that, when possible, active-duty participants are tested together with their organic small unit members from their original unit. All members of a participating small unit should complete all testing sessions as a group to best simulate the operational and training reality. This approach could be adjusted as needed to test differing echelons of small units, such as fire teams or platoons.

2.1 Orientation Session Overview

The previously executed SUPRA testing occurred on-site at the range complex at Fort Devens, MA. If utilizing the procedures outlined within this report to test small units, the orientation session should be used as both a welcome and familiarization session for the participants as well as an opportunity to administer any relevant pre-test questionnaires. The SUPRA orientation session was completed on-site at all relevant testing locations that were utilized throughout the event. The orientation session included site visits to the Fort Devens Range Control Complex, the instrumented Shoot House, and the Range 12 complex, which included the instrumented STX Lane. Participants were given a walkthrough of the test session facilities including the STX Lane, Shoot-house, and Bio-sampling facilities. Participants were provided with an overview of all relevant test session information, equipment, and the schedule of events for the testing, as well as a range safety briefing and an overview of all on-body sensors that would be worn. Participants were allowed to ask any questions of the testing team they had. To evaluate aspects of small unit and teaming performance, it is recommended that participants fill out the following or similar questionnaire instruments during their orientation:

- A daily intake form
- An individual demographics/military demographics form
- The Grit Scale [29]
- The Modified Combat Platoon Cohesion questionnaire [27]
- The Group IBC (Identification Bonding Conflict) Questionnaire [REF]

- The Team Behavior Checklist (pre-mission) [REF]

It is recommended that all forms and questionnaires be administered digitally (via password protected laptop or tablet) when possible for ease of collection and organization. See Appendix A for copies and descriptions of all recommended testing questionnaires based on the previously executed SUPRA testing. The questionnaire instruments listed here focus on individual and squad-level demographics (age, time in service, squad position, time in squad, etc.), assessment of perceived squad cohesion and conflict, and of anticipated or perceived mission performance. These questionnaire instruments could be expanded to focus on differing echelons of small units, such as fire teams or platoons, or to focus on different aspects of mission performance such as mission planning or troop leading procedures as applicable.

2.2 Marksmanship Baseline Session

A critical component of any force-on-force engagement – regardless of the echelon being tested (fire team, squad, or platoon) – is marksmanship. Marksmanship is a foundational military skill that all infantry units are expected to obtain. For any training or operational scenario that will include force-on-force engagements, quantifying the basic marksmanship capabilities of the participating individuals and small units is critical to understanding in-field performance.

Outlined below are the recommended procedures to baseline individual marksmanship ability utilized during the SUPRA testing. Please see Section 2.3 on Lessons Learned from Supporting Test Events for recommendations on alternate procedures as applicable. It is important to note that all marksmanship activities for any testing scenario will be subject to the local approvals and required safety protocols of the execution installation. It is highly recommended that all activities be coordinated with and approved by the appropriate Range Control Complex prior to execution.

In order to better contextualize in-field small unit performance, it is recommended that marksmanship baseline activities include: supervised practice bouts, supervised weapon zeroes, and a simulated dynamic marksmanship task. For the marksmanship baseline session, participants should be assigned a weapon that has been converted to fire non-lethal simunition or blank rounds for use during the in-field testing as well as a demilitarized M4 carbine that simulates weapon discharge using expelled CO₂ gas for the simulated dynamic marksmanship task.

Soldiers should complete a series of marksmanship baseline activities including:

- A supervised weapon-zero utilizing the Multiple Integrated Laser Engagement System (MILES) in accordance with manufacturer recommendations.
- Practice/familiarization with firing blank rounds in conjunction with the zeroed MILES on 5 – 25 m targets.
- Practice/familiarization with firing non-lethal simunition rounds utilizing their assigned, converted weapon on 5 – 25 m targets.

- Practice/familiarization with firing a demilitarized CO₂ M4 carbine on 5 – 25 m targets.
- A simulated dynamic marksmanship task utilizing a FN-Expert simulation system (FN® Expert, Mclean, VA, USA).

A range safety officer should be present at all times during all simunition and blank-fire shooting, and only the participants and the range safety officer(s) should be allowed on the range during the practice and zero tasks. All participants should be required to wear ballistic eye and ear protection for all shooting activities. The simulated marksmanship task can be conducted off-range and does not require a range safety officer or ballistic personal protective equipment (PPE).

The simulated dynamic marksmanship task provides the opportunity to quantify aspects of individual marksmanship ability including but not limited to: accuracy, shot latency, muzzle control, and shot groupings. A detailed description of the simulated dynamic marksmanship task is below.

2.2.1 Simulated Dynamic Marksmanship Task

Prior to starting the simulated marksmanship task, the participants were tested on their proficiency with camouflage pattern detection (threat v. non-threat) by inspecting 20 camouflage flashcards on a tablet set at a distance of 5 m. If the participant passed (80% correct or better), then they proceeded with the marksmanship test. Upon failure, they would repeat the training session and retry the proficiency task.

Upon completion of the training and utilizing the demilitarized CO₂ M4 carbine with a series of LCD screens, participants were presented with a series of scaled E-type silhouette targets with center of mass rings depicted on the screens placed at least 5 m from the location of the participant. The simulated marksmanship assessment began with a static task of firing 3 series of 5 shots (15 shots total) at a 150-m simulated distance ring target, prioritizing accuracy over speed. Targets were engaged in an unsupported standing position to induce a higher level of difficulty. The dynamic portion of the task entailed: (1) sprinting 10 m to the decision cut point, (2) cutting left or right to a second firing line based on the directional arrow displayed on the tablets (randomly assigned per trial), and (3) engaging up to six pop-up threats across six target locations, one target exposure at a time, per Figure 2 below. Each target displayed either a threat or non-threat camouflage pattern, and the participant was instructed to engage all enemy threats with a controlled pair of shots. Presentation varied across the 50-70° arc, and targets were only visible for 30 s. Order, location, and simulated distance of targets was pre-determined to ensure similar degree of difficulty, required movements, and distribution of outcome measures, and was randomly assigned per trial. After identifying all six targets, the participant ran back to the starting line and began the next trial. The participant completed six trials consecutively during the assessment. A trial was considered successful when the simulator accurately registered the shot data. A schematic of the simulated dynamic marksmanship task that was executed as part of the previous SUPRA testing is below (Figure 2A and 2B).

For the previously executed SUPRA testing, The FN® Expert Marksmanship Training System (FN® Expert, Mclean, VA, USA) was utilized. The FN® Expert system was developed to provide instruction to both shooters and coaches. The system focuses on capturing fundamental shooting skills (sight picture, breathing, trigger squeeze, etc.) and providing feedback following a shot. It is a wireless system capable of both live and simulated training on a wide array of simulated rifles or carbines, as well as selected pistols. It can be used indoors with simulated shooting distances, or outdoors with life-size targets and real shooting distances (up to 300 m). It measures rifle movement, detects the shot, shows the location of both hits and misses, and analyzes the shooter's performance.

A simulated marksmanship training system is recommended for marksmanship baseline activities due to the quality and quantity of marksmanship data that can be collected while simultaneously reducing risk, cost, and weather dependency compared to a live-fire event. See Section 2.3 for additional Lessons Learned from the simulated marksmanship test events.

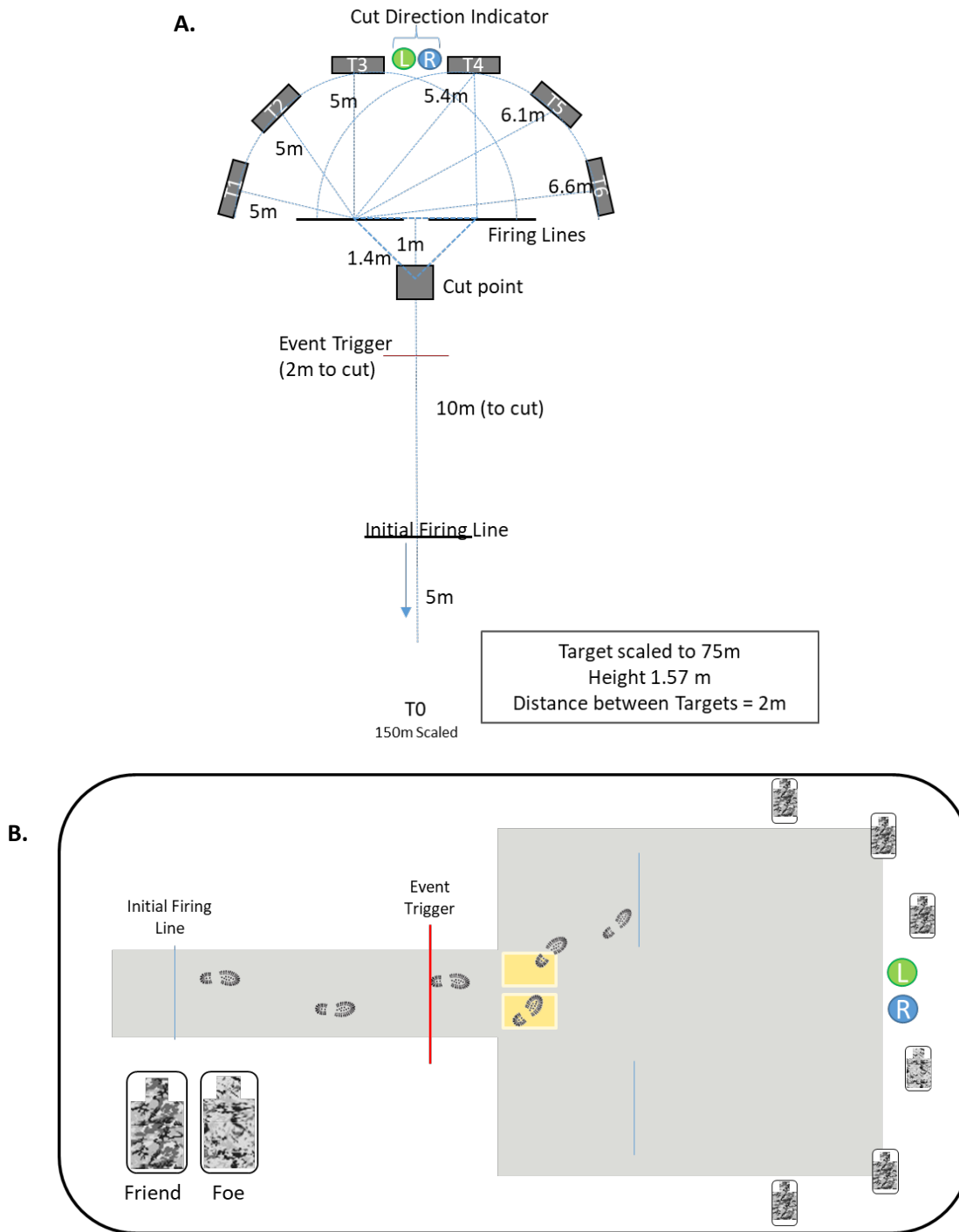


Figure 2A: An overhead schematic of the recommended simulated dynamic marksmanship task set up that was utilized during the previously executed SUPRA testing. Once the participant crosses The Event Trigger line, the Cut Direction Indicator randomizes whether the participant should cut to the left (green circle with an “L”) or cut to the right (blue circle with an “R”) to engage with the simulated targets. **2B:** An overhead view of the recommended simulated dynamic marksmanship task set up that was utilized during the previously executed SUPRA testing. This view shows participant movement throughout the task and examples of “Friendly” vs. “Foe” target camouflages.

2.3 Lessons Learned from Supporting Test Events

Throughout the execution of the Supporting Test Events for the SUPRA testing, several key lessons were learned that significantly reduced data collection errors, increased data quality, increased participant comfort and cooperation, or otherwise helped to ensure that testing was successfully executed. A summarized list of these lessons learned for the previously executed Supporting Test Events includes:

- Ensure testing team personnel are on hand to answer questions about questionnaires as participants fill them out in order to reduce participant confusion and ensure consistency in how questionnaire responses are documented.
- It is important to highlight to all participants that they should fill out questionnaire responses relative to the small unit echelon (in this case – squad) they will be executing the testing with – which may not necessarily be the same as their organic, home station small unit.
- It is recommended that all questionnaires be administered digitally for ease of data collection and organization.
- In place of the simulated dynamic marksmanship task detailed above, a live-fire baseline task such as a standard weapon qualification could be used to baseline individual marksmanship proficiency ahead of testing. However, live-fire tasks are generally high-risk, high-cost, weather-and-range-availability dependent, and would generally only include basic hit/miss information. By contrast, the simulated task is more controlled, lower-risk, lower-cost, can be conducted indoors, and collects more quantifiable data about the shooter. However, a live-fire task is more operationally relevant. Therefore, if a live-fire baseline is to be used instead, it is recommended that a system such as the FN® Expert Marksmanship Training System is still utilized in order to collect additional quantitative data about the shooter beyond just basic hit/miss information.
- Future work for the SUPRA effort will involve adding a fire-team echelon shooting component to the simulated dynamic marksmanship task. In addition to the procedures outlined above, this TSS (team shooting scenario) will be added, which will involve fire-teams standing in the center of the LCD screens and engaging the simulated targets together. In addition to the simulated shooting data collected per shot, overall fire team communication will be collected and analyzed as well. It is therefore recommended that if testing of small unit echelons utilizing the methods and procedures highlighted in this report is undertaken, marksmanship baseline activities including fire teams, squads, and/or platoons be conducted where and if possible.

3.0 OPERATIONAL TEST EVENTS

Operational Test Events include those Battle-Drill-related testing activities that are repeated multiple times throughout the event testing. For the procedures recommended as part of this report, operational test events include:

II. Operational Test Events (x3 per Small Unit Tested):

- i. Task Set (1)
 - a. Pre-Test Data Collection
 - b. STX Lane Data Collection (Battle Drill 2A)
 - c. Post-Test Data Collection
- ii. Task Set (2)
 - a. Pre-Test Data Collection
 - b. Shoot-house Data Collection (Battle Drill 6)
 - c. Post-Test Data Collection

For Task Set (1) of the previously executed SUPRA testing, participants were asked to complete: one Pre-Test Data Collection Session, one STX Lane Data Collection Session (Battle Drill 2A), and one Post-Execution Data Collection Session. For Task Set (2) of the previously executed SUPRA testing, participants were asked to complete one Pre-Test Data Collection Session, one Shoot-house Data Collection Session (Battle Drill 6), and one Post- Execution Data Collection Session. An overview of these recommended test activities – including a detailed test schedule, start-of-day task list, and task set-up procedures – as well as the key test instruments used for each are described in detail throughout this report. Because a significant focus of these procedures is on small unit performance, it is recommended that participants be tested in groups of 7 – 13 at a time (to represent dismounted infantry squads). It is further recommended that, when possible, active duty participants are tested together with their organic small unit members from their original unit. All members of a participating small unit should complete each testing session as a group. This approach could be expanded to test differing echelons of small units, such as fire teams or platoons as applicable.

3.1 Detailed Test Schedule

A schematic of the recommended test schedule can be found in Appendix B. This schedule is based on the previously executed SUPRA testing. This schedule assumes only one instrumented STX Lane and one instrumented Shoot house are available for use at any given time and that Battle Drill 2A (Task Set (1)) and Battle Drill 6 (Task Set (2)) are the battle drills of focus for testing and assessment. This schedule could be expanded to test differing echelons of small units, such as fire teams or platoons, or different battle drills of interest as applicable.

3.2 Start of Day Tasks

3.2.1 *Safety Briefings & PPE*

It is important to note that all marksmanship activities for any testing scenario will be subject to the local approvals and required safety protocols of the execution installation. It is recommended that all activities be coordinated with and approved by the appropriate Range Control Complex prior to execution. In addition to, or, in most cases, in accordance with, the local required range safety protocols, it is recommended that the start of each testing day begin with a Range Safety Briefing. The Range Safety Briefing should include both test team members as well as all Soldier participants and be conducted by either local installation range control personnel or a range safety officer as applicable. The Range Safety Briefing should be conducted at both the instrumented STX Lane and the instrumented shoot house that will be used throughout the testing or at whatever instrumented facility Soldier participants will be executing the battle drills of interest. The Range Safety Briefing should include (at a minimum) the following:

- An overview of all site-specific safety policies and procedures
- An overview of Emergency Procedures in the event of an injury including roles and responsibilities of on-site personnel and any relevant emergency communication procedures
- An overview of the ammunition types that will be utilized on the range as well as all required PPE
- Any relevant weather or environmental conditions that test team personnel and Soldier participants should be aware of prior to execution

Listed below is the recommended PPE to be utilized by participants and observer controllers throughout testing. These recommendations are based on the assumption that either blank rounds or non-lethal simunition rounds will be used in the STX Lane and the Shoot-house respectively. Any alterations to the ammunition types used at either facility will necessitate a change in the recommended PPE and should be coordinated with and approved by the local installation Range Control prior to execution. Recommended PPE based on the previously executed SUPRA testing includes:

- Hearing protection – PVC Foam Ear Plugs should be required for all participants and observer controllers completing both Task Set (1) and (2).
- Eye Protection – approved ballistic eye protection (glasses) should be required for all participants and observer controllers completing both Task Set (1) and (2).
- Ballistic Kevlar Helmet – Either the standard issue Advanced Combat Helmet (ACH), Enhanced Combat Helmet (ECH), ballistic Gentex Corp. Ops-Core helmet, or equivalent should be required for all participants completing both Task Set (1) and (2).

- Ballistic Body Armor – The Soldier Plate Carrier System (SPCS) or equivalent with ballistic plate inserts should be required for all participants completing both Task Set (1) and (2).
- Additional PPE recommended by the Ft. Devens Range Control for the previously executed SUPRA testing included ballistic gloves, face masks, and groin protection required for all participants for Task Set (2).

3.2.2 Soldier Preparations

After completion of the Range Safety Brief, Soldier participants should then be prepared for daily testing. It is recommended that for each day of testing the testing team utilize an execution checklist to ensure that all activities are completed in the appropriate order. An example of execution checklists for both Task Set (1) and Task Set (2) from the previously executed SUPRA testing are included in Appendix C. In general, it is recommended that preparation for daily testing should include:

- Completion of a daily intake form questionnaire and any other relevant pre-test questionnaires
- Assembly of all Soldier participant gear (including weapons and radios) and PPE needed for testing
- Movement of participants to the appropriate testing sites
- Issuing of ammunition and PPE to participants

Specific participant preparations for each component of the data collections within Task Set (1) and Task Set (2) are included in more detail in later sections of this report.

3.3 Task Set (1) Overview

For Task Set (1) of the previously executed SUPRA testing, participants were asked to complete: one Pre-Test Data Collection Session, one STX Lane Data Collection Session (Battle Drill 2A), and one Post-Execution Data Collection Session. An overview of the previously executed SUPRA test sessions as well as the key test instruments used for each are described in detail below. These approaches could be expanded to test differing echelons of small units, such as fire teams or platoons, or different battle drills of interest as applicable.

3.3.1 Pre-Test Data Collection Session

The Pre-Test Data Collection session began with a brief overview to provide participants explanations of all the tasks being conducted on that day and all equipment and safety procedures. Participants were reminded of the session specific sensors they would be wearing as well as all check-in and check-out procedures to be completed for sensor placement and removal. The Pre-Test Data Collection Session included filling out questionnaires, having resting physiological data taken, and having blood- and saliva-based biomarkers collected.

Participants first filled out the daily intake form with questions relating to their health, recent food and drink consumption, and other factors that could affect their performance that day as well as the Rating of Pain, Soreness, and Discomfort (RPSD) questionnaire (see Appendix A). All forms and questionnaires were administered digitally (via password protected laptop or tablet).

Next, resting Heart Rate Variability (HRV), Heart Rate (HR), Breathing Rate (BR) were collected for 10 min during prone resting. Saliva- and blood-based biomarkers were also collected during this time. Resting measures were collected via a chest mounted Polar Team Pro© heart rate monitor (Polar, Bethpage, NY). Biomarkers of physiologic systems status, including an 11-analyte metabolic/hematology panel (Sodium, Potassium, Chloride, TCO₂, Anion Gap, Calcium, Glucose, Urea Nitrogen/Urea, Creatinine, Hematocrit, and Hemoglobin), and an 8-analyte Lactate test (Lactate, pH, PCO₂, PO₂, TCO₂, HCO₃, Base Excess, and sO₂) were collected via capillary puncture (i.e. finger stick). Approximately 200 µL of blood (equivalent to ~2 drops of blood) was obtained from the distal end of each participant's finger (2nd, 3rd, or 4th digit) using a 2.3 mm high flow, single-use safety lancet (MarketLab, Cat No. ML5422), and collected in a lithium heparin evacuated capillary collection microtube (MarketLab, Cat No. ML5601). Standard sanitization procedures were employed prior to and directly after the blood draw including: cleaning and disinfecting of the study equipment, cleaning the participant hand and finger utilizing alcohol swabs prior to and after sample is taken, and bandaging of the participant finger after the sample is taken and the wound site is cleaned. Samples were then immediately analyzed using an i-STAT handheld blood analyzer (Abbott Diagnostics, USA) with single-use i-STAT test cartridges for each panel described above. Approximately 95 µL of blood was added to each cartridge for analysis and the assay was run for 2 min. Any remaining volume of sample and used cartridges were discarded in appropriate biohazardous waste containers. Approximately 200 µL of blood was taken with each single finger stick. In order to properly capture anticipation and recovery periods, samples were provided immediately before (pre) and immediately after (post) the STX Lane Data Collection Sessions. All blood collection, processing, handling, and disposal procedures were conducted in accordance with World Health Organization (WHO) Guidelines on Drawing Blood: Best Practices in Phlebotomy. Geneva: World Health Organization; 2010. 7, Capillary sampling. <https://www.ncbi.nlm.nih.gov/books/NBK138654/>.

Saliva was collected via passive drool or oral saliva swab techniques to assess changes in acute stress response markers (Salivary Amylase and Cortisol). Prior to a sampling time, participants were asked to avoid eating, chewing tobacco, and drinking acidic drinks (coffee, juices) for at least 30 min. Participants were instructed to rinse their mouth at least twice with cool water and then either spit through a straw directly into a 15 mL saliva collection tube or place an oral swab underneath their tongue to collect saliva for 2 min. Once removed, used swabs were inserted into a swab storage tube. Saliva and swab collection tubes were then labeled with an identification number and stored at -20° Celsius (or colder) until they were assayed. Saliva was transported to DEVCOM-SC and/or DEVCOM Chemical Biological Center for analysis. All samples were

disposed of in biohazard bags in accordance with all state and federal regulations that govern biohazardous waste.

3.3.2 STX Lane Data Collection Session (Battle Drill 2A)

3.3.2.1 Battle Drill 2A Overview

Battle Drill 2A (07-4-D9515), commonly referred to as “Conduct a Squad Assault,” is one of the 15 essential Infantry battle drills outlined in the U.S. Army techniques publication ATP 3-21.8 (updated from U.S. Army field manual FM 3-21.8) titled “INFANTRY PLATOON AND SQUAD” [28].

For this battle drill, it is assumed the squad is moving as part of the platoon conducting a movement to contact or an attack. This drill typically begins when the enemy initiates direct fire contact with the squad. The standards, or goals, for this battle drill include:

1. The squad locates and suppresses the enemy
2. The squad establishes supporting fire
3. The squad assaults the enemy position using fire and maneuver
4. The squad destroys or causes the enemy to withdraw
5. The squad conducts consolidation and reorganizes

Battle Drill 2A includes 8 task steps and performance measures with over 45 additional sub-tasks that the squad is expected to perform as applicable. Appendix D contains the full list of task steps and performance measures for Battle Drill 2A. Battle Drill 2A can be expanded to other small unit echelons including platoon (Battle Drill 2).

3.3.2.2 STX Lane Data Collection Session Setup

The STX Lane Data Collection Session began with a brief overview to provide participants explanations of all the tasks being conducted on that day and all equipment and safety procedures. They were reminded of the session specific sensors they would be wearing as well as all check-in and check-out procedures to be completed for sensor placement and removal. The STX Lane Data Collection Session included filling out questionnaires, receiving the mission brief and CONOP, and initiation and completion of the STX Lane activities (Battle Drill 2A).

Participants first filled out a RPSD questionnaire (see Appendix A) which was filled out daily during testing. All forms and questionnaires were administered digitally (via password protected laptop or tablet). Participants were then briefed on the STX Lane mission CONOP, which provided directions for the Squad on the tasks they were expected to complete for the data collection event. Copies of the CONOP are included in Appendix E and were standardized for every group of participants so that every participating squad received the same information prior to execution of the STX Lane. Once the CONOP was briefed, participants then moved to the

check-in location to have all on-body sensors, weapons, blank cartridges, and equipment provided to them. All STX Lane Activities involved the use of non-lethal, blank fire rounds and the U.S. Army MILES laser-based system. For a complete list of all study equipment, devices, and products, see Section 3.3.4. If not completed previously as part of the Marksmanship Baseline activities, both the BLUFOR (participating squad) and the OPFOR (opposing force) then completed a 30-m supervised weapon-zero utilizing the MILES in accordance with manufacturer recommendations to ensure the accuracy of the converted weapons at range. The participants were then given a step-off time and allowed to conduct whatever rehearsals they deemed appropriate before that time. While the squad was finishing rehearsals, OPFOR personnel were equipped with data collection equipment, PPE, M4 carbines, and military kit. OPFOR test fired their weapons to ensure weapons were functioning properly and were emplaced within the STX lane by OC personnel. BLUFOR weapons were also test fired at step off time, and a whistle was blown indicating the start of the mission, which allowed manual syncing of all data collection equipment across participants. Once initiated, the activities on the STX Lane included:

- **Movement to Contact:** As part of their CONOP/FRAGO, participants were directed to move to and engage with an OPFOR (opposing force) at a given location and time. The location information for and engagement time with the OPFOR were the same for every group of participants tested. The OPFOR were comprised of two test team personnel or reserve or active duty volunteers under the direct supervision of a test team member. The OPFOR location was approximately 350-500 m from the step-off point depending on the route the participants chose to take (see Figure 3). Participants were able to decide how best to navigate to the estimated OPFOR location, and at what movement speed, to attempt to meet the required engagement time.
- **Conduct a Squad Assault:** As part of their CONOP, participants were advised of the number of and threat level of the OPFOR. They were told they should expect to receive contact from the OPFOR and directed to move to and engage with the OPFOR at a given location by a designated time. This necessitated the participating squads completing all tasks associated with a Squad Attack (Battle Drill 2A). Once the squads crossed a pre-set boundary line, the OPFOR engaged with the participants. In some cases, the participants engaged the OPFOR prior to crossing the boundary or prior to the OPFOR being aware that they had crossed the boundary. Whichever group (the OPFOR or the participating squads) engaged first was tracked for subsequent analysis. The squad attack was considered complete when all participating OPFOR were incapacitated and the participants completed all consolidation and re-organization tasks. Hits and strikes for both participating squads and OPFOR were tracked via the MILES laser-based system.

During the STX Lane activities outlined above, four military subject matter expert observer-controllers (OCs) were observing the participants and rating their overall performance on all events and activities. One OC was assigned to primarily assess the squad leader, one to assess the alpha fire team, one to assess the bravo fire team, and one to observe the OPFOR location and

assess the squad approach. In instances where the BLUFOR received hits and were incapacitated (according to the MILES), they were immediately resurrected by OCs so that they could resume the fight. This meant that in some cases, OPFOR members might incapacitate the same BLUFOR member several times throughout the battle drill. Total OPFOR “kills” (meaning the total number of times the OPFOR incapacitated any members of the BLUFOR) and BLUFOR “kills” (meaning the total number of times the BLUFOR incapacitated any members of the OPFOR) were collected and included in subsequent analysis. Otherwise, the military raters were directed not to interfere with any participant activities and functioned as observers and assessors only. The grading schema all military raters used is included in Appendix F. The grading schema was administered digitally via a custom-built Soldier Performance Application for Readiness and Talent Assessment (SPARTA) digital application tool (Peraton, Herndon, VA, USA) and utilized by all OCs, which automatically synchronized the assessment data across observers. The outputs of the digitized rating sheets were tracked and utilized for subsequent analyses. For a complete list of all study equipment, devices, and products, see Section 3.3.4.

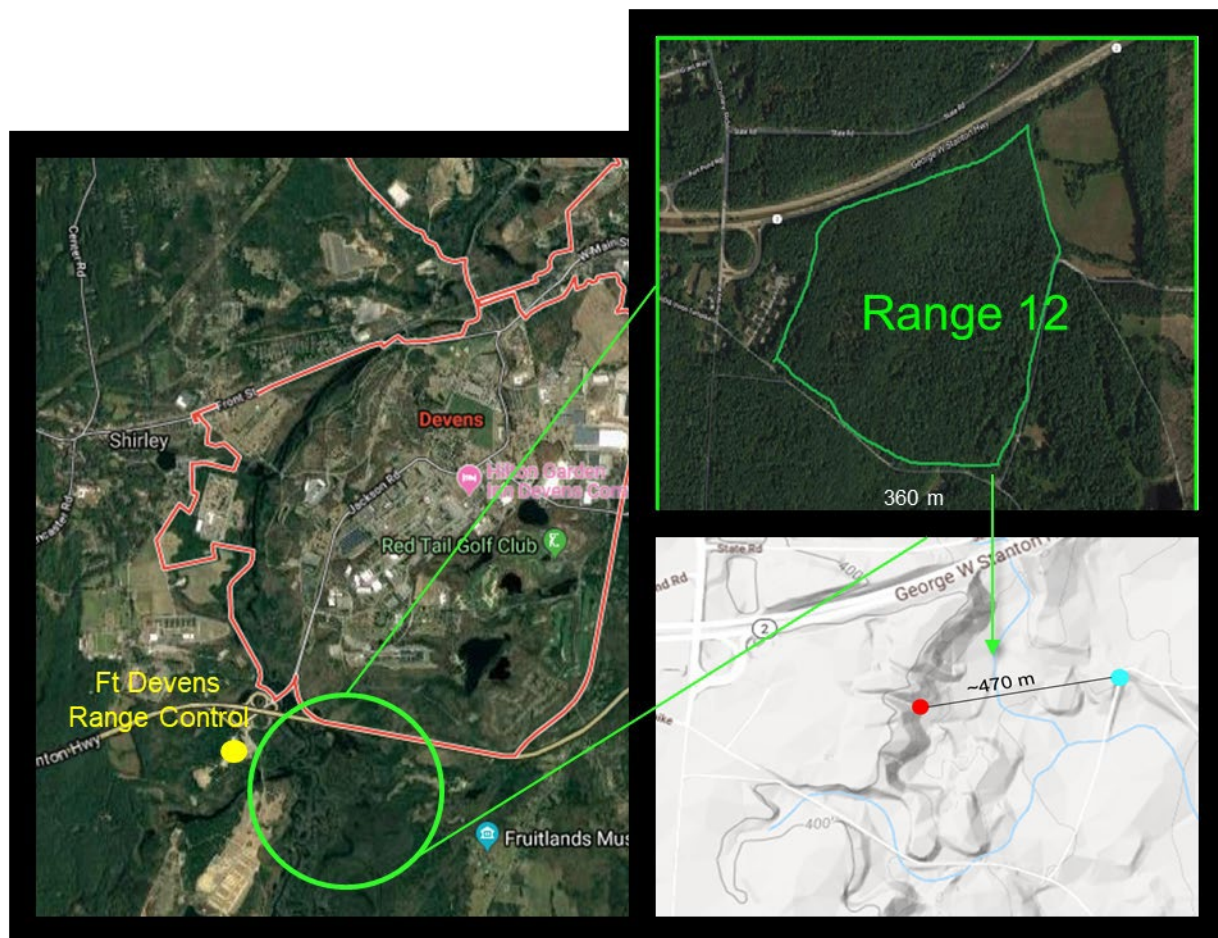


Figure 3: An overview of the Range complex used during the previously executed SUPRA testing for Task Set 1, including the approximate distance from the initial Squad location (blue) to the opposing force (OPFOR) location (red).

3.3.3 Post-Test Data Collection Session

The Post-Test Data Collection session was conducted identically to the Pre-Test Data Collection Session and began immediately upon the participating Squad's completion of the STX Lane activities. The Post-Test Data Collection Session included filling out questionnaires, having resting physiological data taken, and having blood- and saliva-based biomarkers collected.

Participants were asked to again complete the Rating of Pain, Soreness, and Discomfort (RPSD) questionnaire (see Appendix A). All forms and questionnaires were administered digitally (via password protected laptop or tablet). HRV, HR, BR, and the saliva- and blood-based biomarkers were all collected for 10 min during prone resting identically to the methods and procedures outlined in the Pre-Test Data Collection Session section (see Section 3.3.1 for complete testing details).

3.3.4 STX Lane Test Equipment, Devices, and/or Products Used

Listed below are the devices, products, and testing equipment used throughout the previously executed SUPRA testing for Task Set (1). It is important to note that the products detailed herein do not constitute official government endorsement of any of these devices. These product descriptions are only included as recommendations based on the previously executed testing, but alternative equipment with similar technical specifications would be sufficient. It is highly likely that if the recommended procedures and methods outlined within this report are expanded beyond the squad echelon or to include additional battle drills of interest, then the proposed test equipment will likely need to be expanded or altered as well. For more detailed information on the equipment-specific usage procedures, considerations, and lessons learned based on the previously executed SUPRA testing, see Chapter 4.0 Sensor Overviews & Test Preparation.

1. Polar Team Pro© heart rate monitor (Polar, Bethpage, NY): The Polar Team Pro© system was used to capture GPS-derived movement data and integrated heart rate monitoring throughout testing. This system comprised the PSM for the SUPRA testing.
2. Inertial Measurement Units (IMUs, APDM Inc., Portland, OR, USA): The IMUs were affixed to BLUFOR and OPFOR helmets and weapons to measure high-precision acceleration, angular rate, and orientation data.
3. GoPro Mounted Cameras (GoPro Inc., USA): On-body (OC helmets or chests) cameras collected video for the duration of the STX lane Execution providing insight into BLUFOR and OPFOR activities.
4. Spartan After Action Review (SPAAR) display (Aptima® Woburn, MA, USA): SPAAR allows users to visualize multiple time-synced video, an overhead map, and other data feeds for quick and effective after-action reviews and data visualization and synchronization. In SUPRA's context,

the SPAAR system was used as a data visualization and data quality control aid as well as an after action aid for participants conducting Task Set (1) and (2).

5. Soldier Performance Application for Readiness and Talent Assessment (SPARTA) digital application tool (Peraton, Herndon, VA, USA): The SPARTA digital tool is a custom mobile enterprise application platform that digitizes assessment tools such as gradebooks, grade sheets, and Training and Evaluation Outlines (TE&O). The application, originally designed by the Army Research Institute (ARI) and developed by Peraton, has been used previously for both individual and collective task assessments in military settings.
6. Multiple Integrated Laser Engagement System (MILES) (Cubic Corp., San Diego, CA, USA): The MILES is a laser-based, force-on-force, combat simulation system frequently used by active duty infantry units. The system collects information including critical hits, near misses, shooter identification, etc. which are logged for subsequent analysis.
7. Digital Audio Recorder: The Tascam[®] DR-40X Four-Track Digital Audio Recorder (TEAC Corp., Montebello, CA, USA) is a high quality audio recorder that can be used (in conjunction with a microphone) for dual recording and non-destructive overdub recording, etc. to track participant communication during execution of both Task Set (1) and (2).
8. Throat Microphone: The NT-3 Throat Mic Headset (IASUS Concepts, Richmond, BC, CAN) is a throat-mounted microphone used to collect individual verbal communication information and is compatible with the digital audio recorder described above. In the event a participant did not feel comfortable wearing the system or it could not be placed properly due to the configurations of other military equipment or PPE, the lower profile Califone Light-Weight Neck Microphone (Califone, Jessup, MD, USA) or the XLR Lavalier Microphone (Maono, USA) was used instead. Both are also compatible with the digital audio recorder described above. A web-based speech-to-text software application (Transcribe, Wreally LLC, Los Angeles, CA, USA) was used to transcribe the audio files taken from each participant for subsequent analysis.
9. i-STAT (Abbott Laboratories, Chicago, IL, USA): The handheld i-STAT is a mobile point-of-care-testing platform that provides diagnostic information on blood gases, chemistries, electrolytes, cardiac markers, coagulation, hematology, and endocrinology when combined with whole blood and the appropriate test cartridges.

10. Personal Protective Equipment (PPE): All participants and personnel acting as OPFOR were asked to wear a significant amount of PPE including:
- a. Hearing protection – PVC Foam Ear Plugs were required for all participants completing both Task Set (1) and (2).
 - b. Eye Protection – approved ballistic eye protection (glasses) were required for all participants completing both Task Set (1) and (2).
 - c. Ballistic Kevlar Helmet – Either the standard issue ACH, ECH or ballistic Gentex Corp.Ops-Core helmet was required for all participants completing both Task Set (1) and (2).
 - d. Ballistic Body Armor – The SPCS with ballistic plate inserts was required for all participants completing both Task Set (1) and (2).

3.4 Task Set (2) Overview

For Task Set (2) of the previously executed SUPRA testing, participants were asked to complete: one Pre-Test Data Collection Session, one Shoot house Data Collection Session (Battle Drill 6), and one Post-Execution Data Collection Session. An overview of the previously executed SUPRA test sessions as well as the key test instruments used for each are described in detail below. These approaches could be expanded to test differing echelons of small units, such as fire teams or platoons, or different battle drills of interest as applicable.

3.4.1 Pre-Test Data Collection Session

The Task Set (2) Pre-Test Data Collection session was conducted identically to the Task Set (1) Pre-Test Data Collection Session and began with a brief overview of the session to provide participants explanations of all the tasks being conducted on that day and all equipment and safety procedures. Participants were reminded of the session-specific sensors they would be wearing as well as all check-in and check-out procedures to be completed for sensor placement and removal. The Pre-Test Data Collection Session included filling out questionnaires, having resting physiological data taken, and having blood- and saliva-based biomarkers collected. Participants were asked to complete the RPSD questionnaire (see Appendix A). HRV, HR, BR, were all collected for 10 min during prone resting. Saliva- and blood-based biomarkers were also collected during this time identically to the methods and procedures outlined in the Task Set (1) Pre-Test Data Collection Session section (see Section 3.3.1 for complete testing details).

3.4.1.1 Battle Drill 6 Overview

Battle Drill 6 (07-4-D9509), commonly referred to as “Enter and Clear a Room,” is one of the 15 essential Infantry battle drills outlined in the U.S. Army techniques publication ATP 3-21.8 (updated from field manual FM 3-21.8) titled “INFANTRY PLATOON AND SQUAD” [28]. For this battle drill, it is assumed the squad is conducting operations as part of a larger unit and has been given the mission to clear a room. Enemy personnel are believed to be in the building.

Noncombatants may be present in the building and are possibly intermixed with the enemy personnel. It is assumed that the unit has support and security elements positioned at the initial foothold and outside the building. The standards, or goals, for this battle drill include:

1. The unit clears and secures the room by killing or capturing the enemy while minimizing friendly casualties, noncombatant casualties, and collateral damage
2. The unit complies with Rules of Engagement (ROE)
3. The unit maintains a sufficient fighting force to repel an enemy counterattack and continues operations

Battle Drill 6 includes four task steps and performance measures with over 15 additional sub-tasks that the squad is expected to perform as applicable. Appendix D contains the full list of task steps and performance measures for Battle Drill 6. Battle Drill 6 can be expanded to other small unit echelons up to platoon level.

3.4.1.2 Shoot House Data Collection Session Setup

The Shoot House Data Collection Session began with a brief overview to provide participants explanations of all the tasks being conducted on that day and all equipment and safety procedures. They were reminded of the session specific sensors they would be wearing as well as all check-in and check-out procedures to be completed for sensor placement and removal. Participants first filled out a daily RPSD questionnaire (Appendix A). All forms and questionnaires were administered digitally (via password protected laptop or tablet). Participants were then briefed on the shoot house mission CONOP, which provided directions for the squad on the tasks they were expected to complete for the data collection event. Copies of the CONOP are included in Appendix E and were standardized for every group of participants so that every participating squad received the same information prior to execution of the shoot house.

Once the CONOP was briefed, participants then moved to the check-in location to receive all on-body sensors, weapons, simunition-ammo, and equipment that was provided to them. BLUFOR and OPFOR personnel were armed with non-lethal man marking 5.56mm cartridges (blue and red paint rounds, respectively) and associated bolt carrier assemblies. The simunition projectiles traveled at 114 m/s (375 fps) which is significantly slower than 5.56mm live rounds which travel at 993 m/s (3260 fps). The ballistic properties of these simunition rounds allowed for significantly less energy transfer upon impact and consequently safe use for force-on-force use in close quarters (assuming proper PPE). For a complete list of all study equipment, devices, and products used, see Section 3.4.3.

The participants were given a step-off time and allowed to conduct whatever rehearsals they deemed appropriate before that time. Participants were not allowed within the shoot house during rehearsals, but the squad was provided an alternative building that they could choose to utilize for practice. During rehearsals, the study team staff prepared the main shoot house equipment,

emplaced OPFOR personnel, and closed all doors. Of the three rooms in play within the shoot house, one room contained paper targets, one room contained an armed OPFOR actor, and the final room contained an unarmed, non-hostile actor. With the exception of the targets and actors, all rooms were emptied (all furniture removed) to help simplify the room clearings for the squads and to simplify and standardize analysis for study staff. Within the paper target room, three paper International Practical Shooting Confederation (IPSC) targets were mounted approximately 1.7 m off the ground on stands and placed in corners. Two of three targets had an AK47 rifle image stapled atop the target, indicating a threat. Participants were provided blank target examples prior to training and a target with an AK47 and instructed to only engage the latter. The position of the hostile OPFOR actor within the second room was randomized between three different corners in order to maintain surprise for the squads. The OPFOR was instructed to stay in place, to engage the BLUFOR upon sighting after door opening, and to drop to the floor if shot. Within the final room, the non-hostile actor was emplaced in a corner and was instructed to initially resist instructions received by the BLUFOR squad. For instance, if the squad told the actor to place his hands in the air or to get to the floor, the actor was instructed to refuse until the squad forcefully moved the actor. This consistent resistance created a more realistic interaction and allowed a wider range of BLUFOR responses to help further differentiate squad behavior.

Following rehearsals, BLUFOR test fired their weapons in an unused corridor within the shoot house. They moved towards the shoot house entrance, received a final data collection equipment check performed by study staff, and prepared to enter the shoot house by forming a stack along the exterior walls. At the step-off time, data collection equipment was time synched using a clapperboard and the participants were then given permission to initiate the shoot house activities. Shoot house activities included:

- Precision Room Clearing: As part of their OPORD/WARNO, participants were advised of the number and threat level of the OPFOR occupying the shoot house. They were told they should expect to receive contact from the OPFOR. Participants were directed to move to and engage with the OPFOR and were asked to clear the shoot house room by room to neutralize all threats by a pre-set time. This necessitated the participating squads completing all tasks associated with Entering and Clearing a Room (Battle Drill 6). The OPFOR was comprised of two study team personnel or reserve or active duty volunteers under the direct supervision of a study team member. Participants needed to clear three rooms and one hallway (see Figure 4). Within the shoot house, participants were presented with several critical decision points including (but not limited to) which side of entryway doors to stack on, clearing the fatal funnels, and making go/no-go decisions on whether to engage any OPFOR or paper targets in the rooms. The room clearing was considered complete when all participating OPFOR were incapacitated and the squads called the “all clear.” This signaled the end of the shoot house activities. Hits were tracked via the marking, non-lethal, simunition rounds, which left distinct colored residue at the location of a strike, similar to a paintball.

During the shoot house activities outlined above, four military subject matter expert observer controllers (OCs) observed the participants and rated their overall performance within each room and the hallway. The military raters were directed not to interfere with any participant activities and functioned as observers and raters only. Three of four military raters stood above and out of the way of the participants on the suspended observational walkways. The other rater shadowed the squad leader on the ground and moved throughout the shoot house without interfering in any of the squad's activities. The grading schema all military raters used is included in Appendix F. The grading schema was administered digitally via a custom-built Soldier Performance Application for Readiness and Talent Assessment (SPARTA) digital application tool (Peraton, Herndon, VA, USA). The outputs of the rating sheets were tracked and utilized for subsequent analyses. For a complete list of all study equipment, devices, and products see Section 3.4.3.

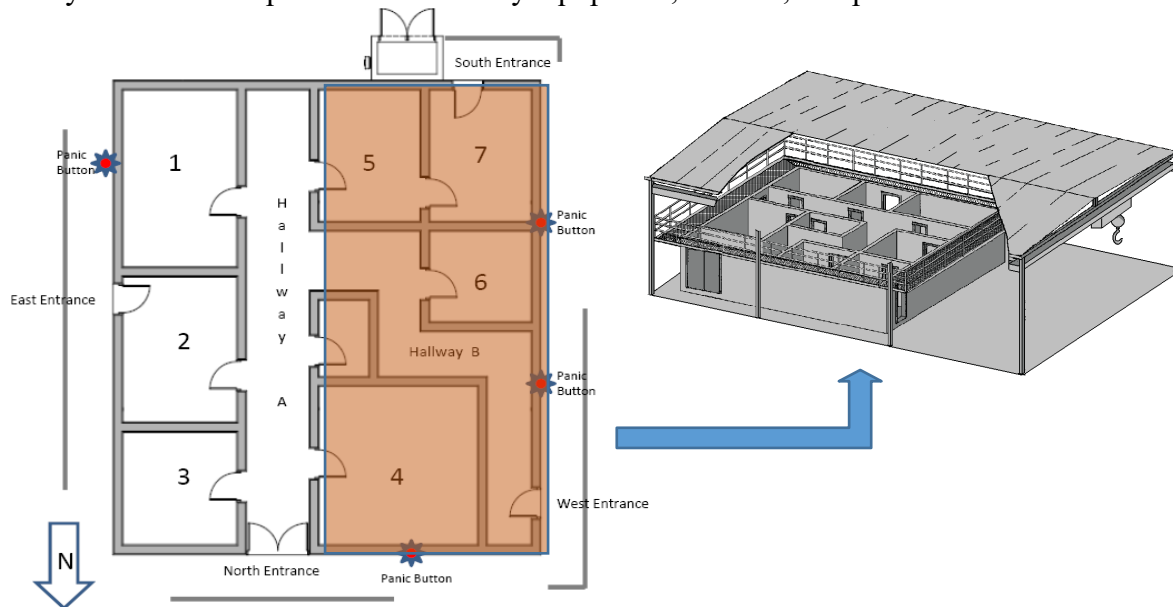


Figure 4: A schematic of the shoot house for Task Set 2. For the previously executed SUPRA testing, only rooms 1-3 were utilized for room clearing events. Shaded orange regions were considered out of bounds and were not cleared by the participating squads. Prior to step-off, the length of Hallway B near the West Entrance was utilized for weapon test firing.

3.4.2 Post-Test Data Collection Session

The Post-Test Data Collection session was conducted identically to the Pre-Test Data Collection Session and began immediately upon the participating Squad's completion of the Shoot House activities. The Post-Test Data Collection Session included filling out questionnaires, having resting physiological data taken, and having blood- and saliva-based biomarkers collected. Participants were asked to again complete the RPSD questionnaire (see Appendix A). All forms and questionnaires were administered digitally (via password protected laptop or tablet). HRV, HR, BR were all collected for 10 min during prone resting. Saliva- and blood-based biomarkers were also collected during this time identically to the methods and procedures outlined in the Pre-Test Data Collection Session section (see Section 3.3.1 for complete testing details).

3.4.3 Task Set (2) Test Equipment, Devices, and/or Products Used

Listed below are the devices, products, and testing equipment used throughout the previously executed SUPRA testing for Task Set (2). It is important to note that the products detailed herein do not constitute official government endorsement of any of these devices. These product descriptions are only included as recommendations based on the previously executed testing, but alternative equipment with similar technical specifications would be sufficient. It is highly likely that if the recommended procedures and methods outlined within this report are expanded beyond the squad echelon or to include additional battle drills of interest, then the proposed test equipment will likely need to be expanded or altered as well. For more detailed information on the equipment-specific usage procedures, considerations, and lessons learned based on the previously executed SUPRA testing, see Chapter 4.0 Sensor Overview & Test Preparation.

1. Polar Team Pro© heart rate monitor (Polar, Bethpage, NY): The Polar Team Pro© system was used to capture integrated heart rate data throughout shoot house testing. This system comprised the PSM for the SUPRA testing.
2. CCTV Mounted Cameras (Lockheed Martin Inc., USA): Off-body closed-circuit television (CCTV) cameras were used in this study and mounted to overhead rafters within the shoot house. CCTV cameras collected video for the duration of the shoot house execution.
3. Oqus motion capture system (Qualisys AB, Gothenburg, Sweden): the 3D motion capture (MOCAP) system collected participant weapon, torso, and helmet kinematics within the shoot house. Cameras were focused on key areas within each room and the hallway that had to be cleared by participants. The cameras were positioned on each side, anterior and posterior, and above the viewing area.
4. UTM© Ultimate Training Munitions (Ultimate Training Munitions, NJ., USA): The UTM© training system is comprised of non-lethal marking cartridges, weapon conversion kits, and PPE that provide realistic close-range combat effects. The reduced-energy, non-lethal cartridges leave a color-marking compound on clothing and armor. The visible impacts allow accurate assessment of simulated lethality.
5. Spartan After Action Review (SPAAR) display (Aptima® Woburn, MA, USA): in partnership with Soar Technology, has developed SPAAR, the Spartan After Action Review tool for the Office of Naval Research (ONR). SPAAR allows users to utilize multiple time-synced video, overhead map, and other real-time data feeds for quick and effective after-action reviews and data visualization and synchronization. The SPAAR system was used as a data visualization and data quality control aid as well as an after action aid for participants conducting Task Set (1) and (2).

6. Soldier Performance Application for Readiness and Talent Assessment (SPARTA) digital application tool (Peraton, Herndon, VA, USA): The SPARTA digital tool is a custom mobile enterprise application platform used to digitize assessment tools such as gradebooks, grade sheets, and military TE&O. The application, originally designed by the ARI and developed by Peraton, has been used for both individual and collective task assessments in military settings.
7. Digital Audio Recorder: The Tascam[®] DR-40X Four-Track Digital Audio Recorder (TEAC Corp., Montebello, CA, USA) is a high-quality audio recorder that can be used (in conjunction with a microphone) for dual recording and non-destructive overdub recording, etc. to track participant communication during execution of both Task Set (1) and (2).
8. Throat Microphone: The NT-3 Throat Mic Headset (IASUS Concepts, Richmond, BC, CAN) is a throat-mounted microphone used to collect individual verbal communication information and is compatible with the digital audio recorder described above. In the event a participant did not feel comfortable wearing the system or it could not be placed properly due to the configurations of other military equipment or PPE, the lower profile Califone Light- Weight Neck Microphone (Califone, Jessup, MD, USA) or the XLR Lavalier Microphone (Maono, USA) was used instead. Both are also compatible with the digital audio recorder described above. A web-based speech-to-text software application (Transcribe, Wreally LLC, Los Angeles, CA, USA) was used to transcribe the audio files taken from each participant for subsequent analysis.
9. i-STAT (Abbott Laboratories, Chicago, IL, USA): The handheld i-STAT is a mobile point-of-care-testing platform that provides diagnostic information on blood gases, chemistries, electrolytes, cardiac markers, coagulation, hematology, and endocrinology when combined with the appropriate test cartridges.
10. Personal Protective Equipment (PPE): All participants and personnel acting as OPFOR were asked to wear a significant amount of PPE including:
 - a. Hearing protection – PVC Foam Ear Plugs were required for all participants completing both Task Set (1) and (2).
 - b. Eye Protection – approved ballistic eye protection (glasses) were required for all participants completing both Task Set (1) and (2).
 - c. Ballistic Kevlar Helmet – Either the standard issue ACH, ECH or ballistic Gentex Corp.Ops-Core helmet was required for all participants completing both Task Set (1) and (2).

- d. Ballistic Body Armor – The SPCS with ballistic plate inserts was required for all participants completing both Task Set (1) and (2).
- e. Additional PPE was required by the Ft. Devens Range Control including gloves, Close Combat Mission Capability Kit (CCMCK) face masks, and groin protection which was required for all participants for Task Set (2).

4.0 SENSOR OVERVIEWS & TEST PREPARATION

Detailed information on the equipment- and sensor-specific usage procedures, considerations, and lessons learned is provided below. It is important to note that the products detailed herein do not constitute official government endorsement of any of these devices. These recommended procedures are only included to highlight how the previous SUPRA testing was executed and important lessons learned from that testing. It is highly likely that if the recommended procedures and methods outlined within this report are expanded beyond the squad echelon or to include additional battle drills of interest, then these proposed equipment testing procedures will likely need to be expanded or altered accordingly.

4.1 Task Set (1) Sensor Overviews & Test Preparations

4.1.1 Inertial Measurement Unit (IMU) Overview & Preparation

During execution of Task Set (1), Inertial Measurement Units (IMUs, APDM Inc., Portland, OR, USA) were used as wearable human movement tracking sensors. The IMUs measured high-precision acceleration, angular rate, and orientation data, sampled at 128 Hz, throughout the testing. The IMUs were affixed to the participants' weapons and helmets to track weapon and head orientation, weapon firing rates, and other metrics of interest. The data was logged and downloaded off the devices for follow-on analyses. IMU-based data were used to calculate in-field performance metrics (focused predominantly on collective lethality) such as: squad security, individual firing rate and shot timings, overall squad firing rates, and squad talking-the-guns ratios (defined in Section 5.2.3).

Prior to execution of the battle drill, IMUs were configured to a common wireless channel to ensure all IMU data, across all participants, were time synchronized. IMUs were affixed to both BLUFOR and OPFOR helmets and weapons via custom 3D-printed mounts (Figure 5).

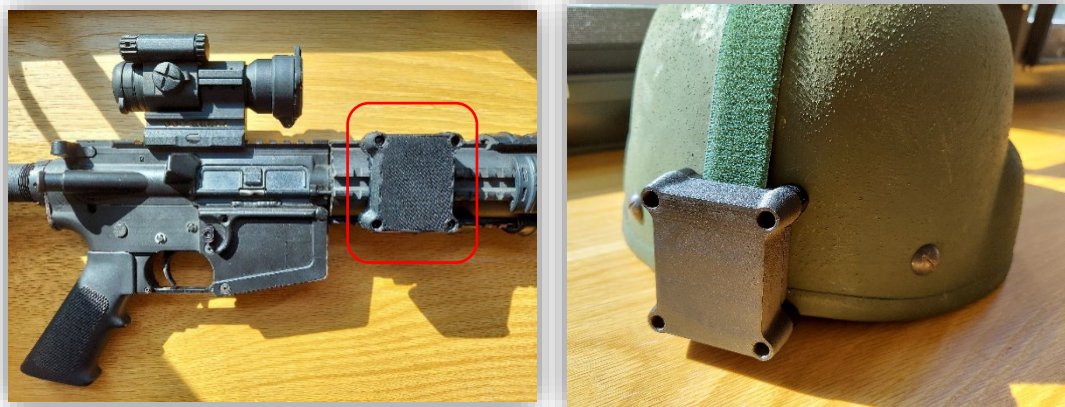


Figure 5: Images of the custom 3D-printed mounts used to affix the inertial measurement units (IMUs) to both the Picatinny Rails of the weapons (left) and the standard ACH helmet (right).

Weapon mounts were attached on the side Picatinny rails of either the participating squads' M4 carbines or M249 automatic rifles. Depending upon the handedness of the participant, the left or right side of the weapon was selected in order to avoid conflicts with preferred hand placement. Regardless of side, the mount was attached as close to the magazine as possible (furthest from the muzzle) to standardize placement along the length of the weapon barrel. The helmet mount included integrated hook and loop straps that allowed for exterior attachment on the center posterior edge of the helmets. The IMU related performance metrics did not require sensor calibrations beyond the standard factory calibrations. The quality of the factory calibrations was ensured prior to study execution using built-in tools designed by the IMU developer. During execution of the battle drill, two key times were logged in order to post-process the IMU data into phases: 1) mission start, and 2) when the squad reaches the limit of advance (LOA – the point beyond which the attacking element will not advance). These logged time points, along with post-hoc shot detection analysis of the weapon mounted IMUs, ultimately allowed the creation of three time phases: 1) movement to contact, 2) contact, and 3) actions on the objective. All IMU performance metrics were analyzed across these common time phases to standardize analysis across all trials.

4.1.2 MILES Overview & Preparation

During execution of Task Set (1), the MILES (Cubic Corp., San Diego, CA, USA) was used to track engagement data in the field. The MILES is a laser-based, force-on-force, combat simulation system frequently used by active-duty infantry units. The MILES consists of a chest-borne harness with embedded receivers and user interface, a helmet-borne harness with embedded receivers, and a weapon mounted laser. For the previously executed SUPRA testing, each member of the participating squad and each OPFOR player was issued and wore a complete MILES. The system utilizes encoded infrared light emitters and receivers to log information about the shooter, weapon, and ammunition as well as when a successful “hit” is scored on an OPFOR (enemy) or BLUFOR (squad) actor. The system uses auditory signals to indicate when hits or misses occur. Hit and miss information was downloaded and stored for subsequent analyses. MILES-based data were used to calculate in-field performance metrics (focused predominantly on individual and collective lethality) such as: total BLUFOR hits, total OPFOR hits, total BLUFOR near-misses, total OPFOR near-misses, shooter identification, and the timing of each hit or near-miss.

Prior to execution of the battle drill, IDs were set for each MILES harness for each squad position utilizing the designations below:

VestID	Label	Definition
1200	SL	Squad Leader
1202	ATL	Alpha Team Leader
1206	AAR	Alpha Automatic Rifleman
1208	AGRN	Alpha Grenadier
1204	ARM	Alpha Rifleman
1210	BTL	Bravo Team Leader
1214	BAR	Bravo Automatic Rifleman
1216	BGRN	Bravo Grenadier
1212	BRM	Bravo Rifleman
1501	OPFOR1	Enemy Actor 1
1503	OPFOR2	Enemy Actor 2

Each MILES harness was then paired with a corresponding helmet harness and an identical duty position label was added. All data from previous iterations were cleared prior to battle drill execution and the internal clocks for each harness were synchronized. The lasers were then mounted to the weapons of both the OPFOR and BLUFOR participants and paired with the corresponding harness system. Once the battle drill was completed, the events were downloaded to an exercise group file for subsequent analyses using the corresponding custom MARS software tool application (Cubic Corp., San Diego, CA, USA),.

4.1.3 Heart Rate and GPS Monitor Overview & Preparation

During execution of Task Set (1) and Task Set (2), the Polar Team Pro© heart rate monitor (Polar, Bethpage, NY) was used to track global positioning (GPS) and physiological response (heart rate) data. The Polar Team Pro© system combines GPS-derived movement data (sampled at 10 Hz), inertial sensor metrics (sampled at 200 Hz) and integrated heart rate monitoring into a mobile wearable human performance tracking sensor. This system comprised the PSM for the SUPRA testing. The Polar Team Pro© device is comprised of a chest strap (with integrated heart rate sensors) and a removable puck, which contains the inertial measurement unit and GPS receiver. Chest straps are variable in size to fit a wide variety of body dimensions. Heart rate and movement data were streamed real-time via Bluetooth within 200 m and data logged for post-analysis. Heart rate maximums, minimums, and averages were calculated for the duration of each battle drill execution. Heart rate-based data were also used to calculate pre/post testing physiological metrics such as: resting HR, HRV, and BR. GPS-based data were used to calculate in-field performance metrics (focused predominantly on individual and collective movement) such as: individual location, squad movement speed, and squad formation spacing.

Prior to execution of the battle drill, “player profiles” are built and established within the web-based Polar Team Pro© application. Each squad is set up as a “team” within the application so that heart rate, inertial, and GPS-data can be time synched across all squad positions within that team. Player profiles require information about each squad members’ height, age, and weight. It is recommended that no other personal identifiers be used and instead participant numbers and

squad positions should be used and assigned to player numbers. Once the teams and player profiles are built and player numbers have been assigned, each Polar Team Pro© puck must be synched with a player profile for each member of the squad directly prior to battle drill execution. OPFOR participants were also assigned a team, profile, player number and puck so that their position information could be logged relative to the BLUFOR participants. During execution of the Task Set (1), three time phases were created within the Polar Team Pro© web-based application including: 1) Pre-Test, 2) STX Lane Execution, and 3) Post-Test. All heart rate, inertial, and GPS-based performance metrics were analyzed across these common time phases to standardize analysis across all trials. Once data collection is completed and all sensor pucks have been returned to their charging docks, the data can be downloaded for subsequent analysis.

4.1.4 Audio Recorder Overview & Preparation

During execution of Task Set (1) and Task Set (2), the Tascam® DR-40X Four-Track Digital Audio Recorder (TEAC Corp., Montebello, CA, USA) was used to record all squad communications. The Tascam® is a high quality audio recorder utilizing unidirectional stereo condenser microphones that can record in A-B and X-Y positions with up to 4-channel mode that can be used (in conjunction with a microphone) for dual recording and non-destructive overdub recording, etc. to track participant communication during executions of both Task Set (1) and (2). The NT-3 Throat Mic Headset (IASUS Concepts, Richmond, BC, CAN) is a throat-mounted microphone that was used to collect individual verbal communication information and is compatible with the digital audio recorder described above. This system is elastic and is worn like a choker about the neck. In the event a participant did not feel comfortable wearing the system or it could not be placed properly due to the configurations of other military equipment or PPE, the lower profile Califone Light-Weight Neck Microphone (Califone, Jessup, MD, USA) or the XLR Lavalier Microphone (Maono, USA) were used instead. Both are also compatible with the digital audio recorder described above. A web-based speech-to-text software application (Transcribe, Wreally LLC, Los Angeles, CA, USA) was used to transcribe the audio files taken from each participant for subsequent analysis. The uploaded audio data are only used to generate transcriptions and are not stored. Subsequent analysis of the participant communications was conducted on the transcribed data. Audio-based data were used to calculate in-field performance metrics (focused predominantly on collective communication) such as: total closed loop communications, number of procedural leadership commands issued, and total words spoken.

Prior to execution of the battle drill, all recorders were fully charged and SD cards were inserted to ensure each recorder was able to data-log for the entirety of the battle drill. All recorders were set to record simultaneously prior to emplacement on the participating squads. Recorders were placed in available magazine pouches on each Soldier's kit. Each participant wore two recorders – one plugged directly into the corresponding throat or lapel microphone (see above) and one attached to the back of the body armor. This allowed for simultaneous collection of both direct (throat microphone) and indirect (secondary recorder) communication data. A whistle blow was used to start each battle drill execution trial so that the sound would register on the recorders'

logs. The verbal confirmation call of “limit of advance” indicated the end of the battle drill execution and was used to truncate each audio recording data file.

4.1.5 OC Assessment Application Overview & Preparation

During execution of Task Set (1) and Task Set (2), the SPARTA digital application tool (Peraton, Herndon, VA, USA) was used to record all observer controller (OC) assessment information. The SPARTA digital tool is a custom mobile enterprise application platform used to digitize assessment instruments such as surveys, gradebooks, grade sheets, and military TE&O for battle drill execution. The application, originally designed by the ARI and developed by Peraton, has been used for both individual and collective task assessments in military settings. A custom application was built for both Battle Drill 2A and Battle Drill 6 to track OC ratings of squad mission performance in support of SUPRA testing execution. SPARTA-based data were used to calculate in-field performance metrics (focused predominantly on collective task execution quality) such as: performance ratings for each battle drill task step, performance ratings for each battle drill sub task step, overall ratings of squad tactical performance constructs.

Prior to execution of the battle drill, specific data collection instances for each drill and each trial/iteration were established within – and published to – the SPARTA application. Each team of four OCs synchronized each instance of the battle drill to ensure evaluation start times and scores were synched properly across iterations. Once the OCs had completed scoring for each battle drill execution, data were stored for subsequent analysis. The complete grading schema all military raters used is included in Appendix F of this report. The grading schema expands the battle drill task steps outlined in ATP 3-21.8 to allow for a three-point (0, 1, or 2) grade to execution of each required task step and sub task. A score of “0” for a task step indicated failed or sub-standard execution. A score of “1” indicated standard acceptable execution. A score of “2” indicated higher or above standard performance for that task step. Both raw scores and weighted scores were captured and stored for subsequent analysis. Weighted scores applied a mathematical weighting to task steps that required collective action as opposed to individual action. During execution of the battle drill, the OCs were directed to never correct, assist, or otherwise train the participating squads. They were directed not to interfere with any participant activities and functioned as observers and assessors only. Only if there was a direct safety violation or increased risk to the participating squad were the OCs authorized to intervene in the execution of the drill.

4.1.6 Lessons Learned from Task Set (1) Sensors & Test Preparations

Over the course of the SUPRA testing for Task Set (1), several key lessons were learned in-field, which significantly reduced data collection errors, increased data quality, increased participant comfort and cooperation, or otherwise helped to ensure testing was successfully executed. These lessons are summarized below, specific to each sensor system of interest.

- For IMU preparation and usage, it is recommended that all weapon- and helmet-mounts be affixed to all equipment during the Orientation session ahead of execution. This ensures that IMUs can be quickly attached and removed directly prior to and after battle drill execution.
- For the MILES, it is recommended that MILES outcomes including hit/miss information and shooter identification be shared directly with participating squads as part of their After Action Review (AAR) activities if they are conducted. Additionally, if zeroing and test firing of the MILES cannot occur during the Orientation Day activities, field-expedient zeroing of the MILES utilizing a 30-m target on the TA-12 range complex was shown to be acceptable for zeroing the system during the previously executed SUPRA testing.
- For the Polar Team Pro© system preparation and usage, it is recommended that pre-set, labeled “phases” be built within the web-based application for all test activities within each task set including the pre-test data collection, STX Lane Data Collection, SH Data Collection, and post-test data collection. Starting and stopping all sensor data collection within each pre-set and pre-labeled phase allowed for faster post-processing of the Polar Team Pro© data. In addition, if event data appear to be missing, double check the stored data to see if cross-talk between sensors resulted in merged data. This is acceptable, as data are still appropriately labeled and segmented, and will simply need to be separated during post-processing. To reduce the likelihood of this, it is recommended that participants stay within a designated area once their sensor is activated and data collection is not initiated until the live-streaming interface indicates that all participant sensors are successfully streaming.
- For the audio recorder instrumentation preparation and usage, there are several considerations that came about as a result of the previously executed testing. The quality of audio from the throat microphone can be extremely variable. As a result, an additional external microphone was added to achieve higher data quality. For future testing, the throat mics will be replaced with lapel microphones for increased data quality and participant comfort. It is also important to note that recorders may come loose and fall out during execution of the drill. It is recommended that an Apple Airtag (or similar) be affixed to each recorder so that they can be recovered from the lane if lost.
- For the SPARTA application preparation and usage, it is critical that all members of the OC team receive adequate training and familiarity with the system prior to usage. It is also recommended that the OC team as a whole discusses and agrees upon specific examples of sub-standard (0), standard (1), and above standard (2) performance for each task step of each battle drill in order to maximize agreement and consistency in ratings across the OC teams. OC team scoring is, by necessity, subjective and should therefore be treated carefully in post-processing and analysis. In addition, it is critical that the OC team understands they are not meant to interfere with, or otherwise actively “train,” the participants during any assessment activities, but should save all comments and training principles for AAR activities if they are conducted. If OCs actively train or correct participants during drill execution, it would be difficult to interpret the performance data during post-processing.

4.2 Task Set (2) Sensor Overviews & Test Preparations

4.2.1 Motion Capture Overview & Preparation

During execution of Task Set (2), the Oqus motion capture system (Qualisys AB, Gothenburg, Sweden) captured participant position and orientation data when engaging with an OPFOR combatant. The motion capture (MOCAP) system, operating at 100 Hz, consisted of 13 cameras mounted on catwalk railings and atop walls surrounding key areas of interest. Specifically, the capture volume included the corridor leading up to the shoot house entrance and the room occupied by the OPFOR combatant. All BLUFOR and OPFOR weapons, torsos, and helmets were tracked using Qualisys Traqr modules. The Traqrs consisted of four active markers that emitted infrared light so that the mocap system could track 6° of freedom motion of each module. Sequence coding of the markers allowed the system to distinguish each Traqr, allowing for automated participant and body segment identification. Traqrs were equipped to participant weapons via custom 3D-printed mounts that attached to the Picatinny Rails of either the M4 carbine or M249 automatic rifle. Depending upon the handedness of the participant, the left or right side of the weapon was selected in order to avoid conflicts with preferred hand placement. Regardless of side, the mount was attached as close to the magazine as possible (furthest from the muzzle) to standardize placement along the length of the weapon barrel. The helmet mount included integrated hook and loop straps that allowed for exterior attachment on the center posterior edge of the helmets. All captured data were logged stored on a central capture computer for follow-on analyses. MOCAP-based data were used to calculate in-field performance metrics (focused predominantly on collective motion) such as: the percentage of the room cleared by the squad, squad movement speeds, time spent in the fatal funnel, and weapon barrel tracking.

Prior to battle drill execution, and in order to create a coordinate system that aligned with the barrel of each weapon, calibration trials were collected prior to shoot house execution. Additional passive reflective markers were placed along the barrel of the weapon, which allowed the creation of a barrel axis. Another passive marker was placed atop the weapon to help create a coordinate system with an origin contained within the barrel. Using the known orientation and position of the weapon Traqr and barrel coordinate systems, a rotation matrix and translation between coordinate system origins was calculated. This coordinate transformation information was recorded for each weapon so that accurate weapon aim points could be calculated using only the weapon Traqrs. No weapon passive markers were required during shoot house trial executions. However, passive markers were affixed to the OPFOR combatant room's door in order to identify room entry timings. MOCAP performance metrics were calculated during the 20 s duration following door opening in order to standardize the analysis across all squads and trials.

4.2.2 CCTV Overview & Preparation

During execution of Task Set (2), CCTV Mounted Cameras (Lockheed Martin Inc., USA) were used to capture video documentation of all shoot house activities. The CCTV cameras were mounted to overhead rafters within the shoot house. The CCTV cameras collected 720p – 4k30 video for the duration of the shoot house execution. All cameras were time synched at the start of

the event. Video and audio data were live streamed, recorded, and stored by a central data collection computer for subsequent download, after-action review, and post-analysis. Video data captured by the CCTV Mounted Cameras were primarily utilized by the OC team to review and replay aspects of squad execution when making their assessments (see Section 4.2.5 below). Video-based data were used to calculate in-field performance metrics (focused predominantly on task identification) such as: the first and last squad position/personnel entering or exiting each room, key task steps completed within each room, and shooter identification. Prior to execution of the battle drill, all CCTV cameras had to be mounted and the corresponding clocks synchronized so that video replay for all rooms could occur simultaneously as needed.

4.2.3 Heart Rate and GPS Monitor Overview & Preparation

During execution of Task Set (1) and Task Set (2), the Polar Team Pro© heart rate monitor (Polar, Bethpage, NY) was used to track GPS and physiological response (heart rate) information. This system comprised the PSM for the SUPRA testing. For full details on the use of the Polar Team Pro© system, see Section 4.1.3. Specifically, for Task Set (2), GPS positioning data were not captured during execution of Battle Drill 6. Interference from the ballistic walls of the shoot house decreased the quality of the GPS signal such that individual shooter locations could not be distinguished within each participating squad. Shooter location was instead determined by the captured CCTV video data and MOCAP data. However, heart rate data was still captured via the Polar Team Pro© system for all participating squads. Heart rate maximums, minimums, and averages were calculated for the duration of each battle drill execution. Heart rate-based data were also used to calculate pre/post testing physiological metrics such as: resting HR, HRV, and BR. For full details on the use of the Polar Team Pro© equipment, see Section 4.1.3. Polar Team Pro© systems for Task Set (2) were used identically to the procedures outlined for Task Set (1).

4.2.4 Audio Recorder Overview & Preparation

As stated previously, during execution of Task Set (1) and Task Set (2), the Tascam® DR-40X Four-Track Digital Audio Recorder (TEAC Corp., Montebello, CA, USA), was used to record all squad communications. The NT-3 Throat Mic Headset (IASUS Concepts, Richmond, BC, CAN) throat-mounted microphone and the Califone Light-Weight Neck Microphone (Califone, Jessup, MD, USA) or the XLR Lavalier Microphone (Maono, USA) were used as both are compatible with the digital audio recorder described above. A web-based speech-to-text software application (Transcribe, Wreally LLC, Los Angeles, CA, USA) was used to transcribe the audio files taken from each participant for subsequent analysis. For full details on the use of the audio recording equipment, see Section 4.1.4. Audio recorders for Task Set (2) were used identically to the procedures outlined for Task Set (1).

4.2.5 OC Assessment Application Overview & Preparation

During execution of Task Set (1) and Task Set (2), the SPARTA digital application tool (Peraton, Herndon, VA, USA) was used to record all OC assessment information. For full details

on the use of the SPARTA application, see Section 4.1.5. The SPARTA application procedures for Task Set (2) were identical to the procedures outlined for Task Set (1).

4.2.6 Lessons Learned from Task Set (2) Sensors & Test Preparations

Over the course of the SUPRA testing for Task Set (2), several key lessons were learned in-field which significantly reduced data collection errors, increased data quality, increased participant comfort and cooperation, or otherwise helped to ensure testing was successfully executed. These lessons are summarized below, specific to each sensor system of interest.

- For the Motion Capture system preparation and usage, there are several key recommendations based on lessons learned from the previously executed testing. It is recommended that motion capture volume calibrations are completed before and after shoot house execution so that post-processing data analysis staff has two options. Many of the motion capture cameras were mounted to a rafter system that was somewhat unstable and could vibrate when OCs traversed the overhead walkways. Since accurate relative 3D location information is vital to motion capture analysis (i.e. location of each camera relative to the lab's coordinate frame of reference), capturing a backup calibration file proved extremely useful to ensure data integrity. When utilizing active Traqr modules, conduct multiple pre-checks to ensure each Traqr is powered on and functioning properly prior to data collection. This is especially vital when many Traqrs are in use; in the case of the SUPRA data collection, 30 Traqrs (3 body segments and 10 individuals including the BLUFOR and OPFOR) were utilized per trial. In one instance, a single Traqr was not powered on, leading to missing data for a participant's helmet kinematics that could not be recovered.
- Recommendations for the Polar Team Pro © system, audio recorders, and SPARTA application are identical to those outlined in Section 4.1.6 for Task Set (1) above.

4.3 Pre- and Post- Test Data Collection Session Sensor Overviews & Test Preparations

4.3.1 i-STAT Overview & Preparation

During the execution of both the pre- and post-test data collection sessions for Task Set (1) and Task Set (2), the handheld i-STAT (Abbott Laboratories, Chicago, IL, USA) blood analysis system was used. The i-STAT is a mobile point-of-care-testing platform that provides diagnostic information on blood gases, chemistries, electrolytes, cardiac markers, coagulation, hematology, and endocrinology when combined with the appropriate test cartridges. Two to three drops of whole blood were required per test cartridge in order to generate the outputs. Full procedures for how finger-stick blood draws were accomplished are outlined in Section 3.3.1. i-STAT-based data were used to calculate pre- and post-test physiological response data (focused on collective fatigue and/or energy expenditure response) such as: Anion Gap, Glucose, and Creatinine blood concentrations.

Prior to battle drill execution, the testing team would update the i-STAT firmware/software or confirm that it had been appropriately updated and installed. The i-STAT TriControls, a system-specific calibration and quality control procedure, can be run in a laboratory prior to field data collection activities. The testing team would confirm that the TriControls had not expired, and would follow all guidelines outlined by Abbott (<https://www.globalpointofcare.abbott/en/product-details/apoc/istat-controls.html>). The testing team would conduct TriControl quality control as often as defined in the Abbott Point of Care guideline (and at least prior to each new field testing iteration). Each morning prior to testing, the team would ensure the i-STAT was within operating temperature, turn the unit on, and wait for the start screen. The team would wait for the system to warm to operating temperature before usage. The “Electronic Simulator” was run as a final quality control check before analyzing any whole-blood enabled i-STAT cartridge inputs.

4.3.2 Saliva Sampling Overview & Preparation

During the execution of both the pre- and post-test data collection sessions for Task Set (1) and Task Set (2), saliva was collected via passive drool or oral saliva swab techniques to assess changes in acute stress response markers. Prior to a sampling time, participants were asked to avoid eating, chewing tobacco, and drinking acidic drinks (coffee, juices) for at least 30 min. Participants were instructed to rinse their mouth at least twice with cool water and then either spit through a straw directly into a 15 mL saliva collection tube or place an oral swab underneath their tongue to collect saliva for 2 min. Once removed, used swabs were inserted into a swab storage tube. Saliva and swab collection tubes were then labeled with an identification number and stored at -20° Celsius (or colder) until they were assayed. Saliva was transported to DEVCOM-SC and/or DEVCOM Chemical Biological Center for analysis. All samples were disposed of in biohazard bags in accordance with all state and federal regulations that govern biohazardous waste. Saliva-based data were used to calculate pre- and post-test physiological response data (focused on collective stress response) such as: Cortisol and Alpha-amalyse concentrations.

4.3.3 Heart Rate Monitor Overview & Preparation

During execution both the pre- and post-test data collection sessions for Task Set (1) and Task Set (2), the Polar Team Pro© heart rate monitor (Polar, Bethpage, NY) was used to track physiological response information including HRV, HR and BR collected during 10 min of prone resting prior to and immediately after execution of the battle drills of interest. This system comprised the PSM for the SUPRA testing. Heart rate-based data were used to calculate pre/post testing physiological metrics such as: resting HR, HRV, and BR. For full details on the use of the Polar Team Pro© system, see Section 4.1.3.

4.3.4 Lessons Learned from Pre- and Post- Test Data Collection Session Sensors & Test Preparations

Over the course of the SUPRA testing for both the pre- and post-test data collection sessions for Task Set (1) and Task Set (2), several key lessons were learned in-field, which significantly reduced data collection errors, increased data quality, increased participant comfort and cooperation, or otherwise helped to ensure testing was successfully executed. These lessons are summarized below, specific to each sensor system of interest.

- For the capillary blood collection, a few observations and lessons learned were noted. Cold weather significantly impacts the ability to collect whole blood from the distal extremities. Properly warming and prepping the hand optimizes successful sample retrieval. It is also recommended that raw data are printed directly to hard copy from the i-STAT each day and a scanner is used to create a digital copy as soon as possible. At the end of each day, it is recommended that the raw data for all participants be entered into a master data file for easy summary statistics at the end of each week.
- Recommendations for the Polar Team Pro © system are identical to those outlined in Section 4.1.6 for Task Set (1) above.

5.0 SMALL UNIT COLLECTIVE PERFORMANCE METRICS

5.1 Collective Military Performance Assessments Background

The U.S. Army DEVCOM SC established the MASTR-E Program's SUPRA effort to, among other priorities, develop novel small unit metrics of operational performance. Based on the SUPRA work executed to date, a major objective of this report is to provide recommendations on approaches to the development of metrics of collective small unit performance that correlate meaningfully with mission outcomes.

As previously stated, this is a challenging area for many reasons. While aspects of individual proficiency may be generalized to groups, teams, or units, the literature on military collective operational performance measurement and quantification is sparse [17]. This is due in no small part to the fact that, historically, assessments of small unit proficiency occur at home station and are largely observational and subjective in nature. Even at large, highly instrumented training centers such as the U.S. Army National Training Center (NTC) or Joint Readiness Training Center (JRTC), very little data are stored and collected at the small unit level. The focus of these training centers is – by necessity – on the leadership chain-of-command at the battalion level echelon or higher. Small unit performance quantification is further complicated by the complexity of the operational environment. Small units operate within an ever-shifting paradigm of locations, mission demands, and equipment capabilities.

Throughout the design and execution of the SUPRA testing, steps were taken to reduce operational complexity without compromising operational validity through the focus on battle drill execution at the squad level. Each drill-set was scored by military experts to allow for multivariate correlations of small unit performance metrics to quality of execution and task outcomes. Each drill was repeated up to three times over the course of the testing. Drills were repeated in order to better understand and develop measures that were sensitive to changes in small unit performance over time. The previously executed SUPRA testing was treated as a mixed-model design. The experimental design for both Battle Drill 2A within Task Set (1) and Battle Drill 6 within Task Set (2) were of the form: Squads (1 to N) by Iteration (1st, 2nd, 3rd) within Skill Group. This allowed for the application of established analytical techniques to the development of quantitative small unit performance measures. Quantitative measures were developed first by detailed examination of the standards and task steps required at the squad level for successful execution of the battle drills of interest (see Section 5.2.1 for more detail). Particular attention was given to task steps that fell into high level operational priority areas including “Shoot” (Lethality), “Move”, and “Communicate.” Once determinations were made about the components of each task step that could be directly measured, performance metrics were developed from the directly measured data.

There are many instances during battle drill execution in which it is difficult to differentiate what constitutes team performance and what is simply the result of an aggregate of individual performances. Both *interactive* (individual duties are collaborative and involve joint action) and

coactive (group productivity is a function of separate, but coordinated, individual efforts) [17] measures of performance were considered for the SUPRA effort. Performance measures were therefore developed through one of two methods, either by (1) Aggregation of Individual & Fire Team Performance (*coactive*) or (2) Novel Small Unit Metric Development (*interactive*). See Section 5.2.2 & 5.2.3 for more detail on these two approaches. Sections 5.3 – 5.7 below give examples of a limited set of performance metrics that were developed for the previously executed SUPRA testing utilizing these approaches and calculated from the measured data taken. Particular emphasis was given to measures that were sensitive to differences between the squads tested, and/or that were sensitive to changes over time and execution trials, and/or that correlated very strongly with the military rater assessments. It is hoped that by following and expanding upon the testing and metric development procedures outlined here, future research can be done to expand quantitative in-field performance measures for other military echelons and mission sets of interest.

5.2 Approaches to Developing Collective In-Field Performance Measures

5.2.1 Breakdown of TE&Os for Battle Drills

Quantitative measures were developed first by detailed examination of the standards and task steps required at the squad level for successful execution of the battle drills of interest. Particular attention was given to task steps that fell into high level operational priority areas including “Shoot” (Lethality), “Move”, and “Communicate.” Once determinations were made about the components of each task step that could be directly measured, performance metrics were developed from the directly measured data. An example of this process is provided for Battle Drill 2A below.

Battle Drill 2A includes 8 task steps and performance measures with 45 additional sub-tasks that the squad is expected to perform as applicable. Appendix D contains the full list of task steps and performance measures for Battle Drill 2A. The first task step included in Battle Drill 2A is the following:

The team in contact immediately returns well-aimed fire on known enemy position(s) and assumes the nearest covered positions. Soldiers receiving fire take up nearest positions that afford protection from enemy fire (cover) and observation (concealment)

A detailed examination of this task step allows for the determination of several directly measurable components related to operational priority areas including “Shoot” and “Move.” The first statement, “*the team in contact*” can be directly measured via a combination of positioning (GPS) and engagement information to determine the location of the team that is receiving contact and the associated firing activity such as who from the squad is engaging (MILES) and at what firing rate (IMUs). This statement is followed by the qualifier “*immediately*” which indicates a critical timing component. Time can be directly measured from several different sensors, but for the previously executed SUPRA testing, the MILES was used to track timing information related

to firing engagements. The statement continues with “*returns well-aimed fire on known enemy position(s).*” Firing orientation and rate can be directly measured via IMUs while enemy position can again be measured via GPS. Audio recorders were used to track squad communications about the enemy positioning, including the accuracy of the shared information and the clarity of the communication. The next part of the task step includes the phrase “*and assumes the nearest covered positions*” which can be measured via a combination of GPS location tracking and OC assessment of the quality of the cover utilized by the squad. Following this same procedure, the second half of the statement “*Soldiers receiving fire take up nearest positions that afford protection from enemy fire (cover) and observation (concealment)*” also includes references to engagements, location, movement, and quality of cover and can thus be directly measured via the combination of MILES, GPS, IMUs, audio recorders, and OC assessments described above. See Section 3.3.4 and Section 4.0 for the full list of equipment and sensors utilized during Battle Drill 2A testing as well as the sensor-specific overviews and testing preparations. By directly measuring key elements of each task step within each battle drill of interest, quantitative performance measures can be developed that directly correlate to mission outcomes and overall quality of battle drill execution.

5.2.2 Aggregating Individual & Fire-Team Performance

Once determinations were made about the components of each battle drill task step that could be directly measured (see Section 5.2.1 above), performance metrics were developed from the directly measured data. One approach taken for the directly measured data was to develop performance metrics that were either means (averages) or summations of the individual and fire team data. This is reflective of *coactive* performance, where group productivity is a function of separate, but coordinated, individual efforts [17]. This includes any instance where collected data were averaged or summated across fire team members or across all members of the squad in order to calculate a performance metric of interest. Examples of performance metrics developed with this approach include:

Total BLUFOR Hits - this is the total number of successful hits or kills the squad as a whole made on the OPFOR during execution of the battle drill as measured via the MILES. This measure is the summation (or aggregation) of all the individual hits made by all squad members and is included in the operational priority area “Shoot”

Fire Team Movement Speed – this is the average movement speed for a fire team within the squad during execution of the battle drill as measured via the GPS system. This measure is the mean (average) of all the individual movement speeds by all fire team members and is included in the operational priority area “Move”

While coactive performance metrics are critical to the overall understanding and assessment of small unit proficiency, it is also important to develop measures reflective of true teaming (synergistic) behavior as opposed to the aggregation of individual performances.

5.2.3 *Novel Small Unit Metric Development*

Once determinations were made about the components of each battle drill task step and subtask that could be directly measured (see Section 5.2.1 above), performance metrics were then developed from the data. The second approach taken was to develop novel performance metrics that were reflective of the squads' overall teaming behavior and could not be calculated from only individually collected data. This is reflective of *interactive* performance, where individual duties are collaborative and involve joint action [17]. This includes any instance where collected data were subjected to additional calculation steps or mathematical equation development based on overall squad behaviors and outcomes in order to calculate a performance metric of interest. Examples of performance metrics developed with this approach include:

Talking-the-Guns Ratio – this is the ratio of time the squad as a whole spends shooting relative to how much time the squad spends not shooting as measured via the weapon-mounted IMUs and is reflective of the squads' rate of fire control. Calculation of this measure is dependent on the firing behavior of all squad members and it cannot be calculated from only individual data. Additional details on this measure are given in section 5.3 below. This measure is included in the operational priority area “Shoot”

Squad Formation Spacing – this is the area of coverage of the squad as measured via the GPS system and is reflective of the overall shape and areas of control of the squads' formations as they execute the battle drill. Calculation of this measure is dependent on the movement behavior of all squad members and it cannot be calculated from only individual data. Additional details on this measure are given in section 5.4 below. This measure is included in the operational priority area “Move”.

Squad Closed Loop Communication count – this is the total number of closed loop communications made by the squad as a whole during execution of the battle drill and is measured via the transcribed audio recordings. This measure is the summation (or aggregation) of all the closed loop statements made by all squad members and requires both call and response from different members of the squad; therefore, it cannot be calculated from individual data only. This measure is included in the operational priority area “Communicate.”

It is important that both coactive performance metrics and interactive performance metrics are considered in order to broaden the overall understanding and assessment of small unit proficiency. It is hoped that by following and expanding upon the metric development procedures outlined above, future research can be done to expand quantitative in-field performance measures for other military echelons and mission sets of interest.

5.3 Collective Performance Measures Highlight – “Shoot”

The Talking-the-Guns Ratio (TG Ratio) was defined as the percentage of the contact phase duration in which any BLUFOR weapons were firing relative to dead space (non-firing). The contact phase was defined between the first and last shot taken by either the OPFOR or BLUFOR during the mission. Typically, OPFOR initiated contact by firing the first shot and BLUFOR ended contact by firing the final shot.

Each shot was detected by low-pass filtering the acceleration and angular rate data from the weapon-mounted IMUs and logging when thresholds were exceeded. Every shot was given a constant duration of 0.0625 s, a value decided upon by examining approximately 500 example shot acceleration profiles from M4 and M249 weapons firing blank rounds. Using the shot timings of each BLUFOR weapon and the assumed constant duration of each shot, a boolean array was generated over the duration of contact where 0 corresponded to not shooting and 1 corresponded to shooting. By summing the array, dividing by the number of elements of the array, and multiplying by 100%, the TG ratio was calculated. A TG ratio value of 0% implied that no BLUFOR weapons were fired during contact, while a value of 100% implied that BLUFOR weapons fired continuously without pause throughout contact.

Direct correlations of the TG Ratio to mission outcomes including the OC assessments, total number of BLUFOR kills, mission success/failure and mission duration are ongoing and will be included in Part II of this reporting. However, a higher value for the TG Ratio may be interpreted as advantageous because it indicates the BLUFOR is actively suppressing the enemy. It is important to consider, however, that there is no directionality of fire or ammunition count included within the metric calculation. BLUFOR could be firing in the opposite direction of the enemy or overspending ammunition and still score a high TG ratio. Care should therefore be taken when examining measures in isolation and metrics, such as TG ratio, are often more meaningful when analyzed alongside other performance metrics.

2.1 Collective Performance Measures Highlight – “Move”

Squad Formation Spacing was defined as the convex hull area of the polygon defined by the BLUFOR participants' Universal Transverse Mercator (UTM) coordinates. The Polar Team Pro© systems worn by all BLUFOR and OPFOR participants logged longitude and latitude GPS coordinates over the duration of the mission. Longitude and latitudes were converted to Universal Transverse Mercator (UTM) coordinates in order to more easily estimate the two-dimensional area between squad members. UTM is a map projection that performs a geographical transformation of Earth's curved surface to a flattened surface based upon the cylindrical transverse Mercator. The cylindrical projection preserves area calculations since the coordinate system provides constant planar distance calculations, allowing simple Cartesian mathematics to calculate the area between participants. Specifically, the area of the convex hull surrounding BLUFOR participants was estimated at each instance in time for the duration of the mission, allowing examination of changes in area over time.

Direct correlations of the formation spacing to mission outcomes including the OC assessments, total number of BLUFOR kills, mission success/failure and mission duration are ongoing and will be included in Part II of this reporting. In general, neither a too high nor a too low value of formation spacing is optimal. Higher values may indicate that the BLUFOR are too spaced out, reducing the ability to communicate (either verbally or via nonverbally, i.e. hand signaling) or to maintain situational awareness. This could potentially lead to fratricide if the squad loses track of friendly positioning. Conversely, lower values of formation spacing could indicate that the BLUFOR were too close together, meaning that the squad could potentially be more easily eliminated by enemy small arms fire (or grenades if present – simulated grenades were not used within SUPRA) and that they are not occupying a large enough space. Consequently, the optimal spacing is likely an area value somewhere in between.

Suspected enemy locations, lighting, and geographical features such as hills, swamps, and foliage density all affect formation spacing (to name a few). Thus, pairing the formation spacing metric with known coordinates is pivotal to understanding the data. When calculating the formation spacing of the entire squad, formation spacing will increase significantly if a fire team decides to execute a flank while the other fire team suppresses the enemy. In situations such as these, examining the metric in isolation, without the context of GPS coordinate movement or other performance metrics, can possibly lead to incorrect interpretations.

5.4 Collective Performance Measures Highlight – “Communicate”

Squad Closed Loop Communication count was defined as the total number of times during each battle drill execution iteration squad members issued a closed-loop communication. A closed-loop communication is one in which a squad member verbalizes information and that information is either acknowledged by, followed up upon, or otherwise responded to by a different member of the squad. This measure is the summation (or aggregation) of all the closed loop statements made by all squad members and requires both call and response from different members of the squad. This is measured via direct transcription of the collected audio data. For the SUPRA testing, recorded audio data were transcribed first via a web-based speech-to-text software application (Transcribe, Wreally LLC, Los Angeles, CA, USA). The uploaded audio data were only used to generate transcriptions and were not stored, accessed, or used for any other purpose. Due to the challenges associated with commercial, automated transcription of military-specific phrases and words, the transcribed data outputs were then manually checked and corrected by test team members as needed. Total communication counts were then tallied manually.

Direct correlations of the communication data to mission outcomes including the OC assessments, total number of BLUFOR kills, mission success/failure and mission duration are ongoing and will be included in Part II of this reporting. However, in general, a higher number of closed loop communications is considered desirable, as it indicates the squad is communicating frequently and effectively. Conversely, a decreased number of closed-loop

responses indicates squad members are not communicating or responding as frequently. An increased number of open-loop responses (communications in which information is verbalized but not acknowledged by, followed up upon, or otherwise responded to by a different member of the squad) is currently considered undesirable as it indicates ineffective communication is occurring. However, there may be cases in which a squad is relying predominantly on non-verbal communication strategies or in which mission planning was so effective that verbal communication is not as necessary. Care should therefore be taken when examining measures in isolation and metrics, such as closed-loop communication counts, are often more meaningful when analyzed alongside other performance metrics.

6.0 CONCLUSIONS

Quantifying small unit performance at the collective level in operational settings remains a significant challenge to both Army Science & Technology researchers and military communities to this day. This is due in large part to the overwhelming complexity of the operational environment as well as the high degree of variability found in mission sets, equipment capabilities, and desired operational outcomes. While the rise in commercially available wearable sensors has increased the capacity to record and measure large amounts of data from in-field settings, interpretation and usage of those data are still severely hampered by a lack of understanding about what aspects of performance are meaningful to quantify in a combat setting. Until quantitative performance metrics are developed that reflect and correlate directly to mission execution quality and operational outcomes, wearable data interpretation and data-to-decision models will remain severely limited for the dismounted infantry community. To that end, this report provides recommendations on testing methodologies and procedures that could be used to measure in-field performance of dismounted infantry squads in an operationally meaningful context. By focusing on standard infantry battle drills, operational variability can be reduced without compromising operational validity (see Section 1.3). By combining wearable technologies with data-driven approaches, quantitative performance data can be collected from small units in such a way as to ensure its meaningfulness to the quality of task and mission execution.

Furthermore, this report provides recommendations on approaches for developing quantitative performance metrics reflective of collective performance as opposed to individual performance only. Both coactive and interactive performance metrics were developed directly from the battle drill task steps and sub tasks outlined in current standard military doctrine (see Section 5.2). It is important that both coactive performance metrics and interactive performance metrics are considered in order to broaden the overall understanding and assessment of small unit proficiency. It is hoped that by following and expanding upon the metric development procedures outlined in this report, future research can be done to expand quantitative in-field performance measures for other military echelons and mission sets of interest.

Overall, this report, by focusing on collective outcomes from squad-level battle drill execution, provides a substantial improvement in methodology and a significant step forward in establishing techniques that can be used to assess effects on military small units as a whole, thus ensuring that the dismounted infantry community is able to capitalize on the data-driven approaches made possible by advances in future sensor technologies.

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Appendix A – Questionnaire Instruments

Included in this Appendix is a copy of all questionnaires that were used in the previously executed SUPRA testing, including:

The Rating of Perceived Exertion (RPE)

Rating of Pain, Soreness, and Discomfort (RPSD)

Daily Intake Form

Demographics/Military Demographics

The Modified Combat Platoon Cohesion Questionnaire (CPCQ)

The Grit Scale

The Group Internal Bonding and Conflict (IBC) Questionnaire

Team Behavior Checklist

Volunteer Number: _____

Date: _____ Test Condition: _____

Borg Scale

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

© Gunnar Borg, 1970, 1985, 1998

Instructions for Borg Rating of Perceived Exertion (RPE) Scale

While doing physical activity, we want you to rate your perception of exertion. This feeling should reflect how heavy and strenuous the exercise feels to you, combining all sensations and feelings of physical stress, effort, and fatigue. Do not concern yourself with any one factor such as leg pain or shortness of breath, but try to focus on your total feeling of exertion.

Look at the rating scale below while you are engaging in an activity; it ranges from 6 to 20, where 6 means "no exertion at all" and 20 means "maximal exertion." Choose the number from below that best describes your level of exertion. This will give you a good idea of the intensity level of your activity, and you can use this information to speed up or slow down your movements to reach your desired range.

Try to appraise your feeling of exertion as honestly as possible, without thinking about what the actual physical load is. Your own feeling of effort and exertion is important, not how it compares to other people's. Look at the scales and the expressions and then give a number.

9 corresponds to "very light" exercise. For a healthy person, it is like walking slowly at his or her own pace for some minutes

13 on the scale is "somewhat hard" exercise, but it still feels OK to continue.

17 "very hard" is very strenuous. A healthy person can still go on, but he or she really has to push him- or herself. It feels very heavy, and the person is very tired.

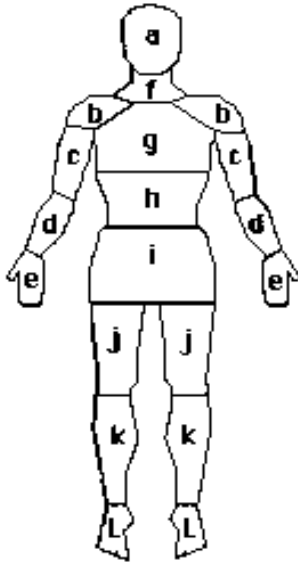
19 on the scale is an extremely strenuous exercise level. For most people this is the most strenuous exercise they have ever experienced.

Borg RPE scale
© Gunnar Borg, 1970, 1985, 1994, 1998

Discomfort Questionnaire (RPSD):

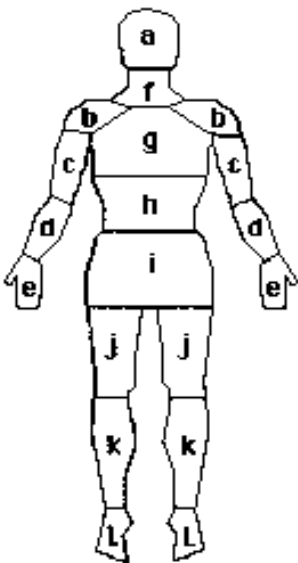
Volunteer Number: _____ Date: _____ Test Condition: _____

1. Rate the degree of PAIN, SORENESS, or DISCOMFORT that you are currently feeling for Body Parts A through L. Do so for the FRONT and the BACK of the body.



FRONT of Body

	a	b	c	d	e	f	g	h	i	j	k	L
NONE	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
SLIGHT	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
MODERATE	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
SEVERE	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
EXTREME	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐



BACK of Body

	a	b	c	d	e	f	g	h	i	j	k	L
NONE	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
SLIGHT	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
MODERATE	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
SEVERE	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
EXTREME	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Post-Test Survey

Intake Form

Date: _____

Subject number: _____

Please answer the following questions:

1. Have you consumed any alcohol in the past 24 hours? ☐ YES ☐ NO
 - a. If YES, how many drinks did you have? _____
 - b. How long ago? _____
2. Have you participated in any strenuous exercise in the past 24 hours?
☐ YES ☐ NO
 - a. If YES, what type of exercise? _____
 - b. How long ago? _____
 - c. Are you currently experiencing any pain, soreness, or discomfort as a result of the exercise? ☐ YES ☐ NO
3. Have you consumed any caffeine (such as coffee or energy drinks) in the past 2 hours? ☐ YES ☐ NO
 - a. If YES, how long ago? _____
4. Have you consumed any tobacco (such as cigarettes or dip) in the past 2 hours? ☐ YES ☐ NO
 - a. If YES, how long ago? _____
5. Have you had any nicotine (such as cigarettes or E- cigarettes) in the past 2 hours? ☐ YES ☐ NO
 - a. If YES, how long ago? _____
6. Are you currently injured or do you feel that you are unable to participate in any of the planned study events today? ☐ YES ☐ NO
 - a. If injured, where and how was the injury acquired?

Demographics Questionnaire

Please fill in the appropriate check box(s) ☐ or write answers legibly on the lines provided.

Date: _____

Subject number: _____

1. Please answer the following demographic questions:

- a. Age: _____
- b. Height: _____
- c. Weight: _____
- d. Time in Service (years/months): _____
- e. Rank/Pay Grade: _____
- f. MOS (number and title): _____
- g. Current Squad Position _____

Please choose the item below that best describes your situation:

2. How long have you been in your current squad?

- ☐ One month or less
- ☐ One to three months
- ☐ Four to six months
- ☐ Seven to nine months
- ☐ Nine to twelve months
- ☐ Greater than 12 months

3. How long have you been in your current position within your squad?

- ☐ One month or less
- ☐ One to three months
- ☐ Four to six months
- ☐ Seven to nine months
- ☐ Nine to twelve months
- ☐ Greater than 12 months

4. How many squad leaders have you had while you have been assigned to your current squad?

- ☐ One

- ☐ Two
- ☐ Three
- ☐ Four
- ☐ Five
- ☐ More than five

5. Have you previously played any organized team sports (football, soccer, hockey, etc.)? ☐ YES ☐ NO

a. If YES, what sport? _____

6. Have you previously been deployed? ☐ YES ☐ NO

b. If YES, where?

c. If YES, how long were you in each location?

d. If YES, were you deployed as part of your current squad for any of the deployments listed above?

☐ YES ☐ NO

7. Please circle which of the following weapons systems you have had previous live-fire experience with:

M9 Pistol

M17 Pistol

M18 Pistol

M16 Rifle

M4 Rifle

M4 Rifle with M203 Grenade Launcher

M249

M2 Browning

M4 Rifle with M320 grenade Launcher

M240 or 240B

Date: _____

Subject/Squad number: _____

Modified Platoon Cohesion Index

Directions: This questionnaire is designed to help the research team assess the general level of cohesiveness (unit cohesion) in your squad. Fill in the information below and respond to each question by filling in the bubble which best represents your view. Your answers will be completely anonymous and other members of your squad will not know how you answered. The study team will combine your answers with the other members in your squad to get an overall picture for research purposes. None of this information will be shared with your unit leadership or squad leader.

What is your pay grade/rank: _____

What is your position in your squad: _____

Approximately how long ago was your last squad live fire event? _____

1. How long have you been in your present squad?

- a. 1 – 3 months
- b. 4 – 6 months
- c. 7 – 9 months
- d. 10 – 12 months
- e. more than 12 months

2. How many different squad leaders have you had since you have been assigned to this squad or section?

- a. I have had the same squad leader all along
- b. 2 different squad leaders
- c. 3 different squad leaders
- d. 4 or more different squad leaders

3. Which of the following best describes your situation?

- a. I have worked with most (75%) of the members of my squad for 1 -3 months?
- b. I have worked with most (75%) of the members of my squad for 4 -6 months?
- c. I have worked with most (75%) of the members of my squad for 7 -9 months?
- d. I have worked with most (75%) of the members of my squad for 10 -12 months?
- e. I have worked with most (75%) of the members of my squad for more than 12 months?

4. Which of the following best describes your career intentions at the present time?
- a. I will probably stay in the Army until retirement
 - b. I will probably re-enlist upon completion of my present obligation but am undecided about staying until retirement
 - c. I am undecided about whether I will reenlist
 - d. I will probably leave the Army upon completion of my present obligation
 - e. I will probably leave the Army before completion of my present obligation

Indicate your level of agreement with the following statements:

How strongly do you agree with the following statements...?	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
Members of this squad uphold and support Army values	☐	☐	☐	☐	☐
Leaders in this squad set the example for Army values	☐	☐	☐	☐	☐
Members of this squad trust each other	☐	☐	☐	☐	☐
Members of this squad care about each other	☐	☐	☐	☐	☐
Members of this squad work together to get the job done	☐	☐	☐	☐	☐
Members of this squad pull together to perform as a team	☐	☐	☐	☐	☐
Leaders in this squad trust each other	☐	☐	☐	☐	☐

How strongly do you agree with the following statements...?	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
Leaders in this squad care about each other	☐	☐	☐	☐	☐
Members of this squad can get help from their leaders on personal problems	☐	☐	☐	☐	☐
Members of this squad and Leaders care about one another	☐	☐	☐	☐	☐
Members of this squad and Leaders in this squad train well together	☐	☐	☐	☐	☐
Leaders in this squad have the skills and abilities to lead squad members into combat	☐	☐	☐	☐	☐
Members of this squad know what is expected of them	☐	☐	☐	☐	☐
In this squad, the behaviors that will get you in trouble are well known	☐	☐	☐	☐	☐
Members in this squad feel they play an important part in accomplishing the unit's mission	☐	☐	☐	☐	☐
Members of this squad are proud to be in this squad	☐	☐	☐	☐	☐
Members of this squad are satisfied with the time available for family, friends, and personal needs	☐	☐	☐	☐	☐

How strongly do you agree with the following statements...?	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
Members of this squad are satisfied with the social events in this squad	☐	☐	☐	☐	☐
Members of this squad feel they are serving their country	☐	☐	☐	☐	☐
Members of this squad have opportunities to better themselves	☐	☐	☐	☐	☐
In this squad, members really care about what happens to each other	☐	☐	☐	☐	☐
Members of this squad can trust one another	☐	☐	☐	☐	☐
Members of this squad feel very close to one another	☐	☐	☐	☐	☐
Soldiers like being in this squad	☐	☐	☐	☐	☐
Members of this squad really respect one another	☐	☐	☐	☐	☐
Members of this squad like one another	☐	☐	☐	☐	☐
Members of this squad make each other feel like doing a good job	☐	☐	☐	☐	☐
Members of this squad work well together	☐	☐	☐	☐	☐
Members of this squad help each other to get the job done	☐	☐	☐	☐	☐
Members of this squad encourage each other to succeed in the field or at competitions	☐	☐	☐	☐	☐
Members of this squad work hard to get things done	☐	☐	☐	☐	☐

How strongly do you agree with the following statements...?	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
Members of this squad pull together and share the load while in the field	☐	☐	☐	☐	☐
Members of this squad respect the leaders in this squad	☐	☐	☐	☐	☐
When a Soldier in this squad goes for help, the leaders listen well and care what the Soldier has to say	☐	☐	☐	☐	☐
Leaders trust the members of this squad	☐	☐	☐	☐	☐
Leaders really understand the Soldiers in this squad	☐	☐	☐	☐	☐
When asked for help in solving a personal problem, leaders in this squad do their best to help out	☐	☐	☐	☐	☐
When a squad member wants to talk, his leaders make themselves available	☐	☐	☐	☐	☐
Leaders like being in this squad	☐	☐	☐	☐	☐
Leaders in this squad respect each other	☐	☐	☐	☐	☐
Leaders in this squad care about one another as individuals	☐	☐	☐	☐	☐
The leaders in this squad are the kind that Soldiers want to serve under in combat	☐	☐	☐	☐	☐
The leaders in this squad can really apply their knowledge to solve problems in the field	☐	☐	☐	☐	☐
The chain of command works well for this squad	☐	☐	☐	☐	☐

How strongly do you agree with the following statements...?	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
Leaders in this squad keep the other members of this squad well informed about what is going on	☐	☐	☐	☐	☐
Leaders in this squad are informed about the progress the other members of this squad are making in their training	☐	☐	☐	☐	☐
Leaders in this squad are experts and can show the other members of this squad how best to perform a task	☐	☐	☐	☐	☐
Leaders in this squad work right along with the other members of this squad under the same hardships in the field	☐	☐	☐	☐	☐

Indicate the level of importance of the following statements to the MEMBERS of the squad you are in:

How important are the following things to Members of this squad...?	Extremely Important	Slightly Important	Neither Important nor Unimportant	Slightly Unimportant	Extremely Unimportant
Loyalty to the United States Army	☐	☐	☐	☐	☐
Loyalty to the unit or organization	☐	☐	☐	☐	☐
Taking responsibility for their actions and decisions	☐	☐	☐	☐	☐
Accomplishing all assigned tasks to the best of their ability	☐	☐	☐	☐	☐
Putting what is good for their fellow soldiers and mission accomplishment ahead of personal desires	☐	☐	☐	☐	☐
Dedication to serving the United States, even to risking their lives in its defense	☐	☐	☐	☐	☐
Having high moral and personal standards	☐	☐	☐	☐	☐
Commitment to working as members of a team	☐	☐	☐	☐	☐

How important are the following things to Members of this squad...?	Extremely Important	Slightly Important	Neither Important nor Unimportant	Slightly Unimportant	Extremely Unimportant
Dedication to learning their job and doing it well	☐	☐	☐	☐	☐
Personal drive to succeed in the Army and advance	☐	☐	☐	☐	☐
Being honest, open, and truthful	☐	☐	☐	☐	☐
Taking responsibility to ensure the job gets done	☐	☐	☐	☐	☐
Being disciplined and courageous in battle	☐	☐	☐	☐	☐
Standing up for what they firmly believe is right	☐	☐	☐	☐	☐
Building and maintaining physical fitness and stamina	☐	☐	☐	☐	☐

Indicate the level of importance of the following statements to the LEADERS of the squad you are in:

How important are the following things to Leaders of this squad...?	Extremely Important	Slightly Important	Neither Important nor Unimportant	Slightly Unimportant	Extremely Unimportant
Loyalty to the United States Army	☐	☐	☐	☐	☐
Loyalty to the unit or organization	☐	☐	☐	☐	☐
Taking responsibility for their actions and decisions	☐	☐	☐	☐	☐
Accomplishing all assigned tasks to the best of their ability	☐	☐	☐	☐	☐
Putting what is good for their fellow soldiers and mission accomplishment ahead of personal desires	☐	☐	☐	☐	☐
Dedication to serving the United States, even to risking their lives in its defense	☐	☐	☐	☐	☐
Having high moral and personal standards	☐	☐	☐	☐	☐
Commitment to working as members of a team	☐	☐	☐	☐	☐

How important are the following things to Members of this squad...?	Extremely Important	Slightly Important	Neither Important nor Unimportant	Slightly Unimportant	Extremely Unimportant
Dedication to learning their job and doing it well	☐	☐	☐	☐	☐
Personal drive to succeed in the Army and advance	☐	☐	☐	☐	☐
Being honest, open, and truthful	☐	☐	☐	☐	☐
Taking responsibility to ensure the job gets done	☐	☐	☐	☐	☐
Being disciplined and courageous in battle	☐	☐	☐	☐	☐
Standing up for what they firmly believe is right	☐	☐	☐	☐	☐
Building and maintaining physical fitness and stamina	☐	☐	☐	☐	☐

Indicate your level of agreement with the following statements:

How strongly do you agree with the following statements...?	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
This squad is very cohesive	☐	☐	☐	☐	☐
There is a very high degree of teamwork and cooperation among members of this squad	☐	☐	☐	☐	☐
The members of this squad get along very well with one another	☐	☐	☐	☐	☐
In this squad, the leaders really care about what happens to the other members of this squad	☐	☐	☐	☐	☐
Overall, the leaders in this squad are very good	☐	☐	☐	☐	☐
Even if this squad was under a great deal of stress or difficulty, it would pull together to get the job done	☐	☐	☐	☐	☐
This is a very high performing squad	☐	☐	☐	☐	☐
The leaders in this squad appreciate the contributions of the other members of this squad	☐	☐	☐	☐	☐
The members of this squad appreciate the contributions of the leaders in this squad	☐	☐	☐	☐	☐

Use the scale below to select your response to each statement:

Use the scale to the right to select your response to each statement.	Extremely High	High	Neither high nor low	Low	Extremely Low
In the event of combat, describe the confidence members of this squad would have in each other	☐	☐	☐	☐	☐
In the event of combat, describe the confidence members of this squad would have in the leaders of this squad	☐	☐	☐	☐	☐
In the event of combat, describe the confidence leaders in this squad would have in each other	☐	☐	☐	☐	☐
Describe the confidence members of this squad have in their weapons and equipment	☐	☐	☐	☐	☐
How high is the morale in your squad?	☐	☐	☐	☐	☐
Describe the state of your squad's readiness	☐	☐	☐	☐	☐
Describe the state of discipline in your squad	☐	☐	☐	☐	☐
How high is the determination or "will" to win in combat in your squad?	☐	☐	☐	☐	☐
Describe the degree of confidence members of this squad have that it would perform well in combat	☐	☐	☐	☐	☐

Grit Survey

Below are 12 statements about grit. Read each one and then click on the dropdown list next to the statement and select how much the statement is like you. Please be honest and accurate!

All questions must be completed for this questionnaire to be scored.

1. I have overcome setbacks to conquer an important challenge.

Not Like Me At All	A Little Like Me	Somewhat Like Me	Mostly Like Me	Very Much Like Me
--------------------	------------------	------------------	----------------	-------------------

2. New ideas and projects sometimes distract me from previous ones.

Not Like Me At All	A Little Like Me	Somewhat Like Me	Mostly Like Me	Very Much Like Me
--------------------	------------------	------------------	----------------	-------------------

3. My interests change from year to year.

Not Like Me At All	A Little Like Me	Somewhat Like Me	Mostly Like Me	Very Much Like Me
--------------------	------------------	------------------	----------------	-------------------

4. Setbacks don't discourage me.

Not Like Me At All	A Little Like Me	Somewhat Like Me	Mostly Like Me	Very Much Like Me
--------------------	------------------	------------------	----------------	-------------------

5. I have been obsessed with a certain idea or project for a short time but later lost interest.

Not Like Me At All	A Little Like Me	Somewhat Like Me	Mostly Like Me	Very Much Like Me
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6. I am a hard worker.

Not Like Me At All	A Little Like Me	Somewhat Like Me	Mostly Like Me	Very Much Like Me
--------------------	------------------	------------------	----------------	-------------------

7. I often set a goal but later choose to pursue a different one.

Not Like Me At All	A Little Like Me	Somewhat Like Me	Mostly Like Me	Very Much Like Me
--------------------	------------------	------------------	----------------	-------------------

8. I have difficulty maintaining my focus on projects that take more than a few months to complete.

Not Like Me At All	A Little Like Me	Somewhat Like Me	Mostly Like Me	Very Much Like Me
--------------------	------------------	------------------	----------------	-------------------

9. I finish whatever I begin.

Not Like Me At All	A Little Like Me	Somewhat Like Me	Mostly Like Me	Very Much Like Me
--------------------	------------------	------------------	----------------	-------------------

10. I have achieved a goal that took years of work.

Not Like Me At All	A Little Like Me	Somewhat Like Me	Mostly Like Me	Very Much Like Me
--------------------	------------------	------------------	----------------	-------------------

11. I become interested in new pursuits every few months.

Not Like Me At All	A Little Like Me	Somewhat Like Me	Mostly Like Me	Very Much Like Me
--------------------	------------------	------------------	----------------	-------------------

12. I am diligent.

Not Like Me At All	A Little Like Me	Somewhat Like Me	Mostly Like Me	Very Much Like Me
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The Grit Survey was developed by Angela L. Duckworth Seligman Research Alliance,
University of Pennsylvania © 2004 Martin E. P. Seligman

Group IBC Questionnaire

Please indicate your agreement with the following statements: Part I

(pre-event)

1. I feel a bond with my team

Strongly Disagree				Strongly Agree
1	2	3	4	5

2. I feel solidarity with my team

Strongly Disagree				Strongly Agree
1	2	3	4	5

3. I feel committed to my team

Strongly Disagree				Strongly Agree
1	2	3	4	5

4. I am glad to be in my team

Strongly Disagree				Strongly Agree
1	2	3	4	5

5. I think that my team has a lot to be proud of

Strongly Disagree				Strongly Agree
1	2	3	4	5

6. It is pleasant to be a member of my team

Strongly Disagree				Strongly Agree
1	2	3	4	5

CONTINUE ONTO NEXT PAGE

7. Being with my team gives me a good feeling

Strongly Disagree				Strongly Agree
1	2	3	4	5

8. I have a lot in common with my teammates

Strongly Disagree				Strongly Agree
1	2	3	4	5

9. I am similar to the other members of my team

Strongly Disagree				Strongly Agree
1	2	3	4	5

10. My team has a lot in common with each other

Strongly Disagree				Strongly Agree
1	2	3	4	5

11. Members of my team are very similar to each other

Strongly Disagree				Strongly Agree
1	2	3	4	5

Part II (Post Event).

1. There was conflict within our group

Strongly Disagree				Strongly Agree
1	2	3	4	5

2. There was conflict about task responsibilities within our group

Strongly Disagree				Strongly Agree
1	2	3	4	5

3. There was emotional conflict within our group

Strongly Disagree				Strongly Agree
1	2	3	4	5

4. I felt comfortable with my role within our group

Strongly Disagree				Strongly Agree
1	2	3	4	5

5. There was an open and supportive atmosphere with our group

Strongly Disagree				Strongly Agree
1	2	3	4	5

6. I was listened to within our group

Strongly Disagree				Strongly Agree
1	2	3	4	5

7. During the games I felt connected with one or more other members

Strongly Disagree				Strongly Agree
1	2	3	4	5

CONTINUE ONTO NEXT PAGE

Part III (Post Event).

1. My team worked well together

Strongly Disagree				Strongly Agree
1	2	3	4	5

2. My team performed better together as a group than we could have individually

Strongly Disagree				Strongly Agree
1	2	3	4	5

3. My team did not function well together

Strongly Disagree				Strongly Agree
1	2	3	4	5

4. My team was successful at working collaboratively

Strongly Disagree				Strongly Agree
1	2	3	4	5

5. Everyone on the team contributed to our outcome

Strongly Disagree				Strongly Agree
1	2	3	4	5

6. My team worked with a unified goal

Strongly Disagree				Strongly Agree
1	2	3	4	5

7. My team worked together effectively

Strongly Disagree				Strongly Agree
1	2	3	4	5

CONTINUE ONTO NEXT PAGE

Pre- Post Checklist Items

Scale	Question	N/A	Never	A little	A lot
Adaptability	My team members are able to handle new events	O	O	O	O
	My team members are able to react to uncertain or changing situations	O	O	O	O
	My team members are able to react to equipment malfunctions	O	O	O	O
	My team members are able to react to environmental changes	O	O	O	O
	My team members can adjust behaviors in response to not reaching goals (from a faulty plan, lack of resources, or internal/external changes)	O	O	O	O
	My team members innovate – refine and improve the way they executed the tasks	O	O	O	O
	My team members assign, distribute, or re-allocate resources as needed	O	O	O	O
Backup Behaviors	My team cross-trains certain skills within the team	O	O	O	O
Team Regulation/ Performance Monitoring/Feedback	My team members monitor the team’s progress toward goals	O	O	O	O
	My team members don’t mind completing tasks even when they involve extra effort	O	O	O	O
	My team members are actively engaged with the tasks	O	O	O	O
	My team members are proactive in starting to work on new tasks	O	O	O	O
	My team balances the workload across team members	O	O	O	O
Trust	My team members trust each other to accomplish the tasks	O	O	O	O
	My team trusts its Leaders to provide a positive climate and constructive feedback	O	O	O	O
	I would be willing to let my team make decisions for me on important issues	O	O	O	O
	I really wish I had a good way to keep track of my team’s behaviors	O	O	O	O
	I would be comfortable giving my team a task or problem which was critical to me, even if I could not monitor their actions	O	O	O	O
	My team members confront each other in an effective manner	O	O	O	O
	My team members depend on each other to complete their own tasks without “checking up” on them	O	O	O	O
	My team members exchange information freely across team members	O	O	O	O
Collective efficacy	My team members have confidence in each other	O	O	O	O
	My team members trust each other to accomplish their goals	O	O	O	O

	My team members work toward accomplishing the team's goals and not just their own	O	O	O	O
	My team's success is due to team members' confidence in each other	O	O	O	O
	My team members have above average capabilities	O	O	O	O
	My team is not able to perform as well as it should	O	O	O	O
	My team is very effective	O	O	O	O
	Some members in my team cannot do their jobs well	O	O	O	O
	My team members go above and beyond to accomplish the mission	O	O	O	O
Leadership/ team management	My Leaders provide feedback on my team's performance	O	O	O	O
	My Leaders appropriately delegate responsibilities	O	O	O	O
	My Leaders foster and implement innovation	O	O	O	O
	My Leaders create clear SOPs	O	O	O	O
	My Leaders push information down	O	O	O	O
	My Leaders exercise mission command	O	O	O	O
	My Leaders leverage subordinates' skill sets	O	O	O	O
	My Leaders tell team members to help each other	O	O	O	O
	My Leaders assign and communicate roles (who does what and when and why)	O	O	O	O
	My Leaders guide others toward the adoption of opinions, behaviors, and attitudes	O	O	O	O
	My Leaders handle conflict and disagreements between team members effectively	O	O	O	O
	My Leaders promote team members learning from each other	O	O	O	O
	My Leaders allow Soldiers to learn from making mistakes	O	O	O	O

Team Behavior Checklist - Mission Checklist Items

Scale	Question	N/A	Never	A little	A lot
Shared Situational Awareness	My team received information on the mission	☐	☐	☐	☐
	My team members understood the mission (goals, objectives, Commander's intent, specified and implied tasks)	☐	☐	☐	☐
	My team understood the role of each individual in accomplishing the mission	☐	☐	☐	☐
	My team members monitored team resources	☐	☐	☐	☐
	My team members effectively monitored the systems used to complete the mission (e.g., BFT, FBCB2, CPOF)	☐	☐	☐	☐
	My team members were able to predict what was about to occur next in the mission	☐	☐	☐	☐
	My team members missed environmental cues (slow to detect and recognize problems, symptoms, or cues)	☐	☐	☐	☐
	My team members' performance degraded over time	☐	☐	☐	☐
	My team members became less vigilant over time in tracking environmental changes	☐	☐	☐	☐
	My team members made battlefield errors in remembering information/digits, math, etc.	☐	☐	☐	☐
Team Regulation/ Performance Monitoring/ Feedback/ Correction	My team members actively performed activities not just observed	☐	☐	☐	☐
	My team members observed others' behaviors and provided corrective feedback	☐	☐	☐	☐
	My team members reinforced positive team behaviors	☐	☐	☐	☐
	My team members asked for help when they needed it	☐	☐	☐	☐
	Team members changed strategies once they realized that a tactic was not working	☐	☐	☐	☐
	My team members persevered to accomplish the tasks/mission	☐	☐	☐	☐
Backup Behaviors	My team members took over for a member when that member was not effective or not productive in accomplishing the mission	☐	☐	☐	☐
	My team members helped each other perform their roles; made adjustments for others	☐	☐	☐	☐
Interpersonal relations Coordination	My team members recognized each other's hard work	☐	☐	☐	☐
	My team members disagreed about techniques and procedures; argued among themselves; pointed fingers; made negative comments	☐	☐	☐	☐
	My team struggled when presented with ethical dilemmas	☐	☐	☐	☐
	My team members went above and beyond to help each other out	☐	☐	☐	☐
	My team members shared expertise; explained the consequences of a mistake to each other	☐	☐	☐	☐

	My team members confronted a member who was not adhering the Army ethic, Army values, unit standards, etc.	O	O	O	O
Coordination	My team did not duplicate or waste efforts	O	O	O	O
	My team members coordinated with each other to accomplish the tasks	O	O	O	O
	My team rehearsed the plan	O	O	O	O
	My team members integrated each other's activities	O	O	O	O
	My team balanced the workload across team members	O	O	O	O
Communication	My team members resolved miscommunication and misunderstandings	O	O	O	O
	My Leaders discussed strategy with their subordinates	O	O	O	O
	My Leaders requested back-briefs	O	O	O	O
	My Leaders distributed information appropriately (passing and receiving of accurate information, passing and receiving of timely information)	O	O	O	O
	My team members actively listened to each other's viewpoints and perspectives	O	O	O	O
	My Leaders practiced collaborative problem solving	O	O	O	O
Decision making	My Leaders had difficulty making decisions	O	O	O	O
	My Leaders had difficulty in prioritizing work, tasks, and/or information requests	O	O	O	O
	My Leaders were proactive in solving problems and making decisions	O	O	O	O
	My Leaders encouraged team members to come up with innovative/creative ways to solve problems/accomplish the mission	O	O	O	O
Emotional Strain	My team members were rude to each other	O	O	O	O
	My team members demonstrated ill-considered or impulsive actions	O	O	O	O
	My team members expressed increased frustration/irritation toward Leaders or each other	O	O	O	O
	There were escalating disagreements/conflicts between my team members	O	O	O	O
	My team members had difficulty in controlling their tempers	O	O	O	O
Performance outcomes	My team members reacted negatively to changes to the plan	O	O	O	O
	My team members suffered injuries attributable to inattention	O	O	O	O
	My team failed to accomplish mission objectives	O	O	O	O
	My team suffered casualty rates	O	O	O	O
	My team had difficulty coordinating with other units	O	O	O	O
	The team responded quickly to signals, directions, or events	O	O	O	O
Physical symptoms	My team members had lapses in attention	O	O	O	O
	My team members were able to understand changes to orders and directions	O	O	O	O

	My team members had difficulty expressing themselves verbally in the form of statements or messages	O	O	O	O
	My team members had unclear or slurred speech	O	O	O	O
	My team members had difficulty reaching decisions	O	O	O	O
	My team members showed mood changes with increased irritability, depression, or apathy	O	O	O	O
	My team members had memory losses or impairment	O	O	O	O

Appendix B – SUPRA Complete Testing Schedule

Day	Task Set	Session	Squad	Time	Activity	Data Collected
Day 1	N/A	Orientation Session	Squads 1 & 2	AM	Familiarization & Overview	
					Participant Preparation	Daily Intake Form
						Demographics/Military Demographics The Grit Scale The Modified CPCQ The Group IBC The Team Behavior Checklist (pre-mission)
					Questionnaires	
					Safety Briefing	
					Practice & Supervised Weapon Zeroes	
	N/A	Marksmanship Baseline Session	Squads 1 & 2	PM	Marksmanship Baseline	FN Expert Marksmanship performance measures
	Task Set (1)	Pre-Test Data Collection Session	Squad 1	AM	Overview	
					Participant Preparation	Daily Intake Form, RPSD
						Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
					Resting Baseline	
		STX Lane Data Collection Session	Squad 1	AM	Overview	
					Participant Preparation	Check In & Sensor preparations
					MILES Zero	Confirm weapon zero
					Squad Rehearsals	
					Squad Mission Execution	Data outputs include GPS location, audio recordings, Inertial Measurement Unit orientations, and Physiological Status Monitoring
		Post-Test Data Collection	Squad 1	AM	Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
					After Action Review	OC Ratings
					Questionnaires	Rating of Percieved Exertion, Rating of Pain Soreness and Discomfort, The Team Behavior Checklist (post-mission)
					Overview	
					Participant Preparation	Daily Intake Form, RPSD

Day 2	Task Set (2)	Pre-Test Data Collection Session	Squad 2	AM	Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
		SH Data Collection Session	Squad 2	AM	Overview	
					Participant Preparation	Check In & Sensor preparations
					Squad Rehearsals	
					Squad Mission Execution	Data outputs include 3D Motion Capture data, audio recordings, video recordings, marksmanship outcomes, and Physiological Status Monitoring
		Post-Test Data Collection	Squad 2	AM	Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
					After Action Review	OC Ratings
					Questionnaires	Rating of Percieved Exertion, Rating of Pain Soreness and Discomfort, The Team Behavior Checklist (post-mission)
	Task Set (1)	Pre-Test Data Collection Session	Squad 2	PM	Overview	
					Participant Preparation	Daily Intake Form, RPSD
					Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
		STX Lane Data Collection Session	Squad 2	PM	Overview	
					Participant Preparation	Check In & Sensor preparations
					MILES Zero	Confirm weapon zero
					Squad Rehearsals	
					Squad Mission Execution	Data outputs include GPS location, audio recordings, Inertial Measurement Unit orientations, and Physiological Status Monitoring
		Post-Test Data Collection	Squad 2	PM	Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
					After Action Review	OC Ratings
					Questionnaires	Rating of Percieved Exertion, Rating of Pain Soreness and Discomfort, The Team Behavior Checklist (post-mission)

	Task Set (2)	Pre-Test Data Collection Session	Squad 1	PM	Overview	
					Participant Preparation	Daily Intake Form, RPSD
					Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
		SH Data Collection Session	Squad 1	PM	Overview	
					Participant Preparation	Check In & Sensor preparations
					Squad Rehearsals	
					Squad Mission Execution	Data outputs include 3D Motion Capture data, audio recordings, video recordings, marksmanship outcomes, and Physiological Status Monitoring
		Post-Test Data Collection	Squad 1	PM	Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
					After Action Review	OC Ratings
					Questionnaires	Rating of Percieved Exertion, Rating of Pain Soreness and Discomfort, The Team Behavior Checklist (post-mission)
	Task Set (1)	Pre-Test Data Collection Session	Squad 1	AM	Overview	
					Participant Preparation	Daily Intake Form, RPSD
					Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
		STX Lane Data Collection Session	Squad 1	AM	Overview	
					Participant Preparation	Check In & Sensor preparations
					MILES Zero	Confirm weapon zero
					Squad Rehearsals	
					Squad Mission Execution	Data outputs include GPS location, audio recordings, Inertial Measurement Unit orientations, and Physiological Status Monitoring
		Post-Test Data Collection	Squad 1	AM	Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
					After Action Review	OC Ratings

Day 3		Collection			Questionnaires	Rating of Percieved Exertion, Rating of Pain Soreness and Discomfort, The Team Behavior Checklist (post-mission)
	Task Set (2)	Pre-Test Data Collection Session	Squad 2	AM	Overview	
					Participant Preparation	Daily Intake Form, RPSD
					Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
					Squad Mission Execution	Data oututs include 3D Motion Capture data, audio recordings, video recordings, marksmanship outcomes, and Physiological Status Monitoring
		Post-Test Data Collection	Squad 2	AM	Overview	
					Participant Preparation	Check In & Sensor preparations
					Squad Rehearsals	
					Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
					After Action Review	OC Ratings
					Questionnaires	Rating of Percieved Exertion, Rating of Pain Soreness and Discomfort, The Team Behavior Checklist (post-mission)
	Task Set (1)	Pre-Test Data Collection Session	Squad 2	PM	Overview	
					Participant Preparation	Daily Intake Form, RPSD
					Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
					Squad Mission Execution	Data oututs include GPS location, audio recordings, Inertial Measurement Unit orientations, and Physiological Status Monitoring
		STX Lane Data Collection Session	Squad 2	PM	Overview	
					Participant Preparation	Check In & Sensor preparations
					MILES Zero	Confirm weapon zero
					Squad Rehearsals	
					Squad Mission Execution	Data oututs include GPS location, audio recordings, Inertial Measurement Unit orientations, and Physiological Status Monitoring

		Post-Test Data Collection	Squad 2	PM	Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
					After Action Review	OC Ratings
					Questionnaires	Rating of Percieved Exertion, Rating of Pain Soreness and Discomfort, The Team Behavior Checklist (post-mission)
	Task Set (2)	Pre-Test Data Collection Session	Squad 1	PM	Overview	
					Participant Preparation	Daily Intake Form, RPSD
					Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
		SH Data Collection Session	Squad 1	PM	Overview	
					Participant Preparation	Check In & Sensor preparations
					Squad Rehearsals	
					Squad Mission Execution	Data oututs include 3D Motion Capture data, audio recordings, video recordings, marksmanship outcomes, and Physiological Status Monitoring
		Post-Test Data Collection	Squad 1	PM	Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
					After Action Review	OC Ratings
					Questionnaires	Rating of Percieved Exertion, Rating of Pain Soreness and Discomfort, The Team Behavior Checklist (post-mission)
		Pre-Test Data Collection Session	Squad 1	AM	Overview	
					Participant Preparation	Daily Intake Form, RPSD
					Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
		STX Lane Data	Squad 1	AM	Overview	
					Participant Preparation	Check In & Sensor preparations
					MILES Zero	Confirm weapon zero
					Squad Rehearsals	

Day 4	Task Set (1)	Collection Session	Squad 1	AM	Squad Mission Execution	Data outputs include GPS location, audio recordings, Inertial Measurement Unit orientations, and Physiological Status Monitoring
		Post-Test Data Collection	Squad 1	AM	Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
					After Action Review	OC Ratings
					Questionnaires	Rating of Percieved Exertion, Rating of Pain Soreness and Discomfort, The Team Behavior Checklist (post-mission)
	Task Set (2)	Pre-Test Data Collection Session	Squad 2	AM	Overview	
					Participant Preparation	Daily Intake Form, RPSD
					Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
					Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
		SH Data Collection Session	Squad 2	AM	Overview	
					Participant Preparation	Check In & Sensor preparations
					Squad Rehearsals	
					Squad Mission Execution	Data outputs include 3D Motion Capture data, audio recordings, video recordings, marksmanship outcomes, and Physiological Status Monitoring
		Post-Test Data Collection	Squad 2	AM	Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
					After Action Review	OC Ratings
					Questionnaires	Rating of Percieved Exertion, Rating of Pain Soreness and Discomfort, The Team Behavior Checklist (post-mission)
					Questionnaires	Rating of Percieved Exertion, Rating of Pain Soreness and Discomfort, The Team Behavior Checklist (post-mission)
		Pre-Test Data Collection Session	Squad 2	PM	Overview	
					Participant Preparation	Daily Intake Form, RPSD
					Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
					Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
					Overview	
					Participant Preparation	Check In & Sensor preparations

	Task Set (1)	STX Lane Data Collection Session	Squad 2	PM	MILES Zero	Confirm weapon zero
					Squad Rehearsals	
					Squad Mission Execution	Data oututs include GPS location, audio recordings, Inertial Measurement Unit orientations, and Physiological Status Monitoring
		Post-Test Data Collection	Squad 2	PM	Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
					After Action Review	OC Ratings
					Questionnaires	Rating of Percieved Exertion, Rating of Pain Soreness and Discomfort, The Team Behavior Checklist (post-mission)
	Task Set (2)	Pre-Test Data Collection Session	Squad 1	PM	Overview	
					Participant Preparation	Daily Intake Form, RPSD
						Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
					Resting Baseline	Saliva- and Blood-based biomarkers
		SH Data Collection Session	Squad 1	PM	Overview	
					Participant Preparation	Check In & Sensor preparations
					Squad Rehearsals	
					Squad Mission Execution	Data oututs include 3D Motion Capture data, audio recordings, video recordings, marksmanship outcomes, and Physiological Status Monitoring
		Post-Test Data Collection	Squad 1	PM	Resting Baseline	Heart Rate Variability Heart Rate Breathing Rate Saliva- and Blood-based biomarkers
					After Action Review	OC Ratings
Questionnaires	Rating of Percieved Exertion, Rating of Pain Soreness and Discomfort, The Team Behavior Checklist (post-mission)					
Day 5	Task Set (1)	Make Up Session	Squads 1 & 2	AM/PM	All missed or necessary make-up activities	All missed or necessary make-up activities
	Task Set (2)	Make Up Session	Squads 1 & 2	AM/PM	All missed or necessary make-up activities	All missed or necessary make-up activities

Appendix C – SUPRA Execution Checklists

SUPRA STX Lane		
LINE #	Action	Time
1	Program MILES and stage in bins under tables	
2	IMUs configured and ready	
3	Soldiers arrive; ground gear/tables/bins; latrine break	
4	Conduct safety brief	
5	Soldiers and OPFOR don Polar systems	
6	Squad enters planning tent for surveys	
7	Squad enters biosampling tent	
8	Tech team mounts and calibrates IMUs on wpns/helmets	
9	Soldiers exit biosampling tent	
10	Squad zeroes MILES lasers on weapons	
11	Squad conducts TLPs including RXLs, ammo, PCCs/PCIs	
12	OCs synch SPARTA tablets; mount GoPros	
13	Emplace OPFOR; test fire OPFOR weapons	
14	Soldiers don voice mic, kit, MILES, and audio recorders	
15	Move to ORP and test fire; OCs confirm MILES active	
16	Start Battle Drill 2a	
17	SP (whistle used to synch audio data)	

18	CONTACT	
19	LOA	
20	CEASE FIRE//Clear weapons and return to start point	
21	Soldiers ground gear and enter biosampling tent	
22	Tech team recovers audio systems, IMUs and MILES	
23	Squad exits biosampling; remove Polar systems	
24	Squad enters planning tent for post surveys	
25	Squad recovers gear; ensures "no brass, no ammo"	
26	Squad released to next task (morning Squad draws MREs)	

SUPRA Shoot House		
LINE #	Action	Time
1	Set up and calibrate cameras; stage paper targets	
2	Stage bolts, ammo, MOCAP markers, flags, PPE	
3	Soldiers arrive; ground gear/tables/bins; latrine break	
4	Conduct safety brief	
5	Soldiers and OPFOR don Polar systems	
6	Squad enters planning tent for survey	
7	OCs/armorer swap bolts in Soldiers' weapons	
8	Soldiers enter biosampling tent	
9	Mount MOCAP markers on wpns/helmets, including OPFOR	

10	Soldiers exit biosampling tent	
11	Squad resumes TLPs	
12	OCs synch SPARTA tablets	
13	Test fire OPFOR weapons; emplace OPFOR	
14	Soldiers don throat mics, kit, PPE, flags and audio recorders	
15	Soldiers draw ammo; test fire weapons	
16	Start Battle Drill 6	
17	Initiate drill with clapper	
18	First room cleared	
19	All rooms cleared	
20	CEASE FIRE//clear weapons	
21	Soldiers ground gear then enter biosampling tent	
22	Tech team calibrates cameras; photo targets; recover markers	
23	Squad exits biosampling; removes Polar systems	
24	Squad enters planning tent for post surveys	
25	Squad recovers gear; exchanges bolts	
26	Squad released to next task (MREs are at TA 12)	

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Appendix D – Battle Drill Outlines from ATP 3-21.8

The following is taken directly from ATP 3-21.8 [28] and re-printed here for reference.

BATTLE DRILL 2A. Conduct a Squad Assault (07-4-D9515)

CONDITIONS: The squad is moving as part of the platoon conducting a movement to contact or an attack. The enemy initiates direct fire contact.

CUE: This drill begins when the enemy initiates direct fire contact.

STANDARDS: The squad locates and suppresses the enemy, establishes supporting fire, and assaults the enemy position using fire and maneuver. The squad destroys or causes the enemy to withdraw, conducts consolidation and reorganizes.

TASK STEPS AND PERFORMANCE MEASURES

1. The team in contact immediately returns well-aimed fire on known enemy position(s) and assumes the nearest covered positions. Soldiers receiving fire take up nearest positions that afford protection from enemy fire (cover) and observation (concealment).
 2. Soldiers in contact assume the nearest position that provides cover and concealment.
 - a. Fire team Soldiers in contact move to positions (bound or crawl) where they can fire their weapons, position themselves to ensure that they have observation, fields of fire, cover, and concealment. They continue to fire and report known or suspected enemy positions to the fire team leader.
 - b. The team leader directs fires using tracers or standard fire commands.
 - c. The fire team not in contact takes covered and concealed positions in place, and observes to the flanks and rear of the squad.
 - d. The squad leader reports contact to the platoon leader and moves toward the fire team in contact.
 3. Lead team locates the enemy:
 - a. Using sight and sound, the fire team in contact acquires known or suspected enemy positions.
 - b. The fire team in contact begins to place well-aimed fire on suspected enemy positions.
 - c. The squad leader moves to a position to observe the enemy and assess the situation.
 - d. The squad leader requests, through the platoon leader, immediate suppression indirect fires (normally 60-mm mortars).
 - e. The squad leader reports the enemy size and location, and any other information to the platoon leader. (As the platoon leader comes forward, he completes the squad leader's assessment of the situation.)
 4. Team in contact suppresses the enemy.

- a. The squad leader determines if the fire team in contact can gain suppressive fire based on the volume and accuracy of the enemy fire.
 - b. If the answer is **YES**, the fire team leader continues to suppress the enemy:
 - (1) The fire team destroys or suppresses enemy crew-served weapons first.
 - (2) The fire team places smoke (M203/320) on the enemy position to obscure it.
 - (3) The fire team leader continues to control fires using tracers or standard fire commands.
Fires must be well-aimed and continue at a sustained rate with no lulls.
 - (4) Buddy teams fire their weapons so that both are not reloading their weapons at the same time.
 - c. If the answer is **NO**, the squad leader then deploys the fire team not in contact to establish a support-by-fire position. The squad leader reports the situation to the platoon leader. Normally, the squad becomes the base-of-fire element for the platoon. The squad continues to suppress the enemy and responds to orders from the platoon leader. (The platoon leader, radio telephone operator, FO, one machine gun team, squad leader of the next squad, platoon sergeant, and the other machine gun team are already moving forward according to Battle Drill 2, Platoon Assault.)
5. The unit leader maneuvers the assault elements into the assault.
- a. Squad leader adjusts fires (both direct and indirect) based on the rate of the assault element movement and the minimum safe distances of weapons systems.
 - b. Once in position, the squad leader gives the prearranged signal for the supporting fire team to shift direct fires to the opposite flank of the enemy position.
 - c. The assaulting fire team assumes and maintains effective fires throughout the assault.
Handover of responsibility for direct fires from support element to the assault element is critical to prevent fratricide.
 - d. If available, unit leader directs the forward observer to shift indirect fire (including smoke) to isolate the enemy position.
6. The assaulting element(s) fight through enemy position(s) using fire and movement.
- a. Team leader controls the movement of the team.
 - b. Team leader assigns specific objectives for each buddy team and designates a base maneuver element.
 - c. Base-of-fire elements maintain visual contact of the near flank of the assaulting element.
 - d. The assault element conducts fire and movement based on volume and accuracy of enemy fires against his element and the amount of cover afforded by the terrain.
 - (1) Assault element leader designates a distance and direction for the assault element and moves with that element.
 - (2) Soldiers maintain contact with team members and leaders.
 - (3) Team leaders direct Soldiers to move as individuals or teams.
 - (4) Soldiers fire from covered positions. Soldiers move using 3- to 5-second rushes or the low or high crawl techniques, taking advantage of available cover and concealment.
 - (5) Soldiers time their firing and reloading in order to sustain their rate of fire.

- (6) Team leaders maintain contact with the unit leader and pass signals to element members.
- (7) If the assault element cannot continue to move, the unit leader deploys the element(s) to suppress the enemy and reports to higher headquarters.
 - 7. The squad consolidates and reorganizes.
 - a. Squad leaders establish local security.
 - b. The squad leader signals for the base-of-fire element to move up into designated positions.
 - c. The squad leader assigns sectors of fire for each element.
 - d. The squad leader positions key weapons to cover the most dangerous avenue of approach.
 - e. The squad leader begins coordination for ammunition resupply.
 - f. Soldiers establish hasty fighting positions.
 - g. Squad leader develops a quick fire plan.
 - h. Squad leader place out observation posts to warn of enemy counterattacks.
 - i. Reestablishes the chain of command.
 - j. Redistributes and resupplies ammunition.
 - k. Mans crew-served weapons, first.
 - l. Redistributes critical equipment such as radios; CBRN; and night vision devices.
 - m. Treats and evaluates wounded.
 - n. Fills vacancies in key positions.
 - o. Searches, silences, segregates, safeguards, speeds, and tags detainees.
 - p. The unit leader consolidates ammunition, casualties' and equipment reports.
 - 8. Squad leader reports situation to platoon leader.

BATTLE DRILL 6: Enter and Clear a Room (07-4-D9509)

CONDITIONS: The unit is conducting operations as part of a larger unit and has been given the mission to clear a room. Enemy personnel are believed to be in building. Noncombatants may be present in the building and are possibly intermixed with the enemy personnel. The

unit has support and security elements positioned at the initial foothold and outside the building.

CUE: This drill begins on the order of the unit leader or on the command of the clearing team leader.

STANDARDS: The unit clears and secures the room by killing or capturing the enemy while minimizing friendly casualties, noncombatant casualties, and collateral damage. The team complies with ROE, maintains a sufficient fighting force to repel an enemy counterattack, and continues operations.

TASK STEPS AND PERFORMANCE MEASURES

1. The unit leader occupies a position to best control the security and clearing teams.
 - a. Unit leader directs a clearing team to secure corridors or hallways outside the room with appropriate firepower.
 - b. The team leader (normally, the number two Soldier) takes a position to best control the clearing team outside the room.
 - c. The unit leader gives the signal to clear the room.

Note. If the unit is conducting high-intensity combat operations and grenades are being used, the unit must comply with the ROE and consider the building structure. A Soldier of the clearing team cooks off at least one grenade (fragmentation, concussion, or stun grenade), throws the grenade into the room and announces, “FRAG OUT.” The use of grenades should be consistent with the ROE and building structure. Soldiers can be injured from fragments if walls and floors are thin or damaged.

2. The clearing team enters and clears the room.
 - a. The first two Soldiers enter the room almost simultaneously. (See figure J-9.)

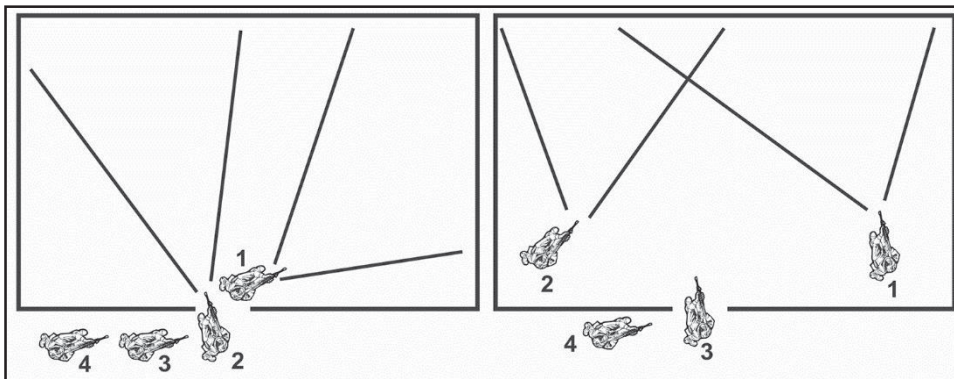


Figure J-9. Clear a room, first two Soldiers enter simultaneously

- b. The first Soldier enters the room, moves left or right along the path of least resistance to one of two corners, and assumes a position of domination facing into

- the room. During movement, the Soldier scans the sector and eliminates all immediate threats.
- c. The second Soldier (normally the clearing team leader) enters the room immediately after the first Soldier and moves in the opposite direction of the first Soldier to his point of domination. During movement the Soldier eliminates all immediate threats in the sector.

Notes. During high intensity combat the Soldiers enter immediately after the grenade detonates. Both Soldiers enter firing aimed bursts into their sectors engaging all threats or hostile targets to cover their entry.

If the first or second Soldier discovers the room is small or a short room (such as a closet or bathroom), he announces, "SHORT ROOM or SHORT." The clearing team leader informs the third and fourth Soldiers whether or not to stay outside the room or to enter.

- d. The third Soldier moves in the opposite direction of the second Soldier while scanning and clearing the sector and assuming the point of domination. (See figure J-10, page J-20.)

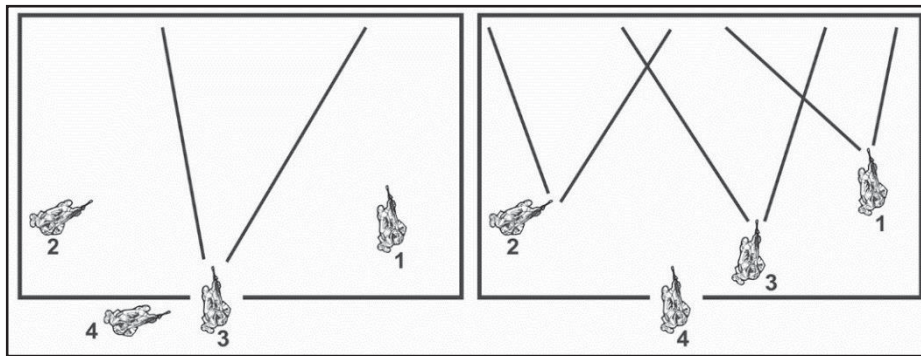


Figure J-10. Clear a room, third Soldier enters clearing his sector

- e. The fourth Soldier moves opposite of the third Soldier to a position dominating his sector. (See Figure J-11.)

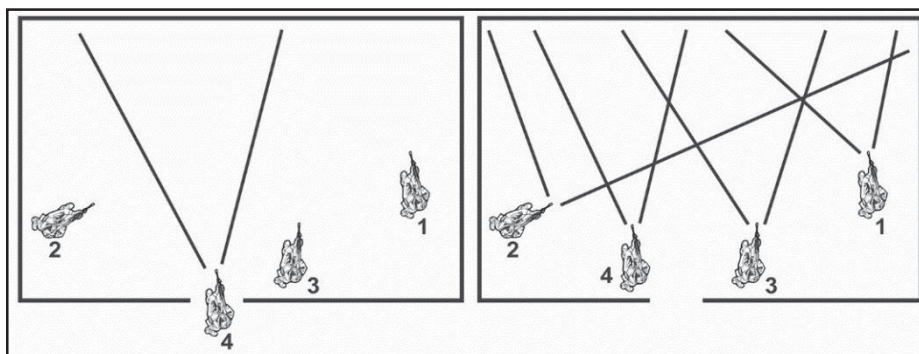


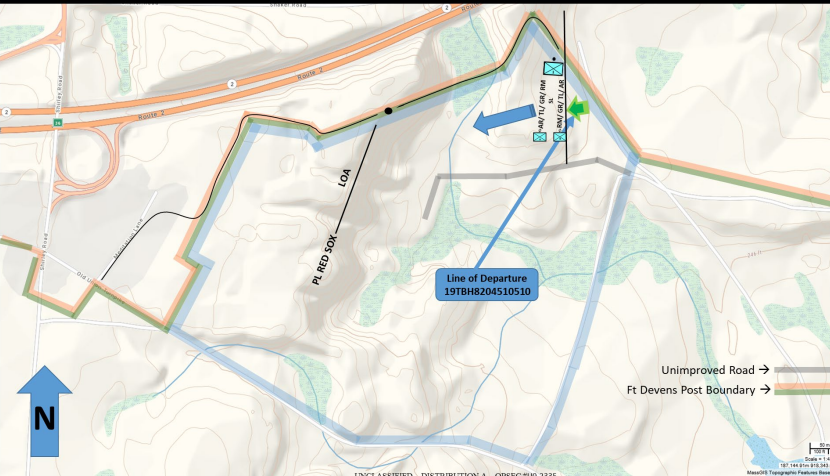
Figure J-11. Clear a room, third Soldier enters dominating his sector

- f. All Soldiers engage enemy combatants with precision aimed fire and identify noncombatants to avoid collateral damage.

Note. If necessary or on order, number one and two Soldiers of the clearing team may move deeper into the room while overwatched by the other team members.

- g. The clearing team leader announces to the unit leader when the room is CLEAR.
3. Marks the entry point according to unit SOP.
 - a. Makes a quick assessment of room and threat.
 - b. Determines if unit has fire power to continue clearing their assigned sector.
 - c. Reports to the higher unit leader the first room is clear.
 - d. Requests needed sustainment to continue clearing his sector.
 - e. Marks entry point according to unit SOP.
 4. The unit consolidates and reorganizes, as needed.

Appendix E – SUPRA CONOP & FRAGO

SITUATION: ____ Platoon conducts a Movement to Contact in sector to identify and eliminate enemy Observation posts. ____ Squad is the Southern Squad of the Platoon with no friendly element to the South or West of their location. ____ Squad is bordered to the North by ____ Squad (ME). During the mission ____ Squads fires must be oriented South and West to prevent FRATRICIDE.			
MISSION: ____ Squad, on order, conducts Movement to Contact in Sector to eliminate any enemy OP in support of ____ Squad, the platoon ME.			
EXECUTION: ____ Squad (SE2) moves from the LD, vicinity 19TBH 820 105 West to eliminate any possible enemy OP. Do not cross the post boundary in the North. Do not cross the unimproved road in the South. PL RED SOX is the LOA.	SERVICE AND SUPPORT: Each Squad member will be allotted one basic load of ammunition per Squad Weapon system. MG teams are being directed to Support the ME and the SE 1 elements. All 60 MM Mortar Support is prioritized to the Company ME.	COMMAND AND SIGNAL: P: FM_____ A: Visual Signal Device C: Whistle per SOP E: Runner	

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SITUATION: ___ Company (BN SE1), ___ Platoon (SE1) conducts attack on Building 1 (OBJ Lion Heart) to secure a foothold for the Company Main Effort. All Platoons are tasked to eliminate Enemy Fighters and protect Civilian Non-Combatants. Engage all threats with direct fire.		EXECUTION: ___ Squad (SE1) enters OBJ Lion Heart through the North Entrance and clears Rooms 3, 2, and 1. ___ Squad (SE2) will be clearing Room 4 and remains as the Platoon Reserve for follow on Operations. ___ Squad, the Platoon ME, will clear Rooms 5, 6, and 7. All Squads must ensure fires are oriented away from Hallway A to prevent FRATRICIDE. - Protect Non-Combatants at all times. - The enemy is using CCTV for false information marketing.
MISSION: ___ Squad (SE1), on order, conducts an attack on Building 1 (OBJ Lion Heart) to clear Rooms 3, 2, and 1, and secure a Foot Hold for the Company Main Effort.		SERVICE AND SUPPORT: Each Squad member will be allotted one basic load of ammunition per Squad Weapon system. MG teams are task organized to the Company and not available for room clearing operations.
MARKINGS: Building Clear: _____ Room Clear: _____ CCP: _____	COMMAND AND SIGNAL: P: FM A: Visual Signal Device C: Whistle per SOP E: Runner	

UNCLASSIFIED – DISTRIBUTION A – OPSEC #UO-2335

SUPRA FRAGO

Key times:

Platoon/Squad OPORD.
Rehearsals.
SP time.
Time on target.
NLT Hit Time.
Others as determined during the planning process.

Task organization:

Weather and light data:

1. SITUATION

Enemy Situation. Increased reports of cross-country movement of small groups (2-4 persons) of insurgents throughout AO Devens. Intelligence agencies suspect that they are consolidating forces to increase harassment of US Forces to cover their leadership's evacuation into remote regions of neighboring countries.

Friendly Situation. ABN BN is increasing PLT search and destroy missions to deny consolidation of enemy forces and destroy their capability to fight.

ACo and CCo are conducting movement to contact operations throughout AO Shirley and AO Ayer.

BCo is conducting movement to contact operations throughout AO Devens.

___ PLT is on 24 hour QRF.

___ PLT is in recovery operations.

2. MISSION.

___ Platoon will conduct MOVEMENT TO CONTACT along AXIS SUPRA in AO Devens NLT _____ in order to find, engage with, and destroy enemy forces.

3. EXECUTION.

Commander's Intent. Use fire and maneuver to search out and destroy small groups of insurgents moving throughout AO Devens IOT deny enemy movement and efforts to consolidate into a larger fighting force. Gather information about the enemy threat (location, disposition, orientation). Intelligence collected from initial operations will inform subsequent direct action combat operations against enemy insurgent positions and networks. The end-state is achieved

when enemy forces are either destroyed or denied unimpeded movement through the wooded areas of AO Devens.

Scheme of Maneuver. ____ PLT will conduct MTC along Axis SUPRA IOT find, engage with, and destroy enemy forces. Then NLT ____ 2100JUN2021 establish Patrol Base Vicinity TA14 to receive Day 3 FRAGO and prepare for follow-on mission.

Tasks to Maneuver Units.

____ Squad [1st Order of Movement (OOM)] (MAIN EFFORT).

Task 1: conduct MOVEMENT TO CONTACT along AXIS SUPRA NLT ____ in order to find, engage with, and destroy enemy forces.

Task 2: establish PB vicinity TA 12 NLT 072000JUL2021 IOT reconsolidate and reorganize as needed, receive Day 3 FRAGO and conduct TLPs for specified on-order tasks.

____ Squad and ____ Squad will occupy 2nd and 3rd OOM and ON ORDER rotate through as lead element for MTC as needed. *[Admin note: trail squads are notional for the exercise. Each squad will be the main effort (1st OOM) for their turn on the lane.]*

Scheme of Fires. No Change.

1. SUSTAINMENT

No Change.

2. COMMAND and SIGNAL.

No Change.

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Appendix F – OC Grading Schema

Conduct Squad Assault	(3 point Scale)	Weight
TASK STEPS (Asterisks indicate a leader performance step.)	[0-2]	
1. The fire team in contact immediately returns well-aimed fire on the known enemy position and calls out the direction and distance of the enemy. Note: Soldiers receiving fire take up the nearest positions that afford cover and concealment.	2	3
* 2. The squad leader reports contact to the platoon leader and moves toward the fire team in contact.	1	1
3. The fire team in contact takes the following actions:		
a. The team leader directs fires using tracers or standard fire commands.	2	1
b. Fire team Soldiers in contact move to positions (bound or crawl) where they can fire their weapons, position themselves to ensure that they have observation, field of fire, cover, and concealment. They continue to fire and report known or suspected enemy positions to the fire team leader.	2	3
4. The fire team not in contact takes covered and concealed positions in place and observes the flanks and rear of the squad.	2	1
* 5. The squad leader moves to a position to observe the enemy, assesses the situation and then completes the following actions:		
a. Reports the enemy size and location, and any other information to the platoon leader.	2	1
b. Requests through higher, immediate indirect fire support.	2	1
c. Determines if the fire team in contact can gain suppressive fire based on the volume and accuracy of the enemy fire.	2	1
6. The fire team in contact suppresses the enemy and the following actions take place:		
a. The team leader identifies target reference points with the squad leader for shifting fires.	2	3
b. The fire team becomes the support by fire team.	2	1
c. The fire team continues suppression of the enemy as follows:		
(1) The fire team leader continues to control fires using tracers or standard fire commands. Fires must be well-aimed and continue at a sustained rate with no lulls.	2	3
(2) The fire team destroys or suppresses enemy crew-served weapons first.	2	1
(3) The fire team places smoke (M203/320) on the enemy position to obscure it.	2	1
(4) Buddy teams alternate their fire so that both are not reloading their weapons at the same time.	1	3
* 7. The squad leader moves to the fire team not in contact and- Note: The fire team not in contact becomes the assault team.		
a. Links up with the fire team leader not in contact.	2	1
b. Identifies the fire team not in contact as the assault team.	2	1

* 8. The squad leader maneuvers the assault fire team into the assault position and the following actions take place:		
a. The squad leader adjusts fires (both direct and indirect) based on the rate of the assault element movement and the minimum safe distances of weapons systems.	2	1
b. The squad leader directs the forward observer, if available, to shift indirect fire, including smoke, to isolate the enemy position.	2	1
c. The squad leader gives the prearranged signal for the support by fire team to shift direct fires to the opposite flank of the enemy position.	2	3
d. The assault fire team assumes and maintains effective fires throughout the assault.	2	1
e. The support by fire team confirms the shift of direct fires with the prearranged signal.	2	3
9. The assault team fights through the enemy position using fire and maneuver and takes the following actions:		
a. The assault team leader controls the movement of the team.	2	1
b. The assault team conducts fire and maneuver based on volume and accuracy of enemy fires and the amount of cover afforded by the terrain as follows:		
(1) Assault team leader designates a distance and direction for the assault team and moves with that element.	2	3
(2) Assault team leader directs Soldiers to move as individuals or teams.	2	3
(3) Soldiers maintain contact with team members and leaders.	2	3
(4) Soldiers move using 3- to 5-second rushes or the low or high crawl techniques, taking advantage of available cover and concealment.	2	1
(5) Soldiers time their firing and reloading to sustain their rate of fire.	2	1
10. The support by fire team maintains visual contact of the near flank of the assaulting team as the assaulting team conducts the assault.	2	1
11. If the assault element cannot continue to move, the squad leader positions the squad to suppress the enemy and reports to higher headquarters.	2	1
12. The squad consolidates and reorganizes as follows:		
a. The squad establishes local security.	2	1
b. The squad leader signals for the support by fire team to move up into designated positions.	2	1
c. The squad places out observation posts to warn of enemy counterattacks.	2	1
d. The squad leader assigns sectors of fire for each element.	2	1
e. The Soldiers establish hasty fighting positions.	2	1
f. The squad leader positions key weapons to cover the most dangerous avenue of approach.	2	1
g. The squad leader develops a quick fire plan.	2	1
h. The squad reestablishes the chain of command.	2	1
i. The squad mans crew-served weapons and then individual weapons.	2	3

j. The squad leader begins coordination for ammunition resupply.	2	1
k. The squad leader consolidates ammunition, casualties and equipment reports.	2	1
l. The squad redistributes and resupplies ammunition.	2	3
m. The squad redistributes critical equipment such as radios, CBRN, and night vision devices.	2	1
n. The squad treats and evaluates wounded.	2	1
o. The squad searches, silences, segregates, safeguards, speeds, and tags detainees.	2	1
* 13. The squad leader reports situation to the platoon leader.	2	1

07-SQD-D9509	Points	Weight	Squad 1 (Room 1 = 69)	Points	Weight	Squad 2 (Room 1 = 29)
Enter and Clear a Room - Squad	(3 point Scale)		Squad 1 (Room 2 = 78)	(3 point Scale)		Squad 2 (Room 2 = 43)
TASK STEPS (Asterisks indicate a leader performance step.)	[0-2]		Squad 1 (Room 3 = 78)	[0-2]		Squad 2 (Room 3 = 52)
* 1. The squad leader						
a. Occupies a position to best control the security and clearing teams.	2	1	2	1	1	1
b. Directs a security team to secure corridors or hallways outside the room with appropriate firepower.	1	3	3	0	3	0
c. Gives the clearing team leader an order to clear the room.	2	1	2	1	1	1
Note: If the squad is conducting high-intensity operations and grenades are being used, the unit must comply with the ROE and consider the building structure. A Soldier of the clearing team cooks off at least one grenade (fragmentation, concussion, or grenade), throws the grenade into the room, and announces: "FRAG OUT" or "STUN OUT." The use of grenades should be consistent with the ROE and building structure. Soldiers can be injured from fragments if walls and floors are thin or damaged.						
* 2. The team leader (normally the number two Soldier) does the following:						
a. Takes a position to best control the clearing team outside the room.	2	1	2	1	1	1
b. Determines the method of entry into the room.	2	1	2	2	1	2
c. Gives the command to enter and clear the room.	2	1	2	2	1	2
3. The first two Soldiers enter the room almost simultaneously as follows:						
a. The first Soldier enters the room, moves left or right along the path of least resistance to one of two corners, and assumes a position of domination facing into the room. During movement, the Soldier scans the sector and eliminates all immediate threats.	1	3	3	0	3	0
b. The second Soldier (normally the clearing team leader) enters the room immediately after the first Soldier and moves in the opposite direction of the first Soldier to a point of domination. During movement, the Soldier eliminates all immediate threats in the sector.	2	3	6	1	3	3
Note: During high-intensity combat, the Soldiers enter immediately after the grenade detonates. Both Soldiers enter while firing aimed bursts into their sectors, engaging all threats or hostile targets to cover their entry. If the first or second Soldier discovers the room is small or a short room (such as a closet or bathroom), he announces, "SHORT ROOM" or "SHORT." The clearing team leader informs the third and fourth Soldiers whether or not to stay outside the room or to enter.						
4. The third Soldier moves in the opposite direction of the second Soldier while scanning and clearing the sector and assuming the point of domination.	1	3	3	1	3	3
5. The fourth Soldier moves opposite of the third Soldier to a position dominating their sector.	2	3	6	0	3	0
6. All Soldiers engage enemy combatants with precision-aimed fire and identify noncombatants to avoid collateral damage.	2	3	6	1	3	3
Note: If necessary or on order, number one and two Soldiers of the clearing team may move deeper into the room while overwatched by the other team members.						
* 7. The clearing team leader scans and clears the room by						
a. Ensuring all threats are neutralized.	2	1	2	1	1	1
b. Ensuring all noncombatants are secured.	2	1	2	1	1	1
c. Announcing, "CLEAR" to the squad leader when the room is clear.	2	3	6	2	3	6
* 8. The squad leader directs the security team to continue to secure the corridor or hallway.	2	3	6	0	3	0
* 9. The squad leader enters the room and						
a. Makes a quick assessment of the room and threat.	2	1	2	1	1	1
b. Determines if the squad has firepower to continue clearing their assigned sector.	2	3	6	1	3	3
c. Reports to the platoon leader that the room is clear.	2	1	2	0	1	0
d. Requests needed sustainment to continue clearing the squad's sector.	2	1	2	0	1	0
e. Marks entry point according to the unit SOP.	2	1	2	0	1	0
10. The squad consolidated and reorganized, as needed.	2	1	2	1	1	1
* 1. The squad leader						
a. Occupies a position to best control the security and clearing teams.	2	1	2	2	1	2
b. Directs a security team to secure corridors or hallways outside the room with appropriate firepower.	2	3	6	0	3	0
c. Gives the clearing team leader an order to clear the room.	2	1	2	1	1	1
Note: If the squad is conducting high-intensity operations and grenades are being used, the unit must comply with the ROE and consider the building structure. A Soldier of the clearing team cooks off at least one grenade (fragmentation, concussion, or grenade), throws the grenade into the room, and announces: "FRAG OUT" or "STUN OUT." The use of grenades should be consistent with the ROE and building structure. Soldiers can be injured from fragments if walls and floors are thin or damaged.						
* 2. The team leader (normally the number two Soldier) does the following:						
a. Takes a position to best control the clearing team outside the room.	2	1	2	2	1	2
b. Determines the method of entry into the room.	2	1	2	2	1	2
c. Gives the command to enter and clear the room.	2	1	2	2	1	2
3. The first two Soldiers enter the room almost simultaneously as follows:						
a. The first Soldier enters the room, moves left or right along the path of least resistance to one of two corners, and assumes a position of domination facing into the room. During movement, the Soldier scans the sector and eliminates all immediate threats.	2	3	6	1	3	3
b. The second Soldier (normally the clearing team leader) enters the room immediately after the first Soldier and moves in the opposite direction of the first Soldier to a point of domination. During movement, the Soldier eliminates all immediate threats in the sector.	2	3	6	1	3	3

Note: During high-intensity combat, the Soldiers enter immediately after the grenade detonates. Both Soldiers enter while firing aimed bursts into their sectors, engaging all threats or hostile targets to cover their entry. If the first or second Soldier discovers the room is small or a short room (such as a closet or bathroom), he announces, "SHORT ROOM" or "SHORT." The clearing team leader informs the third and fourth Soldiers whether or not to stay outside the room or to enter.

4. The third Soldier moves in the opposite direction of the second Soldier while scanning and clearing the sector and assuming the point of domination.
5. The fourth Soldier moves opposite of the third Soldier to a position dominating their sector.
6. All Soldiers engage enemy combatants with precision-aimed fire and identify noncombatants to avoid collateral damage.
- Note: If necessary or on order, number one and two Soldiers of the clearing team may move deeper into the room while overwatched by the other team members.
- * 7. The clearing team leader scans and clears the room by
- a. Ensuring all threats are neutralized.
 - b. Ensuring all noncombatants are secured.
 - c. Announcing, "CLEAR" to the squad leader when the room is clear.
- * 8. The squad leader directs the security team to continue to secure the corridor or hallway.
- * 9. The squad leader enters the room and
- a. Makes a quick assessment of the room and threat.
 - b. Determines if the squad has firepower to continue clearing their assigned sector.

- c. Reports to the platoon leader that the room is clear.
 - d. Requests needed sustainment to continue clearing the squad's sector.
 - e. Marks entry point according to the unit SOP.
10. The squad consolidated and reorganized, as needed.

- * 1. The squad leader
- a. Occupies a position to best control the security and clearing teams.
 - b. Directs a security team to secure corridors or hallways outside the room with appropriate firepower.
 - c. Gives the clearing team leader an order to clear the room.
- Note: If the squad is conducting high-intensity operations and grenades are being used, the unit must comply with the ROE and consider the building structure. A Soldier of the clearing team cooks off at least one grenade (fragmentation, concussion, or grenade), throws the grenade into the room, and announces: "FRAG OUT" or "STUN OUT." The use of grenades should be consistent with the ROE and building structure. Soldiers can be injured from fragments if walls and floors are thin or damaged.

- * 2. The team leader (normally the number two Soldier) does the following:
- a. Takes a position to best control the clearing team outside the room.
 - b. Determines the method of entry into the room.
 - c. Gives the command to enter and clear the room.
3. The first two Soldiers enter the room almost simultaneously as follows:
- a. The first Soldier enters the room, moves left or right along the path of least resistance to one of two corners, and assumes a position of domination facing into the room. During movement, the Soldier scans the sector and eliminates all immediate threats.
- b. The second Soldier (normally the clearing team leader) enters the room immediately after the first Soldier and moves in the opposite direction of the first Soldier to a point of domination. During movement, the Soldier eliminates all immediate threats in the sector.

Note: During high-intensity combat, the Soldiers enter immediately after the grenade detonates. Both Soldiers enter while firing aimed bursts into their sectors, engaging all threats or hostile targets to cover their entry. If the first or second Soldier discovers the room is small or a short room (such as a closet or bathroom), he announces, "SHORT ROOM" or "SHORT." The clearing team leader informs the third and fourth Soldiers whether or not to stay outside the room or to enter.

4. The third Soldier moves in the opposite direction of the second Soldier while scanning and clearing the sector and assuming the point of domination.
5. The fourth Soldier moves opposite of the third Soldier to a position dominating their sector.
6. All Soldiers engage enemy combatants with precision-aimed fire and identify noncombatants to avoid collateral damage.
- Note: If necessary or on order, number one and two Soldiers of the clearing team may move deeper into the room while overwatched by the other team members.
- * 7. The clearing team leader scans and clears the room by
- a. Ensuring all threats are neutralized.
 - b. Ensuring all noncombatants are secured.
 - c. Announcing, "CLEAR" to the squad leader when the room is clear.
- * 8. The squad leader directs the security team to continue to secure the corridor or hallway.
- * 9. The squad leader enters the room and
- a. Makes a quick assessment of the room and threat.
 - b. Determines if the squad has firepower to continue clearing their assigned sector.

- c. Reports to the platoon leader that the room is clear.
 - d. Requests needed sustainment to continue clearing the squad's sector.
 - e. Marks entry point according to the unit SOP.
10. The squad consolidated and reorganized, as needed.

2	3	6	1	3	3
2	3	6	0	3	0
2	3	6	1	3	3
2	1	2	2	1	2
2	1	2	0	1	0
2	3	6	2	3	6
2	3	6	1	3	3
2	1	2	1	1	1
2	3	6	2	3	6
2	1	2	1	1	1
2	1	2	1	1	1
2	1	2	1	1	1
2	1	2	1	1	1
2	3	6	2	3	6
2	1	2	2	1	2
2	3	6	2	3	6
2	3	6	1	3	3
2	3	6	0	3	0
2	3	6	0	3	0
2	3	6	1	3	3
2	1	2	2	1	2
2	1	2	1	1	1
2	3	6	2	3	6
2	3	6	2	3	6
2	1	2	2	1	2
2	3	6	1	3	3
2	1	2	1	1	1
2	1	2	0	1	0
2	1	2	2	1	2
2	1	2	2	1	2