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AMMPHS Trial Report
CFB Valcartier
28 September to 9 October

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Abstract

A total of eight different AMMPHS prototype mandible conditions were assessed as part of a SIHS helmet trial held at Canadian Forces Bases (CFB) Valcartier from September 28 to October 9, 2009. Twelve participants were required to undertake a battery of human factors tests while wearing the current in-service helmet (CG634) or one of the AMMPHS prototype mandibles in a blocked repeated measures design. During each test, the order of conditions was only partially balanced due to the lack of available resources and mandible prototypes. Human factors tests included assessments of fit, comfort, range of motion, field of view, performance of select battle tasks, and equipment, vehicle and clothing compatibility. Data collection included anthropometric measurements, range of motion measurements, field of view measurements, questionnaires, focus groups, live fire performance measures, and Human Factors (HF) observer assessments.

Résumé

Au total, huit prototypes de systèmes de mandibules du Système de casque de protection modulaire multi-menaces perfectionné (SCPMMP) ont été évalués dans le cadre des essais pour les casques intégrés pour le soldat (CIS) qui ont eu lieu à la base des Forces canadiennes (BFC) Valcartier du 28 septembre au 9 octobre 2009. Une batterie d'essais de facteurs humains a été effectuée à l'aide de douze participants, selon un protocole de mesures répétées par blocs, pendant qu'ils portaient le casque actuellement en usage (CG634) ou un des prototypes des mandibules du SCPMMP. Au cours de chaque essai, l'ordre des conditions était seulement partiellement équilibré à cause du manque de ressources et de prototypes de mandibules disponibles. Les essais de facteurs humains comprenaient une évaluation de l'ajustement, du confort, de l'amplitude des mouvements, du champ de vision, de l'exécution de tâches de combat sélectionnées et de la compatibilité avec l'équipement, les véhicules et les vêtements. La collecte de données incluait des mesures anthropométriques, des mesures de l'amplitude des mouvements, du champ de vision et de rendement de tir réel, ainsi que des questionnaires, des groupes de consultation et des évaluations d'observateurs de facteurs humains.

Executive Summary

In conjunction with a Soldier Integrated Headwear System (SIHS) trial, prototype AMMPHS mandible systems were assessed on a number of static and dynamic stands. The 10 day fit and prototype evaluation trial was conducted at Canadian Forces Bases (CFB) Valcartier from September 28 to October 9, 2009. Although 26 participants passed through the range of motion and field of view test stands, a subset of 12 soldiers were screened to participate in the SIHS and AMMPHS trials (the remaining participants (14) took part in another concurrent experiment). Personnel were required to undertake a battery of human factors tests while wearing the current in-service helmet (CG634) or one of the new helmets with a prototype mandible in a blocked repeated measures design. During each test, the order of conditions was only partially balanced due to the lack of available resources and mandible prototypes. Human factors tests included assessments of fit, comfort, range of motion, field of view, performance of select battle tasks, and equipment, vehicle and clothing compatibility. Data collection included anthropometric measurements, range of motion measurements, field of view measurements, questionnaires, focus groups, live fire performance measures, and Human Factors (HF) observer assessments.

Universally, the ratings for the different AMMPHS mandible conditions were lower than the in-service baseline condition. While the in-service CG634 was rated reasonably to completely acceptable across nearly all evaluation criteria, the AMMPHS conditions were rated completely unacceptable to borderline in acceptance. AMMPHS conditions 9A and 11 outperformed the other AMMPHS mandible conditions receiving an exit acceptance rating of barely unacceptable to borderline (3.7). Clinical tests with the AMMPHS mandibles identified reductions in head movement forward and lateral head movement to the right and left. Although objective reductions in the ranges of motion with the AMMPHS prototypes were measured, participant feedback after the obstacle course and dynamic vehicle tasks did not identify significant concerns. Participants appeared able to accommodate the minor reductions in ranges of motion. The AMMPHS mandibles also limited vision directly down and obliquely to the left side. Cut-outs improved vision to the lower right quadrant. Participants appeared able to accommodate the minor reductions in field of view. Compatibility issues were identified in the C7, M72 and headset static compatibility stands. The AMMPHS conditions were all rated as being acceptable for static compatibility with crew positions in the LAV III vehicle. While minor cases of vision and physical clash interference were noted, the participants believed performance was still acceptable. Although the subjective static and dynamic acceptance ratings for mandibles compatibility with C7 were mixed, the objective live fire results did not demonstrate any discernable drop in shooting performance. Given the small sample size and variation in user response caution was strongly advised in drawing any conclusions from this limited evaluation.

Although not the focus of this trial, the participants were supportive of the new AMMPHS double curved visor. Despite misgivings about wearing any protective mandible, the participant's believed that a cut-out mandible design formed the best basis for further refinement. The participants recommended that AMMPHS development efforts should be focussed on improving C7 compatibility, headset compatibility and refinements to the attachment system. As well the participants noted that efforts should be made to maximize mandible compatibility for the different sized heads and face morphologies.

Recommendations for future testing are provided.

Sommaire

Conjointement aux essais pour les casques intégrés pour le soldat (CIS), les prototypes de systèmes de mandibule du SCPMMP ont été évalués à partir d'une quantité de kiosques statiques et dynamiques. Les essais d'évaluation de l'ajustement et du prototype ont eu lieu pendant 10 jours à la base des Forces canadiennes (BFC) Valcartier, du 28 septembre au 9 octobre 2009. Même si vingt-six (26) participants ont passé par les kiosques pour les essais d'amplitude des mouvements et de champ de vision, un sous-ensemble de douze (12) soldats a été sélectionné pour participer aux essais des CIS et des SCPMMP (les autres participants (14) ont pris part à une expérience concurrente). Une batterie d'essais de facteurs humains a été effectuée sur le personnel, selon un protocole de mesures répétées par blocs, pendant qu'il portait le casque actuellement en usage (CG634) ou un des nouveaux casques avec un prototype de mandibule. Au cours de chaque essai, l'ordre des conditions était seulement partiellement équilibré à cause du manque de ressources et de prototypes de mandibules disponibles. Les essais de facteurs humains comprenaient une évaluation de l'ajustement, du confort, de l'amplitude des mouvements, du champ de vision, de l'exécution de tâches de combat sélectionnées et de la compatibilité avec l'équipement, les véhicules et les vêtements. La collecte de données incluait des mesures anthropométriques, des mesures de l'amplitude des mouvements, du champ de vision et de rendement de tir réel, ainsi que des questionnaires, des groupes de consultation et des évaluations d'observateurs de facteurs humains.

Partout, les évaluations pour les différentes conditions des mandibules du SCPMMP étaient plus faibles que pour la condition actuelle servant de base de référence. Le casque CG634 actuellement en usage a été classé entre raisonnablement acceptable et complètement acceptable pour presque tous les critères d'évaluation, tandis que les conditions pour le SCPMMP ont été évaluées entre « complètement inacceptables » et « à la limite de l'acceptabilité ». Les conditions 9A et 11 du SCPMMP ont mieux réussi que les autres conditions des mandibules du SCPMMP qui ont reçu une évaluation finale entre « à peine inacceptable » et « limite » (3.7). Les essais cliniques des mandibules du SCPMMP ont démontré une réduction des mouvements de la tête avant et latéraux (vers la gauche ou vers la droite). Même si des réductions objectives ont été mesurées pour l'amplitude des mouvements avec les prototypes du SCPMMP, la rétroaction des participants après la piste à obstacles et les tâches dynamiques avec des véhicules ne soulignait aucune inquiétude importante. Les participants semblaient pouvoir s'ajuster aux petites réductions dans l'amplitude des mouvements. Les mandibules du SCPMMP limitaient aussi la vision directe vers le bas et oblique vers la gauche. L'échancrure de parties a permis d'améliorer la vision dans le quadrant inférieur droit. Les participants semblaient pouvoir s'ajuster aux petites réductions du champ de vision. Des problèmes de compatibilité ont été signalés aux kiosques statiques de compatibilité du C7, du M72 et du casque d'écoute. Les systèmes du SCPMMP ont tous été jugés « acceptables » pour la compatibilité statique avec les membres d'équipage dans le VBL III. Même si des cas mineurs d'interférence de la vision et de collisions physiques ont été signalés, les participants ont considéré la performance acceptable. Malgré les évaluations statiques et dynamiques d'acceptabilité mitigées pour la compatibilité des mandibules avec le C7, les résultats du test objectif de tir réel n'ont pas démontré de baisse notable de la performance de tir. Étant donné la petite taille de l'échantillon et les écarts dans les réponses des utilisateurs, il est fortement conseillé d'être prudent au moment de tirer des conclusions de cette évaluation limitée.

Même si ce n'était pas l'objectif de ces essais, les participants ont appuyé la nouvelle visière courbée double du SCPMMP. Malgré quelques doutes en ce qui concerne le port de mandibules de protection, les participants considèrent qu'un modèle de mandibule avec échancrure s'avérerait le meilleur modèle de base à perfectionner. Ils ont recommandé que les efforts d'amélioration du SCPMMP se concentrent sur la compatibilité avec le C7 et le casque d'écoute, et le perfectionnement du système de fixation. Ils ont aussi souligné qu'il faudrait s'efforcer de maximiser la compatibilité des mandibules avec les différentes tailles de tête et morphologies du visage.

Des recommandations pour la poursuite des essais sont formulées.

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Table of Contents

List of Figures

List of Tables

1. Introduction

The Advanced Modular Multi-threat Headwear System (AMMPHS) Technology Demonstrator project was initiated by Defence R&D Canada to explore protective solutions to increase soldier survivability against emerging threats, in particular IEDs. The AMMPHS project builds on the work completed under the Solider Integrated Headwear System (SIHS) TDP by supporting a much more in-depth investigation of protection system design, material selection, manufacturability and performance assessment that was possible under SIHS. The project is exploring both upgrades to the in-service combat helmet to increase coverage as well as a new modular helmet design featuring a split impact/ballistic shell, mandible guard, visor, and nape protector. The designs for the various components are inspired by the SIHS add-on and Alpha helmet concepts as well as the ballistic, blast, and impact studies performed in support of the SIHS conceptual design. Lessons learned through user studies and helmet integration work performed by SIHS (e.g. integrated sensors, sensor selection, displays, augmented hearing) are also being used to drive the geometry of the protective components although protective performance is prioritised in the AMMPHS concepts.

2. Aim

One of the protective items that has proven to be the most difficult to design for the add-on and AMMPHS helmet conditions is the mandible guard. The requirement set at the beginning of the AMMPHS project was for significant levels of both impact and ballistic protection. A rigid structure covering the jaw is therefore a necessary component of the design, as is a significant degree of coverage for meaningful ballistic protection. This results in a conflict with weapon systems, communications, eating/breathing, etc. and a significant challenge to achieve the trade-offs needed to provide a level of protection that justifies the added weight and bulk of not only the mandible guard but also the parasitic weight of the attachment system while minimizing the physiological impact and maintaining soldier system compatibility.

Poor soldier acceptability will lead to the mandible guard (or any piece of protective equipment) not being worn. While there is always a desire to provide the most coverage possible, a slight decrease in coverage that leads to an item being worn is infinitely better than the item not being worn at all (i.e. zero coverage) because it conflicts with the soldiers ability to do his/her job.

A number of options for mandible guards have been investigated in both the SIHS and AMMPHS projects, a reflection of the challenges the design presents. The user trial reported on herein, the second for AMMPHS and the fourth for SIHS, is an assessment of some of the latest designs of the mandible guard under AMMPHS and compliments the assessments of other mandible guards designed under the SIHS project that were trialed at the same time (reported separately).

One aspect that was looked at in some depth was a cut-out for the rifle/machine gun butt-stock. Coverage is sacrificed to try to increase butt-stock compatibility, an issue that had been flagged in previous user trials. This compatibility issue is significant enough to be a barrier for the soldier to wear a mandible guard as the ability to shoot accurately cannot be compromised.

Slight variations in coverage were also investigated through changes in the cut of the top and bottom of the mandible. These will have an effect on range of motion and field of view. A few mandibles also had cut-outs in the top edge at the mouth/nose. The idea was to assess if the soldiers noticed a difference. Again coverage sacrificed to improve acceptability (smoking, breathing, drinking).

An informal assessment of a new visor geometry was conducted during the trials. The visor height and cut is based on the positive results obtained by SIHS for a short visor system. Further improvements to the visor were made under AMMPHS by introducing a double curvature to increase coverage for fragments that might strike the face from below, to increase clearance with the rifle butt-stock and sight, and to decrease the stand-off of the visor from the helmet when in a raised position (i.e. conformal to the helmet shell).

Additionally, soft nape protectors were also informally assessed during the trial. No data was recorded on the performance of the nape protectors but user feedback was gathered in the focus group.

Finally, four concepts for helmet attachment systems for the mandible were trialed. These complimented the e-Clip designs being studied under the SIHS project. The objective was to identify successful aspects of functionality and usability in the concepts that could be merged into the final design for the AMMPHS add-on systems and modular helmet.

3. Method

3.1 Overview

In conjunction with a SIHS trial, prototype AMMPHS mandible systems were assessed on a number of static and dynamic stands. The 10 day fit and prototype evaluation trial was conducted at Canadian Forces Base (CFB) Valcartier from September 28 to October 9, 2009. Although 26 participants passed through the range of motion and field of view test stands, a subset of 12 soldiers were screened to participate in the SIHS and AMMPHS trials (the remaining participants (14) took part in another concurrent experiment). Personnel were required to undertake a battery of human factors tests while wearing the current in-service helmet (CG634) or one of the new helmets with a prototype mandible in a repeated measures design. During each test, the order of conditions was only partially balanced due to the lack of available resources and mandible prototypes. Human factors tests included assessments of fit, comfort, range of motion, field of view, performance of select battle tasks, and equipment, vehicle and clothing compatibility. Data collection included anthropometric measurements, range of motion measurements, field of view measurements, questionnaires, focus groups, live fire performance measures, and Human Factors (HF) observer assessments. Methods are detailed in subsequent sections.

3.2 Test Conditions

A number of dependent variables were measured in this trial. The main focus was the evaluation of eight rigid AMMPHS prototype visors, two reference SIHS soft mandibles, four mandible attachment systems and a new visor system.

3.2.1 Rigid Mandibles

There were a total of eight mandible prototypes evaluated in this trial along with the in-service helmet (CG634) – see Figure 2, Figure 4, Figure 6, and Figure 8. Each mandible prototype was tested separately by a minimum of 6 participants. Not all mandible prototypes were evaluated by all participants. Half of the participants evaluated prototypes 8, 8A, 10, and 12 while the other participants evaluated 9, 9A, 11, and 13. All of the participants evaluated the in-service helmet (CG634) as a baseline for comparison against the mandible prototypes. Therefore, each participant tested either prototype 8 or 9 along with its associated cut-out counterpart 9 and 9A in an attempt to determine if participants prefer a mandible design with specific areas removed.

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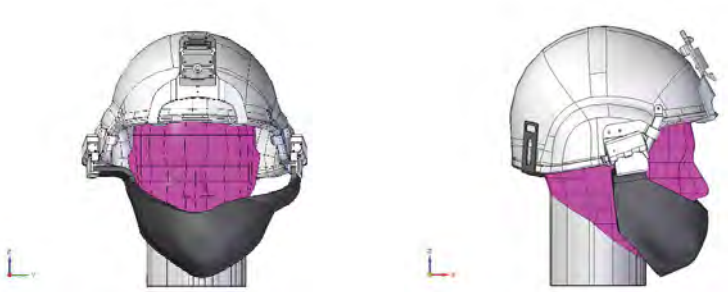

Figure 1: Mandible Prototype 8 Front (left) and Side (right) Views

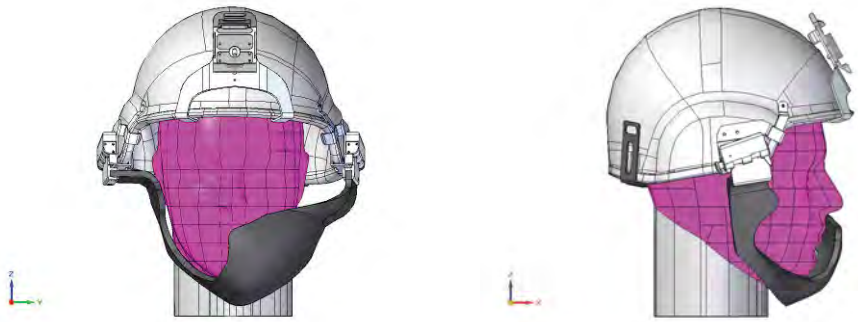

Figure 2: Mandible Prototypes 8A Front (left) and Side Views (right)

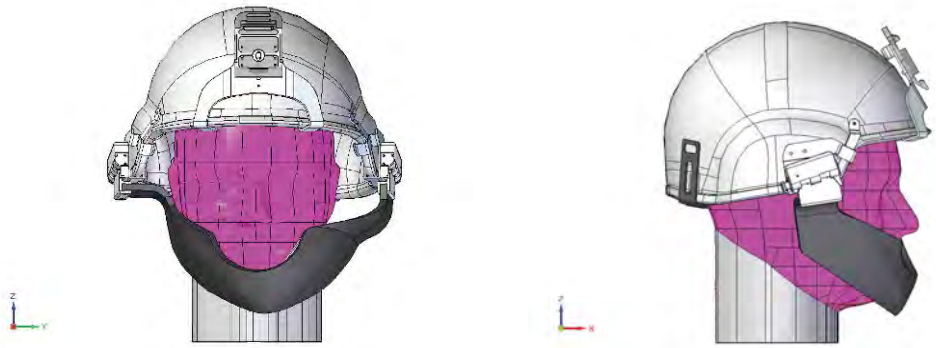

Figure 3: Mandible Prototype 10 Front (left) and Side (right) Views

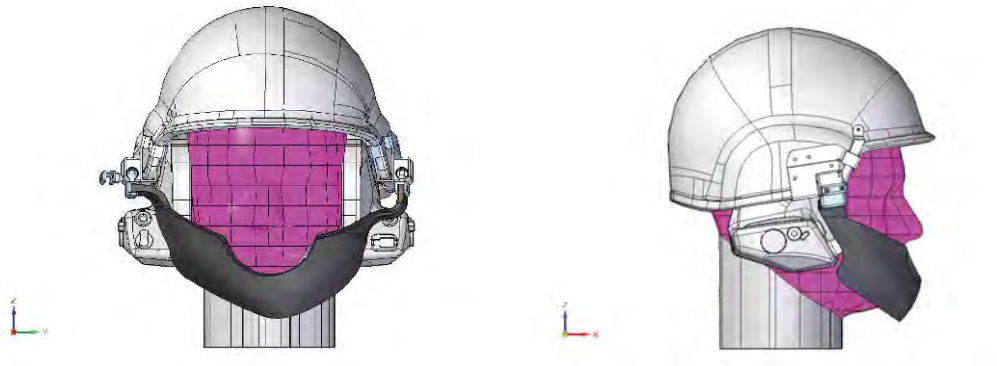

Figure 4: Mandible Prototypes 12 Front (left) and Side (right) Views

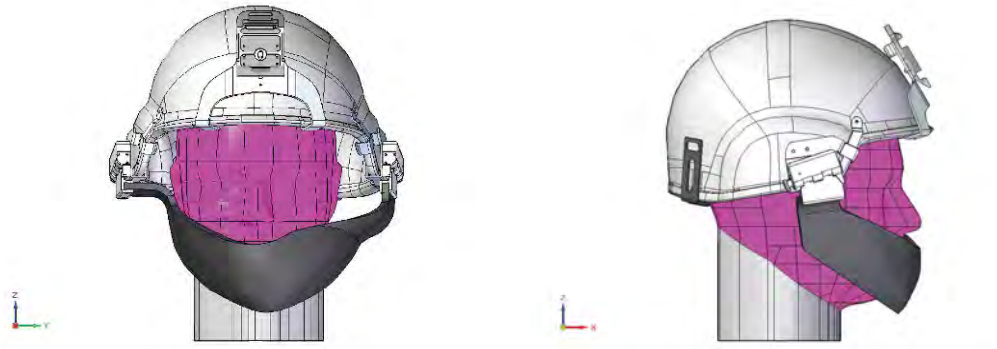

Figure 5: Mandible Prototype 9 Front (right) and Side (left) Views

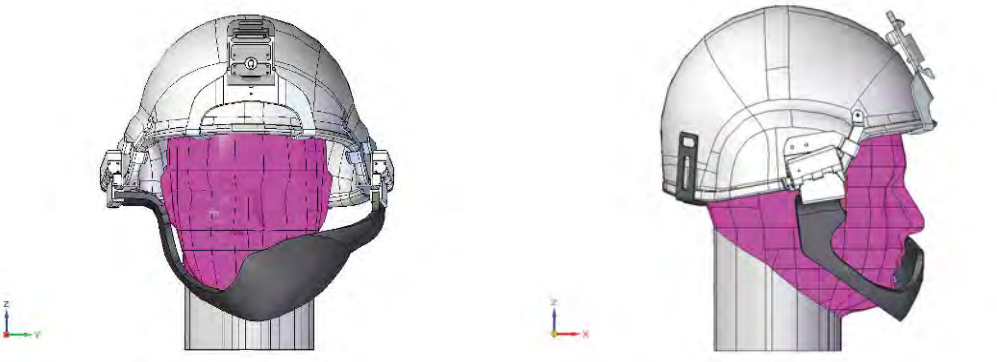

Figure 6: Mandible Prototypes 9A Front (left) and Side (right) Views

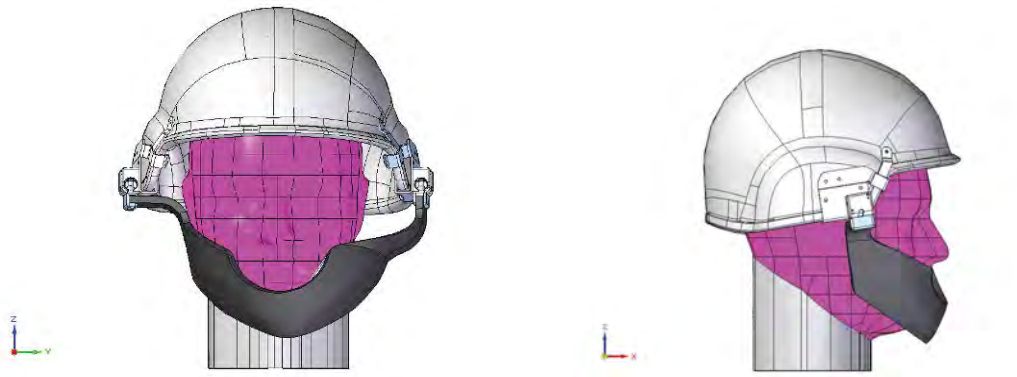

Figure 7: Mandible Prototype 11 Front (right) and Side (left) Views

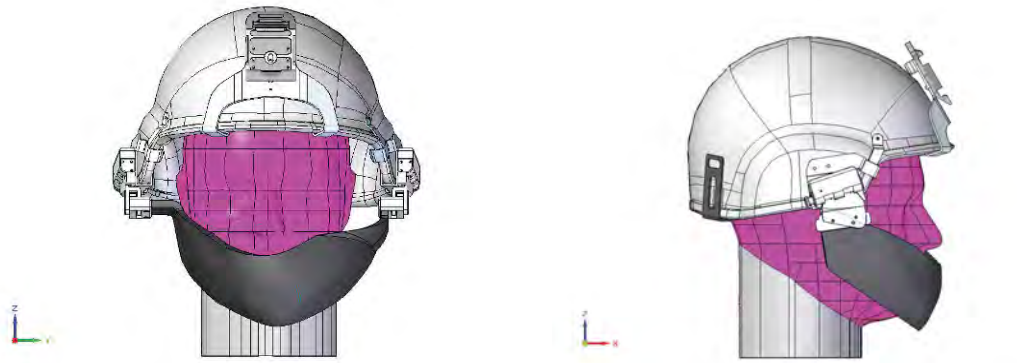

Figure 8: Mandible Prototypes 13 Front (left) and Side (right) Views

3.2.2 Soft Mandibles

In addition to the rigid mandibles the participants evaluated a number of soft mandibles as part of the parallel SIHS trial. Two soft mandible systems (CS and SL) were utilized as reference systems in the exit questionnaire –Tack, McKee, Kelly and Nakaza (2010) for a complete description of the soft mandibles and the SIHS trial report. The twp mandibles used as references utilized different materials and had different lengths. The CS system utilized five layers of flexible ballistic fabric and was short in length while the SL utilized Spectra Shield armour and was long in length. Mandibles were attached to the in-service helmets and Velcro was used to adjust fit and coverage. The differences in mandible length appearance are detailed in Figure 9.

Figure 9: Mandible Prototypes: Long (top) and Short (bottom)

3.2.3 Clips

Along with the eight mandible prototypes there were four types of clip attachment systems evaluated in this trial – see Figure 10, Figure 11, Figure 12, and Figure 13. The clip attachment system is a method of attaching the mandibles to the helmet. All of the participants evaluated all of the different attachment systems and completed a single exit questionnaire that compared the four different attachment systems across a wide range of criteria. These results are provided in the results section of the report. Note, one SIHS attachment system (EVO) was utilized as reference system, see –Tack, McKee, Kelly and Nakaza (2010) for a complete description of the EVO clip system.

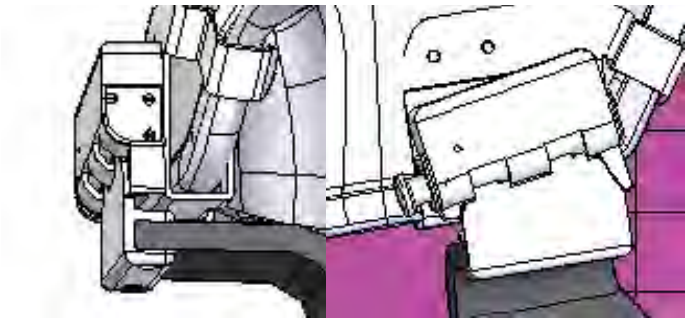

Figure 10: Hinge Only Attachment

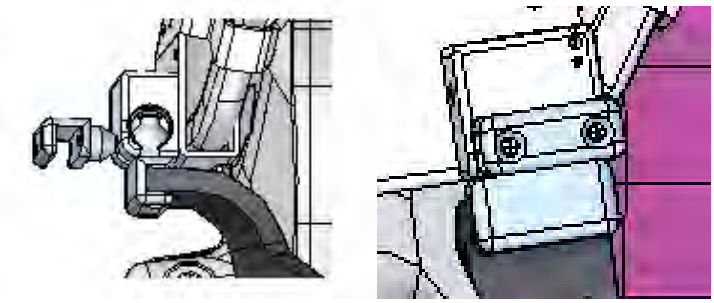

Figure 11: Ball Joint Attachment (multi-position)

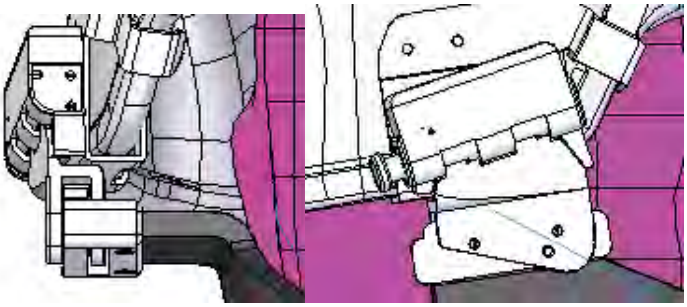

Figure 12: Hinged and Drop Down Attachment

Figure 13: SIHS (EVO) Attachment

3.2.4 AMMPHS Visor

In addition to the evaluation of the AMMPHS mandible, a number of personnel examined the performance of a new double curved AMMPHS visor – see Figure 14. Although the prototype visor was manufactured with the proper shape, the system was not "optically" correct and thus suitable only for weapon compatibility and range-of-motion assessments.

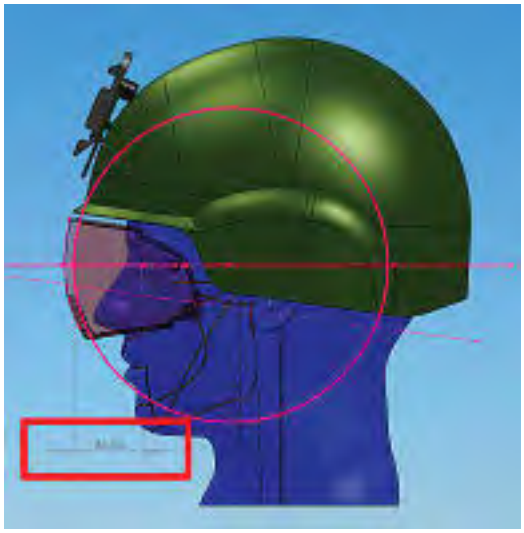

Figure 14: Schematic of the AMMPHS Double Curve Visor

3.3 Protocol

All participants were screened prior to commencement of the study and again screened at the beginning of the study to ensure proper sized head measurements. Only participants with medium sized heads were used in the study due to the limited number of prototypes, all of which had been designed for a size medium wearer. Participants were given an orientation briefing on the overall study, its objectives and test activities prior to the onset of the trial. Questionnaire briefings explained the standard rating scale, the data scoring method and rules of questionnaire completion. Following the orientation and prior to the start of any testing, the participants were provided with instruction on how to conduct each of the tasks until soldiers become familiar with these tasks. The following list shows the tasks that the soldiers completed over the course of the 10 days of testing. Based on the availability of resources these tasks were not performed in the order shown but were conducted over the period of the 10 days in a random order.

1. Anthropometry
2. Range of Motion
3. Field of View
4. Weapons Compatibility
5. Clothing/Equipment Compatibility
6. Static Vehicle Compatibility
7. Dynamic Vehicle Compatibility
8. Obstacle Course
9. Live Fire
    a) Rundowns

b) Tactical Shooting

10. Thermal Comfort
11. Physical Comfort
12. Overall Acceptance

Following the completion of each task, the participants were required to complete a Questionnaire or provide a rating of acceptance for the mandible condition they were assessing. At the completion of the trial, participants completed a series of Exit Questionnaires (Clips Exit, Cut-out Exit, and Mandible Exit) that evaluated the performance of the mandible conditions or clips attachment system over the course of the 10 day trial. A focus group was held at the end of the trial to further discuss their assessments.

3.4 Participants

A total of twelve participants were recruited from the CF, mostly from 3rd Royal 22nd Regiment (R22eR). The mean age of the participants was 22.8 years (SD=5.2, max=37, min=18). The mean length of service in the regular forces for the participants was 20.2 months (SD=22.6, max=84, min=4). Most (11) participants had no operational experience. The only participant that had operational experience served one tour in Afghanistan. All of the participants were right handed and their right eye was their shooting eye. This eliminated any bias in results due to the location of the cut outs in prototypes 8A and 9A which were designed for right handed, right eye dominant shooters.

3.5 Data Measures

Anthropometry: Various anthropometric measurements of the participants were taken. The measurements were used to confirm the head measurements of the participants and to ensure they all had medium sized heads. The measurements were also used to validate that this study had a narrow range of participants based on anthropometrics in an effort to alleviate bias due to fixed helmet and mandible sizes.

Range of Motion: Neck ranges of motion were taken for each helmet/mandible condition and with the current in-service helmet with no mandible. This data was used to identify any deficiencies in neck range of motion caused by the prototype helmet/mandible conditions.

Field of View: Each participant's field of view was measured while wearing each of the helmet/mandible conditions and the current in-service helmet with no mandible. This data was used to identify if any of the helmet/mandible conditions restrict individuals field of view by a significant amount.

Questionnaires: Participants completed a number of questionnaires that were intended to reveal their perceptions about the prototype mandible designs.

Participants were asked to complete the live fire questionnaire. Using a 7-point scale (Figure 15), where 1 was *completely unacceptable*, 4 was b*orderline*, and 7 *completely acceptable*; participants rated the acceptability of a number of criteria important to the conduct of the live fire exercise.

Participants were also asked to complete an obstacle course questionnaire, and exit questionnaires at different points of the trial. Using the same 7-point scale of acceptability, participants rated each specific mandible prototype on a wide range of issues.

Furthermore, participants were asked to complete a discomfort questionnaire at the conclusion of the obstacle course exercise. Using a 5-point thermal discomfort scale, where 1 was neutral, 3 was warm and 5 was very hot, participants rated thermal discomfort of the mandible prototypes. Finally, using a 5-point physical discomfort scale, where 1 was neutral, 3 was noticeable discomfort and 5 was extreme pain, participants rated physical discomfort of the mandible prototypes.

Participants also provided ratings of acceptance to the HF observers, using the 7-point scale of acceptance, for a number of different compatibility areas including weapons, clothing, equipment, and vehicles.

All questionnaires were completed by each participant for each of the mandible prototypes that they assessed. The comparison of the results of these questionnaires was used in the analyses.

Focus Group: Following the completion of the trial participants took part in a guided focus group. They discussed different issues of mandible design in an effort to collect information that can be used in the improvement of the design.

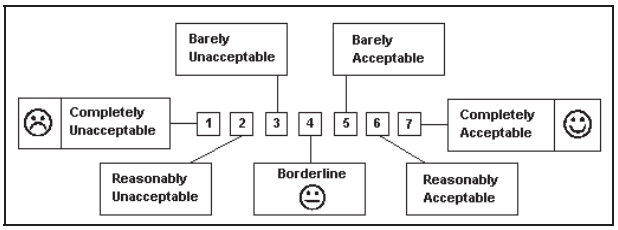

Figure 15: Standard Rating Scale

3.6 Data

3.6.1 Anthropometry

Anthropometric measurements were taken from each soldier prior to the start of the trial. There were a total of eight anthropometric measurements taken for each soldier. Measurements were taken using an anthropometer or using a tape measure. Each anthropometric measurement was recorded three times and the average of the three was used. A detailed description of how the measurements were taken is presented below:

- **Neck Length Front-** The distance between the sternal notch and the submandibular landmark was measured using a tape measure.
- **Neck Length Side-** The distance between the lateral aspects of the base of the neck was measured using a tape measure.
- **Neck Length Back-** The distance between the C7 prominence to the occipital protuberance was measured using a tape measure.

- **Head Circumference-** The maximum circumference of the head above the attachment of the ears to the head was measured with a tape passing just above the ridges of the eyebrows and around the back of the head.
- **Bitragion Chin Arc-** The surface distance between the right and left tragion landmarks across the chin landmark at the tip of the chin was measured with a tape while the subject was seated with their head in the Frankfort plane.
- **Bitragion Coronal Arc-** The surface distance between the right and left tragion landmarks across the top of the head was measured with a tape measure while the subject was seated with their head in the Frankfort plane.
- **Head Breadth-** The maximum horizontal breadth of the head above the attachment of the ears was measured while the subject was seated.
- **Head Length-** The distance from the glabella landmark between the browridges to the opisthocranion was measured using a spreading calliper while the subject was seated.

3.6.2 Range of Motion

Range of motion measurements were taken while the participants wore each of the mandible prototypes and compared to the baseline CG634 in-service helmet. Measurements were taken using a combination of an inclinometer, goniometer and a digital level. The following ranges of motion were measured:

- **Neck Flexion-** With the participants head in a neutral position (Frankfort plane) they were instructed to tilt their head forward until resistance was felt. The angular displacement was measured.
- **Neck Extension-** With the participants head in a neutral position (Frankfort plane) they were instructed to tilt their head backward until resistance was felt. The angular displacement was measured.
- **Neck Lateral Flexion (right/left) -** With the participants head in a neutral position (Frankfort plane) they were instructed to tilt their head to each side until resistance was felt. The angular displacement to each side was measured.

3.6.3 Field of View

Field of View was measured by having the participant place their chin on a standardized platform (i.e. a tripod) to ensure repeatability. Participants were instructed to move only their eyes while keeping their head stationary and facing forward. The maximum horizontal, vertical, and diagonal field of view was evaluated by sliding an object along 5 different tape measures (horizontal, vertical up, vertical down, 45° diagonally down to the left, and 45° diagonally down to the right) until the point when the participant could no longer see the object, as shown in Figure 16.

Figure 16: (a) Horizontal and (b) Vertical FOV

3.6.4 Static Compatibility

3.6.4.1 Clothing/Equipment/Weapons Compatibility

Compatibility with clothing, equipment, and weapons was evaluated at numerous static test stands over the course of the 10 day trial. Participants were instructed to perform the required drills and HF observers collected participant ratings on compatibility. Participants were encouraged to adjust the mandible prototype to the best of their ability to accommodate the test clothing, equipment and weapons prior to each test. Participants were evaluated individually while under the supervision of an HF observer.

The static compatibility test stands comprised the following pieces of equipment:

Clothing:	Gloves, Gen III Fragmentation Vest, Ballistic Eyewear, Rucksack
Equipment:	Tactical Command, Control and Communications System (TCCCS) headset, Personal Role Radio (PRR) headset, AN/PRC 522 headset
Weapons:	C7A1/A2 Rifle with C79 sight (prone, kneeling, standing), C9A1 LMG, C6 MMG, M72 SRAAW, and Carl Gustav

Participants were required to rate the compatibility of each of the mandible prototypes with each of the selected weapons, equipment, and clothing at each test stand. HF observers measured clothing and equipment stand-off and noted instances of compatibility clash and difficulty.

3.6.4.2 Vehicle Compatibility

Test conditions were evaluated for compatibility with the Light Armoured Vehicle (LAV) III. Participants were divided into smaller groups to perform the required drills. Specific evaluations included:

a) **Access/Egress:** Participants were required to rate the ease of access and egress of vehicle hatches and doors. HF observers evaluated soldiers entering and exiting vehicles for any postural, range of movement, and vehicle obstruction effects.

b) **Vehicle Operation:** Participants were required to rate the estimated ease of driving the vehicle in each condition. HF observers evaluated participants during vehicle operation for any postural, range of movement, and crew station obstruction.

c) **Air Sentry and Observer Tasks:** Participants were required to rate the estimated ease of performing air sentry tasks in the LAV III. HF observers evaluated participants during air sentry and observer tasks for any postural or range of movement obstructions.

d) **Commander and Gunner Tasks:** Participants were required to rate the estimated ease of performing commander and gunner tasks in the LAV III. HF observers evaluated participants during commander and gunner tasks for any postural, range of movement, and crew station obstruction.

Participants were required to rate the compatibility of the test conditions noting restrictions on movements with the assigned vehicle. HF observers noted instances where certain tasks could not be performed due to the presence of the mandible prototype.

3.6.5 Dynamic Vehicle Compatibility

Participants completed a short vehicle patrol (approximately 1 km) through a bush lane where enemy forces set up ambushes approximately every 300 metres. Once the enemy forces engaged, the participants were instructed to return fire using blank ammunition and changing magazines when needed while continuing to drive down the bush lane (e.g. to fight through the ambush). During the last enemy attack the participants were instructed to perform a rapid dismount and engage the enemy. The patrol consisted of two LAV III vehicles.

Participants were required to utilize one of the following crew stations per run:

a. Dismounts (only utilized during the dismount portion of the vehicle patrol)

b. Air sentry (all section ran through air sentry crew station position) and

c. Turret

   i. Crew commander and

   ii. Gunner

At the conclusion of the vehicle patrol participants were required to complete a task questionnaire on criteria specific to the task.

3.6.6 Obstacle Course

The following obstacles were undertaken consecutively as part of a single course (see Figure 17 through Figure 24). Participants completed the obstacle course while wearing each of the mandible conditions, as well as, the in-service CG634 helmet. Once participants completed the obstacle course they completed a subjective rating questionnaire that evaluated the performance of the various conditions.

- **Hill Climb:** Subjects were instructed to ascend and descend a large mound of dirt;

Figure 17: Hill Climb

- **Tunnel and Rope Climb:** Participants were required to run through a tunnel and ascend a rope ladder at the end;

Figure 18: Tunnel and Rope Climb

- **Crawl Obstacle:** Participants were required to perform a leopard crawl in sand while traversing under a net obstacle;

Figure 19: Low Leopard Crawl

- **Monkey Bars:** Participants were required to traverse a series of monkey bars using any method they wanted;

Figure 20: Monkey Bars

- **Over Under Obstacle:** Climb over and crawl under three successive metal bars mounted 0.5 and 1.0 meter from the ground; and

Figure 21: Over/Under Obstacle

- **Short Pit Obstacle:** Run up a 2m ramp and jump down into a sand pit;

Figure 22: Short Pit Obstacle

- **Balance Beam Obstacle:** Walk along a balance beam; and

Figure 23: Balance Beam Obstacle

- **Low Wall Obstacle:** Participants had to run a climb a series of low walls.

Figure 24: Low Wall Obstacles

3.6.7 Physical Discomfort

At the conclusion of the obstacle course participants were required to complete a physical comfort questionnaire. This questionnaire was comprised of drawings of the front, back, sides, and top of the head. Participants were required to indicate the location and rate the extent of physical discomfort using the five point rating scale provided. Discomfort could include, but was not limited to, contact irritation or pressure points. HF staff investigated any reports of physical discomfort through photographs and interviews with affected participants.

Using a standard five-point rating scale of discomfort, where 1 was neutral, 3 was noticeable discomfort and 5 was extreme pain, participants rated the acceptability of physical comfort by location – see Figure 25.

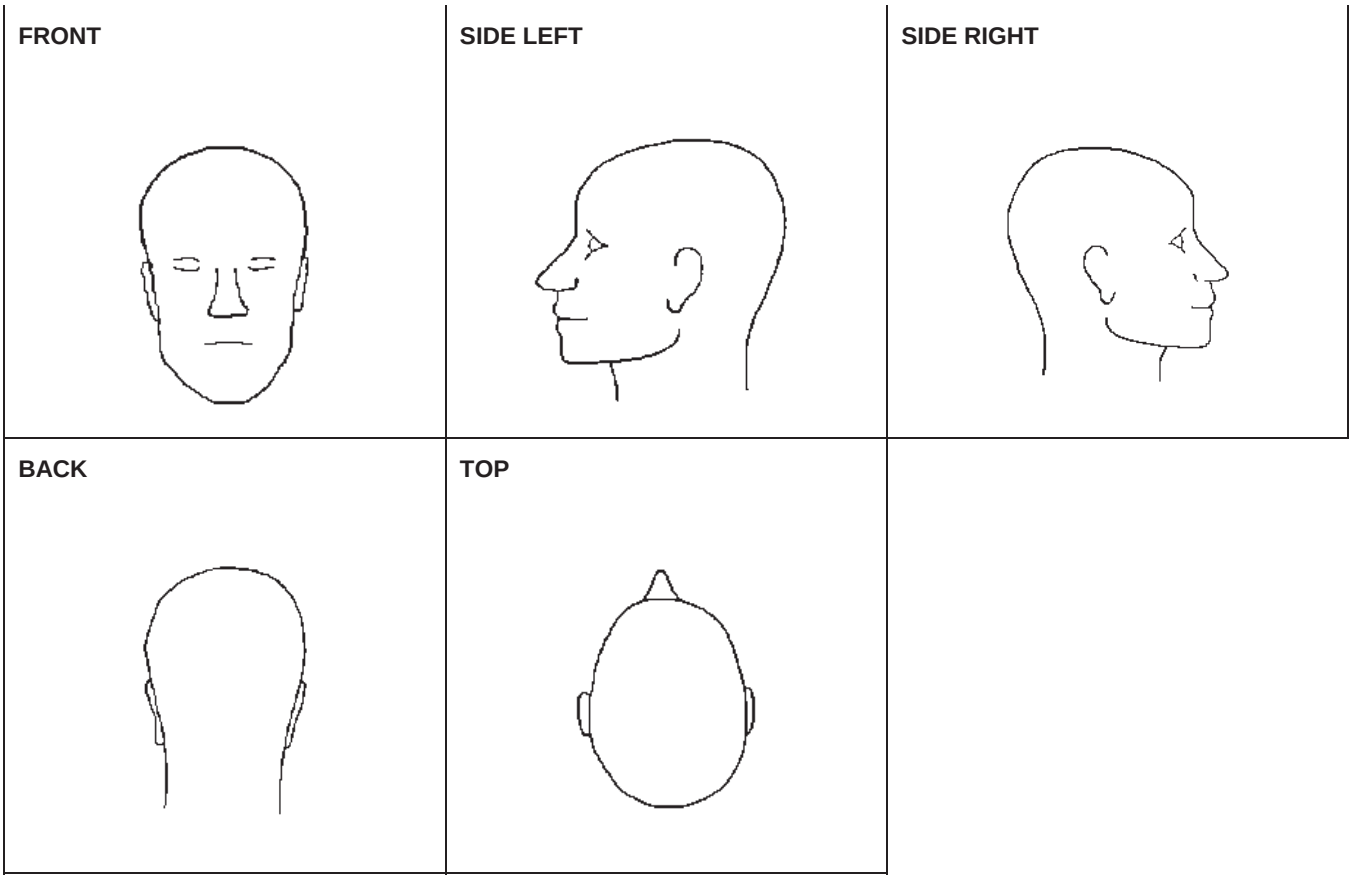

Figure 25: Discomfort Locations

3.6.8 Thermal Discomfort

At the conclusion of the obstacle course participants were also required to complete a thermal comfort questionnaire. This questionnaire was comprised of drawings of the front, back, sides, and top of the head. Participants were required to indicate the location and rate the extent of thermal discomfort using the five point rating scale provided. Discomfort could include, but was not limited to, hot spots or chaffing. HF staff investigated any reports of thermal discomfort through photographs and interviews with affected participants.

Using a standard five-point rating scale of discomfort, where 1 was neutral, 3 was warm and 5 was very hot, participants rated thermal discomfort by location – Figure 25.

3.6.9 Live Fire

All participants completed a number of live fire exercises to evaluate the compatibility of the different mandible conditions while shooting live ammunition. The live fire exercises were broken down into two separate phases; run downs and tactical shooting.

3.6.9.1 Run Downs

During the run down exercise participants began in the prone condition, 300 m from the target. The following table outlines the sequence of events during the live fire rundown task – see Table 1. Participants began with a total of 34 rounds in 2 separate magazines (28 in first, 6 in second). In all

cases the targets were 2 figure 11 targets except for the 100m engagement while standing where only a single figure 11 target was exposed.

Table 1: Live Five Run Down Sequence of Events

Range (m)	Rounds	Description	Instruction	Position	Scoring
300		Prep stage –firer in prone position with 2 magazines with 28 rd magazine loaded, observe target area	With a 28 magazine, load. When the target appears the shooter moves to the 200m firing point. Watch and shoot.		
200	8	At the 200m engages each target with 4 rds from prone position	When the shooter reaches the 200m firing point adopts the prone position and engages each target with 4 rounds each	Prone	1 point per hit 45 sec exposure
200		Upon completion, shooter stands	shooter adopts the standing alert position		
200	4	At the 200m engage target in kneeling	When the target appears the shooter adopts the kneeling position and engages each target with 2 rounds each	Kneeling	1 point per hit 5 sec exposure
200		Upon completion, shooter stands	Shooter adopts the standing alert position		
200	4	At the 200m engage target in prone	When the target appears the shooter adopts the prone position and engages each target with 2 rounds each	Prone	1 point per hit 5 sec exposure
200		Upon completion, shooter remains prone	Shooter remains in the prone position		
200		Rundown from 200m to 100m	When the target appears the shooter moves to the 100m firing point and adopts the kneeling position. Watch and shoot.		

Range (m)	Rounds	Description	Instruction	Position	Scoring
100	8	Engage target in kneeling position	Shooter engages each target with 4 rounds each	Kneeling	1 point per hit 45 sec exposure
100		Upon completion, shooter stands.	Shooter adopts the standing alert position	Standing	
100	4	At the 100m engage target in kneeling	When the target appears the shooter adopts the kneeling position and engages each target with 2 rounds each	Kneeling	1 point per hit 5 sec exposure
100		Change magazine	With an 8 rd magazine reload	Kneeling	
100	4	At the 100m engage target in kneeling	When the target appears the shooter adopts the kneeling position and engages each target with 2 rounds each	Kneeling	Not timed 1 point per hit 5 sec exposure
100		Upon completion, shooter stands.	Shooter adopts the standing alert position	Standing	
100	2	At the 100m engage target in standing	When the target appears the shooter engages the left target in the standing position with 2 rounds	Standing	1 point per hit 5 sec exposure

3.6.9.2 Tactical Shooting

Participants completed a number of tactical shooting evaluations from a number of different distances (5 – 50 metres) as per the direction of the instructor who ran the drill. Participants were required to complete a series of firing tasks including controlled pair firing, Mozambique drills (2 shots to the body, 1 shot to the head), 90° pivots from the left and the right, 180° pivots with a forward move, and speed reload drills. Participants fired a total of 32 rounds during this exercise.

3.6.10 Overall Ratings

Participants were required to rate their overall acceptance of each of the mandible conditions, the overall acceptance of each of the mandible attachment systems, as well as an overall acceptance of the coverage of the mandible conditions using exit questionnaires.

3.7 Statistical Plan

The quantitative (both objective and subjective) results of this evaluation were analyzed using parametric One-way Analysis of Variance (ANOVA) methods. Differences were identified at $p < 0.05$. The statistical plan was as follows:

Table 2: Statistical Plan

Data Source	Data Type	Analysis Type
Range Of Motion	ROM Measurement	ANOVA for repeated measures: - Neck ROM (4)
Field of View	FOV Measurement	ANOVA for repeated measures: - Mandible Conditions (9) - Criteria (6)
Dynamic Vehicle	Subjective assessment by participant	ANOVA for repeated measures: - Mandible Condition (7) - Criteria (1)
Obstacle Course	Subjective assessment by participant	ANOVA for repeated measures: - Mandible Conditions (5)*2 sets - Criteria (4)*2 sets
Live Fire (rundowns)	Subjective assessment by participant	ANOVA for repeated measures: - Mandible Conditions (5)*2 sets - Criteria (1)*2 sets
Live Fire (rundowns)	Objective Range Scores	ANOVA for repeated measures: - Mandible Conditions (5)*2 sets - Criteria (1)*2 sets
Live Fire (tactical shooting)	Subjective assessment by participant	ANOVA for repeated measures: - Mandible Conditions (5)*2 sets - Criteria (1)*2 sets
Coverage Exit Questionnaire	Subjective assessment by participant	ANOVA for repeated measures: - Mandible Conditions (4)*2 sets - Criteria (12)*2 sets
Cut-out Exit Questionnaire	Subjective assessment by participant	ANOVA for repeated measures: - Mandible Conditions (2) - Criteria (11)
Clips Exit Questionnaire	Subjective assessment by participant	ANOVA for repeated measures on overall acceptance: - Mandible Conditions (4)

Note 1: Variation of the sample size because some participants were not able to complete all of the conditions

Note 2: Missing data points for questionnaires because some participants did not complete questionnaires fully due to lack of experience to answer a question or forgetting to answer a question.

Note 3: Missing data points were replaced by the group mean for statistical purposes (if there were 2 or less data points missing).

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4. Results

4.1 Anthropometry

A number of anthropometric measurements were taken both to ensure that all participants could properly fit in a CG634 medium sized helmet and to identify facial shape variability within a medium helmet size. At present, the AMMPHS prototype conditions assessed were optimized for use with the medium sized CG634 helmet and a medium sized/shaped jaw as defined by 3D head forms of the medium CF soldier constructed using data and head scans collected during the 1997 Land Force (LF) Survey (Chamberland, Carrier, Forest and Hachez, 1997).. The results of the anthropometric measures are displayed in Table 3 and compared where possible with the results of the subset of personnel fitting the medium helmet in the 1997 Land Force (LF) Survey. It should be noted that neck length was not assessed in the 1997 LF Survey. In terms of head length and head breadth the differences between the 12 participants was very small (difference of approximately 2 cm in each case). The difference between the smallest participant and largest participant, in terms of head circumference, was only 3 cm which signifies that the participants had uniform head sizes. The differences between the participants, with respect to bitragion chin arc and bitragion coronal arc, were also very small (differences of approximately 4 cm) with standard deviations that were approximately 1 cm. Overall, the head dimensions of the participants were uniform, thereby minimizing any confounding effect of differences in helmet fit.

Table 3: Anthropometry

	Trial participants				LF 97 Survey*			
	Average	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum
Neck Length – Front (cm)	9.5	1.2	7.0	11.6				
Neck Length – Side (cm)	9.9	1.1	8.4	11.7				
Neck Length-Back (cm)	18.3	2.2	14.0	21.0				
Head Circumference (cm)	56.8	0.9	55.2	58.3	57.0	1.3	53.1	60.1
Bitragion Chin Arc (cm)	30.4	1.0	28.5	32.0	31.9	1.5	27.6	36.1
Bitragion Coronal Arc (cm)	36.0	1.2	33.4	38.0	35.0	1.1	32.0	38.0
Head Breadth (cm)	15.1	0.6	13.9	16.0	15.1	0.5	13.7	16.1
Head Length (cm)	19.8	0.5	18.9	20.6	19.5	0.6	17.3	20.5

*separated based on head breadth and head length measurements for a medium sized head

Although the subjects were screened to fit the CG634 medium sized helmet, questions were raised as to whether the face morphology (chin protrusion) of the subjects were representative of the larger population. A comparison of the trial participants versus the LF 97 survey population

(screened for head sizes to match the medium sized helmet) was undertaken for chin arcs. The results indicate that the trial participants were representative of the intended population but did not match the extremes for bitragion chin arc observed in the LF 97 survey.

4.2 Range of Motion

Participants also completed a series of range of motion exercises to determine whether any AMMPHS condition restricted neck motion. Neck range of motion results are shown in Table 4. In terms of neck flexion, participants were able to achieve the greatest flexion while wearing the CG634 helmet followed by helmet condition 12, while participants achieved the least amount of flexion while wearing helmet condition 8.

The greatest amount of neck extension was achieved with helmet condition 10 followed by helmet condition 9, while the least amount of neck extension was achieved with helmet condition 8. The difference between the helmet conditions with the greatest and least amount of neck extension was less than 4 degrees

Participants also achieved the greatest amount of neck lateral flexion (both to the left and right) while wearing the CG634 helmet and least amount of neck lateral flexion (both to the left and right) while wearing helmet condition 8.

Table 4: Range of Motion

Criteria (N=11) mean (SD)	8	8A	9	9A	10	11	12	13	CG634
Neck Flexion (deg)	42.3 (10.6)	43.0 (6.9)	45.7 (13.7)	46.1 (7.7)	45.5 (8.2)	45.0 (11.1)	46.4 (9.2)	44.7 (9.9)	51.9 (7.1)
Neck Extension (deg)	65.5 (11.6)	67.6 (10.6)	68.8 (10.5)	68.5 (12.3)	69.2 (11.4)	67.2 (12.1)	67.9 (12.6)	65.6 (11.4)	67.4 (9.5)
Neck Lateral Flexion-Right (deg)	42.3 (11.3)	43.3 (9.3)	43.5 (9.8)	43.8 (8.2)	42.3 (8.2)	42.7 (9.4)	44.2 (9.1)	43.0 (7.9)	47.6 (7.5)
Neck Lateral Flexion-Left (deg)	38.1 (8.3)	40.2 (9.1)	39.9 (9.1)	41.2 (9.0)	40.9 (8.5)	41.3 (9.9)	44.4 (9.9)	41.0 (9.2)	48.1 (6.1)

While participants were wearing the CG634 helmet they were able to achieve significantly greater neck flexion (forward) over helmet condition 8 at the $p<.05$ significance level. Significant forward flexion differences were not observed between all helmet conditions ($F(8, 80)=1.788$, $MS=81.9$, $p=.09$). There were no statistically significant differences between helmet conditions during neck extension.

With respect to neck lateral flexion to the right, there were statistically significant differences between helmet conditions ($F(8,80)=2.064$, $MS=14.043$, $p=0.049$). While participants were wearing the CG634 helmet they were able to achieve significantly greater neck lateral flexion angles to the right over helmet conditions 8 and 10.

The CG634 helmet condition was also found to be significantly better than all other helmet conditions (except condition 12) for neck lateral flexion to the left ($F(8,80)=7.366$, $MS=12.782$, $p<0.000$).

It should be noted that all the mandible designs were constructed asymmetrically –see Figure 26. The mandible was designed to be nearly flush with the user's right cheek in right-handed models. The asymmetry increased head movement to the right even without the presence of a cut out.

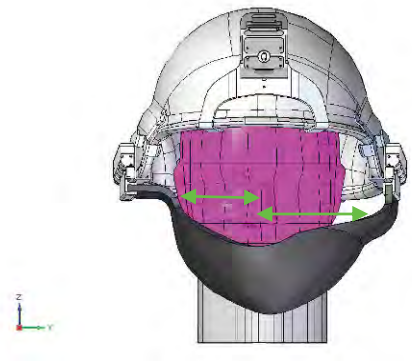

Figure 26: Asymmetrical mandible design

4.3 Field of View

The field of view of each participant wearing each helmet prototype was assessed. The participants were instructed to follow an indicator as it travelled along a straight measuring tape until it was no longer in their view. The distance at which the participant lost sight of the indicator was measured. It is important to note that a number of participants were able to see the floor while following the indicator for the vertical down measure. Therefore, a value of 160 cm (vertical distance from starting point to the floor) was assigned to these instances. Also, while following the indicator 45° down to the left and to the right a few participants indicated that they could see the floor as well. Due to the fact that a measurement of how far passed the floor participants could see could not be taken, an arbitrary value of 1 cm greater than the maximum value gathered was assigned to these measures. The in-service helmet (CG634) was used as a control for this block of testing. Mean values of each helmet condition across all measurements are shown in Table 5. Shadowing indicates helmets with a significant difference which is described in the text.

Table 5: Field of View

N=11 mean (SD)	8	8A	9	9A	10	11	12	13	CG634
Horizontal-Right (cm)	112.7 (17.1)	101.1 (12.7)	117.7 (19.5)	114.5 (18.8)	108.0 (11.2)	107.0 (16.2)	104.8 (13.6)	107.7 (12.9)	102.5 (9.4)
Vertical-Down (cm)	132.3 (32.2)	155.4 (8.4)	132.3 (27.2)	150.2 (18.4)	151.2 (18.3)	147.3 (17.4)	156.1 (9.3)	138.4 (35.4)	153.3 (15.8)
Vertical-Up (cm)	45.0 (13.1)	49.2 (13.8)	41.6 (14.9)	48.0 (13.2)	47.6 (8.5)	45.1 (12.8)	41.3 (6.5)	49.1 (15.7)	38.3 (19.0)
Horizontal-Left (cm)	116.5 (17.6)	114.7 (17.2)	122.9 (17.8)	114.9 (14.0)	126.8 (16.7)	116.7 (13.6)	114.3 (15.5)	125.0 (27.6)	113.5 (15.4)
45° Down-Left (cm)	107.8 (28.7)	100.1 (18.5)	101.3 (23.2)	107.1 (29.6)	97.2 (18.5)	98.2 (14.5)	122.5 (30.1)	107.0 (25.5)	145.7 (25.7)
45° Down-Right (cm)	122.3 (36.5)	121.8 (34.2)	121.0 (33.6)	138.2 (37.8)	107.6 (12.7)	120.0 (22.9)	116.1 (35.8)	119.7 (34.7)	127.1 (31.3)

No significant differences were identified across the helmet conditions for vertical up, horizontal left, horizontal right and 45° down to the right measurements while statistical differences were identified for the vertical down, and 45° down to the left measurements. In the vertical down direction, helmet conditions 12, 8A, and the CG634 had significantly ($F(8, 80)=3.7628$, $p=.00087$) greater FOV measurements than helmet conditions 8 and 9. With respect to the viewing direction of a 45° angle down to the left, the CG634 helmet had significantly ($F(8, 80)=11.425$, $p=.00000$) larger viewing distances than all the other conditions while condition 12 had significantly greater viewing distances than conditions 8A, 9, 10, and 11.

As compared to the in-service CG634 helmet, the AMMPHS mandibles did limit vision directly down and obliquely to the left side. Cut-outs improved vision to the lower right quadrant while the profile of the left side of the mandible guard that was introduced to provide clearance with the helmet chin strap buckle hindered vision obliquely to the left.

4.4 Static Compatibility

Results of the static test stands are presented below by test block. Group A members completed the static stands while wearing helmet conditions 8, 8A, 10, and 12 and Group B completed the static stands while wearing helmet conditions 9, 9A, 11, and 13. In each case the control condition was the in-service CG634 helmet.

Due to the low numbers of subjects involved (six for Group A and six for Group B), caution is strongly advised when interpreting the results detailed below. There were large deviations in the results by mandible and question. The results below should be utilized to identify trends only.

4.4.1 Group A Results

During the course of the trial participants completed a number of static test stands that evaluated the compatibility of the helmet/mandible conditions with a number of different weapons, equipment, clothing, and vehicle crew positions. Results from the questionnaire comparing helmet conditions 8, 8A, 10, and 12 to the CG634 condition are shown in Table 6. Shadowing of the cells indicate means ratings that were below 'borderline' (<4 on the 7-point acceptance scale). In terms of weapon compatibility the CG634 outperformed all of the mandible conditions with ratings between

'reasonably acceptable' to 'completely acceptable'. Out of the four novel test conditions, condition 8A was preferred over the three non cut-out mandible conditions with all ratings being acceptable except for the compatibility with the M72 which had a rating that was just below 'borderline' (3.8). Of the three conditions without a cut-out mandible, condition 8 was preferred for 5 of the weapon conditions (C7-prone, C7 kneeling, Carl G (firer), M72 and C6) while condition 10 was preferred in the remaining three weapon conditions. Condition 12 was rated equally with condition 8 for the firing position of the Carl Gustav but failed to have anymore acceptable ratings across the other weapons. All mandible conditions were found to be acceptable with all of the equipment and clothing that they were tested with, except for the TCCCS radio headset where only the CG634 was found to be acceptable. Condition 8 outperformed the other test conditions for compatibility with gloves, vest, and ballistic eyewear, while condition 10 was the preferred condition for compatibility with both the PRR and the AN/PRC 522 headsets, and finally condition 12 was preferred for compatibility with TCCCS radio headset and the rucksack. The non cut-out mandible condition 8 outperformed condition 8A across all of the equipment and clothing compatibility measures. All helmet conditions were found to be acceptable for all the vehicle crew positions during static vehicle compatibility testing. The in-service CG634 helmet was preferred over all of the mandible conditions for each crew position. Of the mandible test conditions, condition 8A was preferred for the driver position, conditions 10 and 12 was preferred for gunner position, conditions 8A and 10 was preferred for the crew commander position, and condition 10 was preferred for the air sentry position. Therefore, condition 10 was the preferred condition for all vehicle positions except for the driver. These results must however be viewed with caution given the very small sample size for some assessments.

Table 6: Group A Static Equipment Compatibility Results

Criteria - mean (SD) (n=6)	8	8A	10	12	CG634
Weapons					
C7 – prone	4.2 (1.8)	5.5 (1.4)	4.0 (1.4)	3.1 (1.4)	6.8 (0.4)
C7 – kneeling	4.1 (1.5)	5.0 (1.6)	3.4 (1.4)	2.6 (1.1)	6.8 (0.4)
C7 – standing	3.0 (1.4)	4.4 (1.7)	3.3 (1.5)	2.0 (1.2)	6.8 (0.4)
Carl Gustav SHRAAW (firer)	5.2 (1.7)	4.2 (2.5)	4.3 (2.7)	5.2 (1.7)	6.3 (1.6)
Carl Gustav SHRAAW (loader)	4.2 (1.9)	5.2 (1.3)	4.5 (1.4)	2.0 (0.9)	6.3 (1.6)
M72	3.0 (2.4)	3.8 (2.0)	1.8 (1.6)	1.8 (1.3)	6.7 (0.5)
C6	4.2 (1.8)	5.2 (1.7)	3.7 (2.2)	3.3 (2.0)	6.7 (0.5)
C9	4.0 (2.0)	4.5 (1.5)	5.2 (1.2)	3.7 (1.8)	6.8 (0.4)
Equipment/Clothing					
Gloves	6.6 (0.5)	6.0 (1.1)	5.8 (1.0)	5.7 (1.2)	6.2 (1.0)
Vest	5.5 (1.3)	5.0 (0.6)	5.5 (1.2)	5.5 (1.5)	6.5 (0.8)
Ballistic Eyewear	6.8 (0.4)	6.3 (0.7)	6.0 (1.1)	6.0 (1.1)	6.3 (1.0)
TCCCS radio	1.8 (1.2)	1.5 (0.4)	1.7 (1.2)	3.4 (1.7)	5.0 (1.8)
Rucksack (standing)	4.5 (1.8)	4.6 (1.4)	4.3 (1.9)	5.4 (1.0)	4.8 (1.7)
Personal Role Radio (PRR)	4.3 (1.8)	4.4 (1.7)	5.7 (1.0)	4.8 (1.8)	6.3 (0.8)
AN/PRC 522	4.2 (2.5)	4.5 (1.9)	6.0 (1.3)	5.8 (0.8)	6.5 (0.6)
Vehicles (n=5-11)					
Driver	5.1 (1.0)	5.7 (1.1)	4.9 (1.2)	5.2 (2.0)	6.3 (0.7)
Gunner	4.4 (1.7)	4.6 (1.5)	4.9 (1.9)	4.9 (1.1)	6.4 (1.1)
Crew Commander	5.0 (1.5)	5.1 (1.4)	5.1 (1.7)	4.9 (1.1)	6.3 (1.2)
Air Sentry	4.6 (1.6)	5.0 (1.3)	5.5 (1.4)	5.0 (1.4)	6.4 (0.7)

Across the four AMMPHS helmet prototypes tested, condition 12 performed the worst. Issues with C7 compatibility were observed with all prototypes. Except for three isolated cases, all of the AMMPHS prototypes performed less acceptably than the in-service helmet condition. Significant issues were observed with the compatibility of all the AMMPHS prototypes and TCCCS headsets, C7s in the standing position, and with the M72. Issues with condition 10 were also observed with its compatibility with the C6.

Interestingly, the AMMPHS conditions were all rated as being acceptable for static compatibility with crew positions in the LAV III vehicle. While minor cases of vision and physical clash interference were noted, the participants believed performance was still acceptable.

4.4.2 Group B Results

Results from the questionnaire comparing mandible conditions 9, 9A, 11, and 13 to the CG634 condition are shown in

Table 7. In terms of weapon compatibility the CG634 outperformed all of the helmet conditions with ratings between ‘reasonably acceptable’ to ‘completely acceptable’. Out of the four mandible conditions, condition 9A was preferred over the three non cut-out mandible conditions with all ratings being acceptable except for the compatibility with the M72 which had a rating that was just below ‘borderline’ (3.8). Of the three helmet conditions without a cut-out mandible, condition 9 was preferred for three of the weapon conditions (C7 kneeling, C7 standing, and C9) while condition 11 was preferred for four weapon conditions (C7 prone, C7 kneeling, Carl G (loader), and M72). Condition 13 was preferred for both Carl G positions and with the C6. The majority of the mandible conditions were found to be acceptable with all of the equipment and clothing that they were tested with, except for the TCCCS radio headset where only the CG634 was found to be acceptable and for the PRR headset where only conditions 11 and 9A were found to be acceptable. Condition 9 outperformed the other mandible conditions for compatibility with gloves, and rucksack, while condition 11 was the preferred condition for compatibility with the vest and TCCCS, PRR and the AN/PRC 522 headsets, and finally condition 13 was preferred for compatibility with ballistic eyewear. If the non cut-out mandible condition 9A was included in the comparison then it would be the preferred condition for compatibility with the vest, ballistic eyewear, TCCCS, rucksack, and the AN/PRC 522. All mandible conditions were found to be acceptable for all the vehicle crew positions during static vehicle compatibility testing, except for condition 9 in the gunner position which had a rating that was just below ‘borderline’ (3.9). The in-service CG634 helmet was preferred over all of the mandible conditions for each crew position. Of the mandible test conditions, condition 9A was preferred for all of the vehicle crew positions.

Table 7: Group B Static Equipment Compatibility Results

Criteria - mean (SD) (n=6)	9	9A	11	13	CG634
Weapons					
C7 – prone (n=12)	3.5 (1.6)	5.1 (1.1)	4.0 (1.5)	3.1 (2.2)	6.8 (0.4)
C7 – kneeling (n=12)	3.5 (1.6)	4.6 (1.4)	3.5 (1.7)	2.7 (1.9)	7.0 (0.0)
C7 – standing (n=12)	3.4 (1.8)	4.8 (1.4)	2.7 (1.2)	2.4 (1.8)	7.0 (0.0)
Carl Gustav SHRAAW (firer)	5.3 (1.4)	5.7 (1.0)	3.8 (2.2)	5.7 (1.0)	6.8 (0.4)
Carl Gustav SHRAAW (loader)	3.8 (1.9)	4.7 (1.0)	4.3 (2.0)	4.3 (1.6)	6.4 (0.5)
M72	1.8 (1.3)	3.8 (2.3)	3.0 (2.5)	1.8 (1.0)	6.2 (0.4)
C6	4.3 (1.9)	5.9 (0.7)	5.0 (1.6)	5.2 (1.0)	6.7 (0.5)
C9	5.0 (0.9)	6.3 (0.5)	4.3 (2.0)	5.0 (0.9)	6.8 (0.4)
Equipment/Clothing					
Gloves	6.4 (0.5)	5.7 (2.3)	6.2 (1.0)	6.2 (0.4)	6.6 (0.4)
Vest	5.5 (0.5)	6.6 (0.5)	6.4 (0.5)	6.2 (0.4)	6.7 (0.4
Ballistic Eyewear	5.6 (1.8)	6.6 (0.5)	6.5 (0.8)	6.6 (0.5)	6.5 (0.5)
TCCCS radio	1.2 (1.0)	1.8 (1.2)	1.6 (0.8)	1.4 (0.8)	6.5 (0.6)
Rucksack (standing)	5.8 (0.7)	6.0 (0.6)	5.2 (1.2)	5.4 (0.5)	5.3 (2.2)
Personal Role Radio (PRR)	3.7 (1.6)	4.4 (1.4)	5.2 (1.2)	3.7 (2.4)	7.0 (0.0)
AN/PRC 522	4.0 (1.4)	5.2 (1.7)	4.8 (1.3)	3.0 (0.0)	6.5 (0.4)
Vehicles (n=5-11)					
Driver	5.6 (0.5)	6.0 (1.2)	5.6 (0.8)	4.9 (1.5)	6.3 (0.7)
Gunner	3.9 (2.0)	6.0 (0.7)	4.4 (1.8)	4.9 (1.4)	6.4 (1.1)
Crew Commander	4.0 (2.0)	5.4 (1.5)	4.4 (1.8)	5.0 (1.4)	6.3 (1.2)
Air Sentry	4.4 (1.4)	6.4 (0.6)	4.9 (1.7)	5.8 (1.5)	6.4 (0.7)

Across the four AMMHPS helmet prototypes tested, condition 13 performed the worst. Issues with C7 compatibility were observed with all prototypes. Except for four isolated cases, all of the AMMPHS prototypes performed less acceptably than the in-service helmet condition. Significant issues were observed with the compatibility of all the AMMPHS prototypes and TCCCS headsets, C7s in the standing position, and with the M72. Issues with conditions 9 and 11 were also observed on other compatibility tests.

Except for condition 9 used in the gunner position, all the AMMPHS conditions were rated as being acceptable for static compatibility with crew positions in the LAV III vehicle. While minor cases of vision and physical clash interference were noted, the participants believed performance was still acceptable.

4.5 Dynamic Vehicle

Due to limited time and resource availabilities, AMMPHS helmet conditions 12 and 13 were dropped based on their previously observed weaknesses in the static compatibility test stands. Both Group A and B assessed conditions 8, 8A, 9, 9A, 10, 11 and CG634 helmet conditions in a dynamic vehicle task.

Issues with communications compatibility eliminated the ability of the vehicle commander's and drivers to evaluate the mandible conditions. This however provided a venue for these participants to examine the new visor system.

The dynamic vehicle exercise yielded relatively consistent results across the test conditions - see Table 8. Test condition results fluctuated between barely unacceptable and reasonably acceptable,

with the majority of criteria borderline to barely acceptable. Control condition mean results were generally between reasonably and completely acceptable.

Table 8: Dynamic Vehicle Results

Dynamic Vehicle – mean (SD) (n=12)	8	8A	9	9A	10	11	CG634 w/ new visor
Speed of Movement	5.3 (1.5)	5.2 (1.2)	4.9 (1.6)	5.1 (0.6)	5.0 (1.3)	4.8 (1.3)	6.4 (0.9)
Agility	5.0 (1.6)	5.1 (1.0)	4.6 (1.8)	5.3 (0.7)	4.8 (1.4)	4.7 (1.5)	6.6 (0.7)
Flexibility	4.8 (1.6)	4.9 (1.2)	4.6 (1.8)	4.8 (1.2)	4.6 (1.7)	4.4 (1.6)	6.6 (0.7)
Overall Mobility	5.3 (1.7)	4.8 (1.2)	4.9 (1.6)	5.0 (0.9)	5.1 (1.5)	4.7 (1.3)	6.6 (0.7)
Normal Embark/Debark	5.1 (1.2)	5.7 (1.2)	5.2 (1.6)	5.4 (0.9)	5.6 (0.9)	5.3 (1.3)	6.6 (0.9)
Emergency Embark/Debark	4.8 (1.6)	5.3 (1.6)	4.9 (1.9)	5.2 (1.2)	5.4 (1.0)	4.9 (1.5)	6.4 (0.9)
Interior Movement	4.3 (2.0)	5.0 (1.4)	4.4 (2.2)	4.9 (1.6)	5.3 (1.0)	4.6 (1.7)	6.6 (0.9)
Covering arc of fire	4.7 (1.7)	5.0 (1.1)	4.7 (1.7)	4.9 (1.4)	4.3 (1.1)	4.4 (1.6)	6.4 (0.9)
Firing Personal Weapon	3.7 (2.3)	4.3 (2.6)	3.9 (2.4)	4.1 (2.2)	3.6 (2.1)	3.7 (2.1)	6.1 (1.2)
Changing Magazines	5.4 (1.7)	5.1 (1.7)	4.8 (1.8)	5.3 (1.1)	5.4 (0.9)	4.9 (1.5)	6.8 (0.7)
Combat Dismount	4.7 (1.9)	4.8 (1. 6)	4.8 (1.3)	5.0 (1.5)	4.6 (1.8)	4.1 (1.7)	6.1 (1.5)
Overall Compatibility with Mounted Operations	4.3 (1.7)	4.9 (1.4)	4.4 (1.8)	4.7 (1.5)	4.6 (1.7)	4.4 (1. 7)	6.2 (1.4)
Stowage	3.7 (1.9)	5.0 (1.4)	4.2 (1.8)	4.4 (1.7)	4.2 (1.4)	4.6 (1.7)	6.1 (1.2)
Volume	3.6 (1.8)	5.0 (1.7)	4.2 (1.8)	4.4 (1.0)	4.4 (1.3)	4.4 (1.6)	6.2 (0.8)
Snagging	4.7 (1.7)	4.1 (1.8)	4.1 (2.0)	4.6 (1.8)	3.8 (1.7)	3.4 (2.1)	6.2 (1.7)
Ability to complete all tasks assigned	4.4 (1.7)	4.8 (1.49)	4.3 (2.0)	4.7 (1.8)	4.1 (1.5)	4.0 (1.8)	6.2 (1.4)
Overall Vehicle Compatibility	4.2 (1.4)	5.1 (1.2)	4.3 (1.7)	4.7 (1.2)	4.2 (1.2)	4.2 (1.6)	6.1 (1.7)
Tactical Vest Compatibility	4.9 (1.6)	5.2 (1.4)	4.9 (2.0)	5.0 (1.4)	5.1 (1.2)	4.6 (1.7)	6.3 (1.4)
Helmet Compatibility	5.0 (1.5)	5.2 (1.7)	5.1 (1.7)	5.3 (1.4)	5.1 (1.4)	4.7 (1.9)	6.3 (1.4)
Fragmentation Vest Compatibility	5.0 (1.7)	5.2 (1.7)	4.8 (2.1)	5.1 (1.7)	4.9 (1.4)	4.4 (2.0)	6.3 (1.4)
PRR Compatibility	4.5 (2.3)	4.6 (2.2)	4.9 (2.4)	3.8 (1.4)	4.7 (1.5)	5.2 (1.3)	6.0 (1.7)
Vehicle Headset Compatibility	4.0 (2.4)	3.3 (2.6)	2.9 (2.2)	2.6 (1.8)	2.7 (2.0)	3.3 (2.3)	5.8 (2.0)
Glove Compatibility	5.0 (1.2)	5.7 (1.6)	4.9 (2.2)	5.3 (1.1)	5.3 (1.1)	5.1 (1.3)	6.3 (1.4)
Weapon Compatibility	3.8 (2.2)	4.8 (2.1)	4.3 (2.3)	4.4 (1.8)	4.3 (2.2)	4.0 (2.2)	6.1 (1.4)
Snagging	4.4 (2.1)	4.8 (1.9)	4.2 (2.2)	4.4 (1.8)	4.1 (1.7)	3.4 (2.3)	6.4 (0.7)
Overall Compatibility	4.7 (1.6)	5.1 (1.5)	4.4 (1.8)	4.8 (1.3)	4.3 (1.3)	4.2 (1.6)	6.3 (1.1)
Overall Performance	4.6 (1.3)	5.4 (1.1)	4.1 (1.6)	4.6 (1.1)	4.3 (1.4)	4.0 (1.7)	6.4 (1.0)
Inferior Field of View	4.3 (1.8)	4.4 (1.5)	4.1 (2.0)	4.7 (1.5)	4.6 (2.1)	4.8 (1.6)	6.8 (0.4)
Peripheral Field of View	4.3 (1.7)	5.2 (0.8)	4.1 (1.6)	4.8 (1.4)	5.1 (1.4)	5.2 (1.0)	6.6 (0.7)
Bulk	3.9 (1.7)	4.8 (1.3)	4.4 (1.8)	4.7 (1.1)	5.0 (1.0)	4.6 (1.4)	6.2 (1.1
Weight on the Head	4.8 (0.8)	5.4 (1.0)	4.9 (1.5)	5.3 (1.1)	5.3 (1.1)	4.8 (1.3)	6.2 (1.0)
Skin Irritation	5.4 (1.0)	5.8 (1. 6)	5.3 (1.8)	5.4 (1.4)	5.6 (1.4)	5.3 (1.4)	6.0 (1.6)
Overall Physical Comfort	4.8 (1.0)	5.6 (1.2)	4.8 (1.6)	5.4 (0.9)	5.4 (0.9)	4.7 (1.5)	6.4 (0.9)
Overall Thermal Comfort	4.3 (1.6)	5.1 (1.5)	4.3 (1.7)	5.1 (1.4)	5.0 (1.4)	4.7 (1.7)	6.2 (1.1)
Helmet Stability	5.2 (1.2)	5.7 (1.2)	4.8 (1.3)	5.1 (1.2)	4.7 (1.0)	5.2 (1. 6)	6.2 (0.8)
Mandible Stability	4.7 (1.3)	4.6 (1.8)	4.1 (1.7)	4.7 (1.1)	4.3 (1.2)	4.2 (2.2	6.2 (1.0)
Overall Stability	5.1 (1.0)	5.0 (1.4)	4.4 (1.7)	4.8 (0.8)	4.3 (1.0)	4.8 (1.6)	6.3 (0.9)
Overall Acceptability for Field Use	3.9 (1.6)	4.2 (1.9)	3.9 (1.9)	4.1 (1.5)	3.8 (1.6)	3.9 (1.9)	6.3 (1.1)

While the AMMPHS conditions' mean ratings were generally closer to the CG634 with visor than seen in other tasks, the differences were still statistically different ($F(6,48)=7.68, MS=7.48, p<0.000$).

Issues with the compatibility of the AMMPHS prototype conditions with personal weapon compatibility and headsets were frequently observed in the dynamic test. The level of personal weapon compatibility acceptance was higher in this dynamic task than in the static stands. The results suggest that many of the participants appeared to have overcome some of the weapons clash first witnessed in the static stands. Observers did note however that it was uncertain if participants were properly aiming . compatibility of the AMMPHS prototypes and headsets remained a problem for the participants.

4.6 Obstacle Course

Results of the obstacle course test stands are presented below by test block. Group A members completed the static stands while wearing helmet conditions 8, 8A, 10, and 12 and Group B completed the static stands while wearing helmet conditions 9, 9A, 11, and 13. In each case the control condition was the in-service CG634 helmet.

Due to the low numbers of subjects involved (six for Group A and six for Group B), caution is strongly advised when interpreting the results detailed below. There were large deviations in the results by mandible and question. The results below should be utilized to identify trends only.

4.6.1 Group A Results

Group A soldiers rated the in-service CG634 helmet acceptable for the obstacle course task across all evaluation metrics- see Table 9. Conversely, condition 10 was rated 4.6 on average, condition 8 was rated 4.0, and conditions 8A and 12 were rated 3.5 and 3.5 respectively on average across all evaluation metrics. The in-service helmet was rated 6.0 on average across all the evaluation metrics

Table 9: Group A Obstacle Course Results

Obstacle Course – mean (SD) (n=6)	8	8A	10	12	CG634 (1-6)
Ventilation	3.8 (1.9)	3.3 (1.5)	4.6 (2.1)	4.5 (1.4)	6.4 (0.9)
Hot Spots	4.2 (1.6)	3.2 (1.5)	4.4 (2.0)	3.3 (1.5)	6.0 (1.0)
Sweat Management	4.0 (1.8)	3.0 (1.4)	3.8 (1.8)	3.5 (1.6)	5.2 (1.8)
Heat Build-up	3.8 (1.8)	3.2 (1.5)	4.0 (1.7)	3.7 (1.9)	5.4 (1.7)
Use in cold weather (-10°C to -30°C)	2.7 (1.5)	3.3 (2.1)	2.7 (2.1)	4.7 (2.1)	6.0 (1.7)
Use in cool weather (0°C to -10°C)	4.3 (1.9)	3.3 (1.7)	3.3 (2.1)	3.0 (1.4)	5.8 (1.5)
Use in hot weather (20°C to 30°C)	3.8 (2.2)	3.0 (1.8)	3.0 (1.8)	2.5 (1.7)	6.3 (1.2)
Use in extremely hot weather (above 30°C)	4.3 (2.3)	3.0 (2.0)	2.3 (1.5)	2.5 (1.7)	6.0 (1.7)
Dust Environments	3.3 (1.9)	3.0 (1.4)	3.0 (1.6)	3.3 (0.8)	5.0 (2.1)
Overall Thermal Comfort	3.7 (1.8)	3.0 (1.4)	3.6 (1.7)	3.3 (1.0)	5.4 (1.7)
Field of View In Front	5.2 (1.8)	4.2 (1.6)	6.2 (0.4)	4.7 (2.1)	6.8 (0.4)
Field of View Left / Right	3.8 (1.6)	3.8 (1.5)	5.6 (0.9)	4.2 (2.1)	6.6 (0.6)
Field of View Overhead	4.5 (1.4)	3.8 (1.7)	5.6 (1.1)	4.3 (1.9)	5.8 (1.3)
Field of View Down	3.5 (1.8)	2.7 (1.2)	4.8 (1.5)	3.8 (2.0)	6.4 (0.6)
Overall Field of View	4.0 (1.6)	4.0 (0.7)	5.4 (1.1)	4.2 (1.9)	6.4 (0.6)
Stability Left / Right	4.2 (1.5)	3.8 (1.5)	5.0 (1.4)	2.8 (1.6)	6.4 (0.6)
Stability Forward / Backwards	4.3 (1.5)	3.8 (1.5)	5.4 (0.9)	2.8 (1.6)	6.4 (0.6)
Stability Rotation Left / Right	2.8 (1.0)	3.7 (1.5)	5.4 (0.9)	2.7 (1.5)	6.4 (0.6)
Security of additional components	3.3 (1.9)	3.2 (1.8)	5.4 (1.1)	2.5 (1.2)	6.5 (0.6)
Overall Stability	4.0 (1.6)	3.4 (1.3)	5.0 (1.4)	2.8 (1.6)	6.4 (0.6)
Comfort - Pressure Points	4.8 (1.3)	3.7 (1.5)	4.8 (2.3)	3.5 (1.8)	6.2 (1.3)
Weight on the Head	4.0 (1.7)	4.0 (1.6)	5.2 (1.3)	3.7 (1.5)	5.8 (1.3)
Skin Irritation	4.5 (1.8)	4.0 (1.7)	5.2 (2.5)	4.2 (1.6)	6.6 (0.6)
Overall Physical Comfort	4.0 (1.7)	3.7 (1.4)	4.6 (2.1)	3.5 (1.6)	6.4 (0.6)

No significant differences were seen in overall thermal comfort ratings. Overall field of view ($F(4,20)=6.16, MS=6.90, p=0.002$) and stability ($F(4,20)=6.21, MS=11.92, p=0.002$) ratings revealed advantages of the CG634 over conditions 8, 8A, and 12. In terms of physical comfort, overall acceptance scores showed CG634 to be more acceptable than 8A and 12 ($F(4,20)=3.45, MS=8.31, p=0.027$).

While caution is advised in drawing conclusions from the limited data set (n=6) , the performance of condition 10 was the most favourable of the mandibles assessed.

4.6.2 Group B Results

Group B soldiers also rated the in-service CG634 helmet acceptable for the obstacle course task across all evaluation metrics- see Table 10. Of the mandible test conditions, condition 11 was typically the best performing and was rated 4.8 on average across all metrics. Condition 9 was rated 4.1, condition 9A was rated 4.4 and condition 13 was rated 3.1 on average across all evaluation metrics.

Table 10: Group B Obstacle Course Results

Obstacle Course- mean (SD) (n=4)	9	9A	11	13	CG634 (7-12)
Ventilation	3.3 (2.5)	4.3 (1.7)	4.5 (2.4)	1.0 (0.0)	5.8 (1.0)
Hot Spots	3.3 (2.5)	3.8 (1.5)	4.3 (1.7)	2.5 (0.7)	6.0 (0.8)
Sweat Management	3.7 (2.5)	3.3 (2.1)	4.3 (1.7)	2.5 (0.7)	5.5 (1.0)
Heat Build-up	3.7 (2.1)	4.0 (1.4)	4.5 (1.9)	3.0 (0.0)	5.0 (1.6)
Use in cold weather (-10°C to -30°C)	4.0 (2.0)	4.0 (2.8)	6.0 (0.0)	-	4.7 (2.1)
Use in cool weather (0°C to -10°C)	4.3 (2.1)	4.0 (0.0)	5.0 (0.0)	-	5.5 (2.1)
Use in hot weather (20°C to 30°C)	1.5 (0.7)	4.0 (1.4)	3.0 (1.7)	1.0 (0.0)	4.0 (0.0)
Use in extremely hot weather (above 30°C)	1.5 (0.7)	4.0 (0.0)	2.5 (2.1)	-	3.5 (0.7)
Dust Environments	2.0 (0.0)	3.7 (1.5)	4.5 (0.7)	3.5 (0.7)	5.7 (1.5)
Overall Thermal Comfort	3.5 (3.5)	4.0 (1.4)	4.3 (1.7)	1.5 (0.7)	6.0 (1.0)
Field of View In Front	6.3 (0.6)	5.3 (1.0)	5.8 (1.3)	4.5 (2.1)	6.8 (0.5)
Field of View Left / Right	5.7 (1.5)	5.0 (1.2)	5.3 (1.3)	3.5 (0.7)	6.8 (0.5)
Field of View Up	5.0 (2.6)	4.8 (1.5)	5.0 (1.8)	3.0 (1.4)	6.3 (1.0)
Field of View Down	4.7 (2.5)	4.5 (1.9)	5.3 (1.7)	5.0 (1.4)	6.8 (0.5)
Overall Field of View	5.0 (1.7)	4.8 (1.0)	4.8 (1.7)	3.0 (0.0)	6.8 (0.5)
Stability Left / Right	4.7 (2.1)	4.8 (1.5)	5.0 (1.4)	3.5 (0.7)	6.5 (0.6)
Stability Forward / Backwards	4.3 (2.3)	4.8 (1.5)	4.8 (1.7)	3.0 (0.0)	6.5 (0.6)
Stability Rotation Left / Right	5.0 (2.0)	4.8 (1.5)	5.3 (1.5)	4.0 (1.4)	6.5 (0.6)
Security	4.7 (2.1)	4.5 (1.7)	4.8 (1.7)	2.5 (0.7)	6.5 (0.6)
Overall Stability	4.7 (2.1)	4.8 (1.5)	5.0 (1.4)	3.5 (0.7)	6.5 (0.6)
Comfort – Pressure Points	4.3 (2.5)	4.8 (1.0)	5.0 (1.8)	3.0 (0.0)	6.0 (0.8)
Weight on the Head	4.7 (2.5)	4.3 (1.3)	5.0 (1.8)	4.0 (0.0)	5.5 (0.6)
Skin Irritation	4.0 (2.6)	4.5 (1.0)	5.0 (1.2)	4.0 (0.0)	5.3 (0.5)
Overall Physical Comfort	4.3 (2.5)	4.5 (1.0)	5.0 (1.8)	3.5 (0.7)	5.8 (1.0)

Caution is strongly advised in drawing any conclusions from the limited data set (n=4), the performance of condition 11 was the most favourable of the mandibles assessed, even though the majority of its ratings were between ‘borderline’ and ‘barely acceptable’.

4.7 Live Fire

Participants performed two live fire evaluations with their assigned helmet conditions. The live fire serials included a modified run down test and a tactical shooting test. Results of the live fire test stands are presented below by test block. Group A members (n=6) completed the static stands while wearing mandible conditions 8, 8A, 10, and 12 and Group B members (n=5) completed the static stands while wearing mandible conditions 9, 9A, 11, and 13. In each case the control condition was the in-service CG634 helmet.

Due to the low numbers of subjects involved (six for Group A and six for Group B), caution is strongly advised when interpreting the results detailed below. There were large deviations in the results by mandible and task. The results below should be utilized to identify trends only. .

4.7.1 Group A Run Down Results

In general, the performance of the prototype conditions for the run down task was unacceptable, compatibility ranged from an average rating of 2.2 for Condition 8 to 3.7 for Condition 8A. Condition 8A was rated slightly more acceptable than conditions 8, 10, and 12 for the rundown range firing task - see Table 11.

Table 11: Live Fire Range Rundown Results –Group A

Rundowns- mean (SD) (n=6)	8	8A	10	12	CG634 (1-6)
Prone	2.8 (2.2)	3.7 (1.5)	2.5 (1.8)	1.8 (1.0)	6.8 (0.4)
Kneeling	2.2 (1.6)	3.5 (1.8)	2.2 (1.6)	1.5 (0.6	6.8 (0.4)
Standing	2.2 (1.6)	3.8 (1.7)	2.0 (2.0)	1.2 (0.4)	6.8 (0.4)
Running	2.0 (1.7)	3.7 (2.0)	2.2 (1.6)	2.7 (2.2)	6.8 (0.4)
Sighting	2.2 (1.5)	3.5 (1.6)	1.7 (1.2)	1.4 (0.6)	6.8 (0.4)
Stock weld	2.2 (1.6)	3.5 (1.6)	2.2 (1.6)	1.7 (0.8)	6.8 (0.4)
Weapon Stability	2.2 (1.6)	3.7 (1.9)	2.3 (1.5)	1.8 (1.0)	6.8 (0.4)
Shooting	2.7 (2.4)	3.5 (2.4)	2.3 (1.2)	1.5 (0.8)	6.8 (0.4)
Change Magazines	2.8 (2.6)	4.2 (2.1)	2.8 (1.7)	2.2 (2.0)	6.8 (0.4)
Access Magazines	1.5 (1.0)	3.5 (2.1)	3.0 (1.9)	2.0 (1.2	7.0 (0.0)
Clearing Stoppages	2.2 (1.3)	3.4 (2.0)	3.0 (1.9)	3.0 (2.3	6.7 (0.8)
Ease of Movement	2.0 (1.6)	3.7 (2.1)	3.2 (1.7)	2.0 (1.7)	6.8 (0.4)
Speed of Movement	2.0 (2.0)	4.0 (2.2)	3.0 (1.9)	1.7 (1.0)	6.8 (0.41)
Overall Task Performance	2.3 (1.6)	3.5 (1.9)	2.5 (1.5)	1.8 (1.0)	6.8 (0.41)
Helmet Compatibility	2.8 (2.0)	4.2 (2.1)	3.3 (2.4)	4.0 (2.2)	6.8 (0.41)
Weapon Compatibility	2.5 (1.8)	4.0 (2.5)	2.5 (1.9)	3.5 (2.4)	6.8 (0.41)
Clothing Compatibility	2.3 (1.5)	4.2 (2.1)	3.0 (2.3)	4.0 (2.2)	6.8 (0.41)
Glove Compatibility	2.2 (1.5)	4.2 (2.5)	3.2 (2.1)	3.7 (2.2)	6.8 (0.41)
Overall Compatibility	2.0 (1.3)	4.2 (2.1)	3.0 (2.4)	3.5 (2.3)	6.8 (0.41)
Helmet Strap Stability	2.5 (1.8)	3.7 (2.1)	2.7 (2.0)	3.3 (1.5)	6.8 (0.41)
Overall Stability	2.3 (1.5)	3.8 (2.0)	2.5 (1.8)	3.5 (1.9)	6.8 (0.41)
Overall Shooting Compatibility	2.2 (1.3)	3.7 (1.8)	2.3 (1.5)	2.3 (1.5)	6.8 (0.41)
Adjustment	2.7 (2.4)	4.0 (2.1)	3.3 (2.3)	3.8 (1.7)	6.7 (0.82)
Weight	2.7 (2.4)	3.8 (1.9)	3.3 (2.1)	3.8 (2.1)	6.0 (1.67)
Volume	2.7 (2.3)	3.7 (2.2)	3.0 (1.90	3.3 (2.0)	6.8 (0.41)
Irritation	2.5 (2.4)	4.2 (2.1)	3.7 (2.3)	4.7 (2.1)	6.0 (2.45)
Stiffness	2.8 (2.4)	3.8 (2.2)	2.8 (1.6)	3.2 (1.9)	6.0 (2.45)
Overall Physical Comfort	2.5 (2.4)	3.8 (2.2)	2.8 (1.7)	3.0 (1.3)	6.7 (0.52)
Overall Thermal Comfort	3.2 (2.6)	4.0 (2.0)	2.7 (1.6)	3.8 (2.1)	6.7 (0.52)

The in-service condition of the CG634 was rated significantly more acceptable than the AMMPHS conditions ($F(4,20)=14.75, MS=23.45, p<0.000$) clearly showing the impact of the mandible on live fire acceptability.

While a clear preference for the CG634 condition was demonstrated in soldier acceptance, range scores showed no significant differences between conditions CG634, 8, 8A, 10, and 12 - see Table 12. The soldiers may have been able to overcome any compatibility clash introduced by the novel conditions or have been exerting more conscious effort in taking aimed shots when their normal muscle memory patterns were disrupted by the mandibles Future evaluations should incorporate timing measures to determine if extra effort was required.

Table 12: Live Fire Range Rundown Scores

Conditions	Participants 1-6	Conditions	Participants 7-12
CG634	15.5 (8.6)	CG634	18.4 (6.7)
8	15.3 (8.4)	9	20.4 (3.0)
8A	17.7 (9.4)	9A	21.0 (3.9)
10	15.0 (9.1)	11	20.8 (2.4)
12	10.7 (7.9)	13	21.2 (2.3)

4.7.2 Group A Tactical Shooting Results

In general, the performance of the prototype conditions for the tactical shooting task was unacceptable, overall shooting compatibility ranged from an average rating of 2.0 for condition 8 to 4.0 for condition 8A. Condition 8A was rated slightly more acceptable than conditions 10, and 12 and noticeably different than condition 8 for the rundown range firing task – see Table 13.

Table 13: Live Fire Range Tactical Shooting Results – Group A

Tactical Shooting – mean (SD) (n=6)	8	8A	10	12	CG634 (1-6)
Kneeling	1.2 (0.4)	2.4 (1.1)	2.2 (1.1)	2.2 (1.6)	6.8 (0.4)
Standing	1.2 (0.4)	2.8 (1.57)	1.8 (1.0)	2.5 (1.9)	6.8 (0.4)
Sighting	1.2 (0.4)	2.5 (2.1	1.7 (0.8)	2.3 (2.0)	6.8 (0.4)
Stock weld	1.2 (0.4)	2.5 (1.6)	1.5 (0.8)	2.2 (1.9)	6.8 (0.4)
Weapon Stability	1.8 (1.0)	3.2 (1.8)	1.8 (0.8)	2.2 (1.6)	6.8 (0.4)
Shooting	1.5 (0.6)	2.7 (2.0)	1.5 (0.8)	2.3 (1.2)	6.8 (0.4)
Change Magazines	2.0 (1.3)	3.5 (2.3)	2.2 (1.0)	2.3 (2.0)	6.8 (0.4)
Access Magazines	1.2 (0.4)	3.4 (2.3)	2.0 (1.0)	1.5 (1.0)	7.0 (0.0)
Clearing Stoppages	2.0 (1.3)	3.5 (2.1)	2.7 (1.5)	2.3 (1.5)	6.8 (0.4)
Ease of Movement	1.8 (1.0)	3.0 (1.8)	2.3 (1.0)	2.5 (1.5)	6.8 (0.4)
Speed of Movement	1.5 (0.6)	3.0 (1.8)	2.3 (1.0)	2.7 (2.0)	6.8 (0.4)
Overall Task Performance	1.7 (0.8)	3.2 (1.7)	2.3 (1.0)	2.3 (1.5)	6.8 (0.4)
Helmet Compatibility	2.2 (1.3)	4.5 (1.8)	3.2 (1.9)	3.5 (2.6)	6.2 (2.0)
Weapon Compatibility	1.8 (0.8)	4.3 (1.9)	2.3 (1.2)	3.3 (2.4)	6.2 (2.0)
Clothing Compatibility	2.8 (1.6)	5.3 (1.4)	3.7 (2.0)	3.5 (2.6)	6.2 (2.0)
Glove Compatibility	2.2 (1.5)	5.2 (1.2)	3.8 (2.0)	3.3 (2.4)	6.2 (2.0)
Overall Compatibility	1.8 (1.2)	4.5 (1.6)	3.7 (2.0)	3.2 (2.3)	6.2 (2.0)
Helmet Strap Stability	2.5 (1.4)	3.0 (1.3)	4.0 (2.0)	3.3 (2.4)	6.2 (2.0)
Overall Stability	2.3 (1.5)	3.2 (1.5)	3.8 (1.9)	3.2 (2.3)	6.2 (2.0)
Overall Shooting Compatibility	2.0 (1.1)	4.0 (0.6)	3.5 (2.0)	3.3 (2.4)	6.8 (0.4)
Adjustment	2.8 (1.7)	4.7 (1.4)	3.7 (2.2)	3.0 (2.3)	6.7 (0.8)
Weight	2.5 (1.4)	4.5 (1.4)	3.7 (2.2)	2.8 (2.3)	6.8 (0.4)
Volume	2.3 (1.4)	4.8 (1.2)	3.8 (2.4)	2.8 (2.2)	6.8 (0.4)
Irritation	2.8 (1.9)	5.0 (1.3)	4.0 (2.2)	3.2 (2.4)	6.5 (1.2)
Stiffness	2.0 (1.36)	4.5 (1.2)	4.0 (2.4)	2.8 (2.3)	6.5 (1.2)
Overall Physical Comfort	1.8 (1.2)	4.3 (1.4)	4.0 (2.2)	3.0 (2.3)	6.8 (0.4)
Overall Thermal Comfort	2.2 (1.5)	4.3 (1.5)	4.0 (2.2)	2.7 (2.4)	6.7 (0.8)

For tactical shooting, condition 8A was again preferred, but not to a statistically significant level; however a number of the subjective scores for this task were found to be unacceptable, while CG634 was significantly more acceptable than the mandible conditions ($F(4,20)=8.39, MS=19.05, p<0.000$) – see Table 13.

4.7.3 Group B Run Down Results

In general, the performance of mandible prototypes 9, 9A, 11 and 13 were marginal for the run down task; overall weapon compatibility ranged from an average rating of 3.2 for condition 9 to 4.8 for condition 13. Condition 13 was rated slightly more acceptable than conditions 9, 9A, and 11 for the rundown range firing task – see Table 14.

Table 14: Live Fire Range Rundown Results – Group B

Rundowns – mean (SD) (n=5)	9	9A	11	13	CG634 (7-12)
Prone	3.6 (1.7)	4.6 (0.9)	4.6 (1.1)	4.2 (1.3)	7.0 (0.0)
Kneeling	2.6 (1.7)	3.8 (1.5)	4.6 (1.1)	4.2 (1.3)	7.0 (0.0)
Standing	2.6 (1.7)	3.6 (1.5)	4.6 (1.1)	4.2 (1.3)	7.0 (0.0)
Running	4.2 (1.5)	4.0 (1.6)	5.0 (1.6)	4.8 (1.6)	7.0 (0.0)
Sighting	2.6 (1.1)	3.4 (1.5)	3.8 (1.5)	3.6 (1.1)	7.0 (0.0)
Stock weld	3.8 (1.3)	4.0 (1.2)	4.8 (1.3)	4.6 (1.1)	7.0 (0.0)
)Weapon Stability	4.0 (1.68)	4.0 (1.4)	4.6 (1.5)	4.4 (1.8)	7.0 (0.0)
Shooting	3.4 (1.7)	3.2 (1.9)	4.5 (1.9)	4.2 (1.8)	7.0 (0.0)
Change Magazines	4.6 (1.3)	4.4 (1.1)	4.8 (1.6)	4.6 (1.3)	7.0 (0.0)
Access Magazines	4.5 (1.0)	4.4 (1.1)	4.5 (1.0)	4.0 (0.8)	7.0 (0.0)
Clearing Stoppages	5.0 (1.2)	4.5 (1.3)	5.3 (1.5)	4.8 (1.5)	7.0 (0.0)
Ease of Movement	3.6 (2.3)	4.0 (1.4)	4.4 (2.3)	4.4 (1.5)	7.0 (0.0)
Speed of Movement	3.6 (2.1)	4.0 (1.4)	4.6 (2.0)	4.4 (1.5)	7.0 (0.0)
Overall Task Performance	3.4 (1.1)	4.0 (1.2)	4.3 (1.3)	4.2 (1.3)	7.0 (0.0)
Helmet Compatibility	4.2 (1.6)	4.2 (1.3)	4.8 (1.6)	4.8 (1.3)	7.0 (0.0)
Weapon Compatibility	3.2 (1.9)	4.0 (1.2)	4.4 (2.0)	4.0 (1.6)	7.0 (0.0)
Clothing Compatibility	4.4 (1.1)	4.6 (1.3)	5.0 (1.4)	4.8 (1.3)	7.0 (0.0)
Glove Compatibility	5.8 (1.3)	5.8 (1.3)	5.3 (1.5)	5.3 (1.5)	7.0 (0.0)
Overall Compatibility	3.8 (1.1)	4.8 (0.8)	5.0 (1.4)	4.4 (1.5)	7.0 (0.0)
Helmet Strap Stability	4.8 (1.5)	4.6 (1.5)	3.8 (1.6)	4.6 (2.0)	7.0 (0.0)
Overall Stability	4.0 (1.2)	4.2 (1.3)	3.8 (1.9)	4.6 (2.0)	7.0 (0.0)
Overall Shooting Compatibility	3.2 (1.6)	4.0 (1.6)	4.2 (1.6)	4.8 (1.6)	7.0 (0.0)
Adjustment	3.4 (1.7)	3.6 (1.7)	4.2 (1.8)	4.8 (1.6)	7.0 (0.0)
Weight	3.6 (1.7)	3.6 (1.7)	3.8 (2.2)	4.6 (1.3)	7.0 (0.0)
Volume	3.4 (1.8)	3.6 (1.7)	4.0 (1.4)	4.2 (1.8)	7.0 (0.0)
Irritation	3.6 (1.8)	3.4 (1.5)	4.4 (1.5)	4.0 (0.7)	7.0 (0.0)
Stiffness	3.6 (2.1)	3.8 (1.9)	4.0 (1.9)	4.4 (1.5)	7.0 (0.0)
Overall Physical Comfort	3.4 (1.5)	3.4 (1.8)	4.2 (1.6)	4.4 (1.5)	7.0 (0.0)
Overall Thermal Comfort	4.4 (1.1)	4.0 (1.9)	3.8 (2.2)	4.2 (1.6)	7.0 (0.0)

Again the novel conditions did not come close to the acceptability of the CG634 condition ($F(4,16)=8.69, MS=10.34, p<0.000$). The CG634 conditions shows signs of participant bias, as indicated by the lack of variance in the mean ratings of the 5 participants evaluating these conditions (participant 9 was unable to complete the rundown range exercise due to a leg injury). Once again no significant differences were observed in the limited objective range scores collected - see Table 12.

4.7.4 Group B Tactical Shooting Results

Little differentiation was seen between the mandible conditions in the tactical shooting soldier acceptance ratings – see Table 15. In general condition 9 was less favoured than the others, but again differences were statistically non-significant.

Table 15: Live Fire Range Tactical Shooting Results – Group B

Tactical Shooting – mean (SD) (n=5)	9	9A	11	13	CG634 (7-12)
Kneeling	3.6 (1.8)	4.4 (1.8)	4.4 (1.8)	4.4 (1.5)	7.0 (0.0)
Standing	3.4 (1.5)	4.4 (2.2)	4.4 (1.8)	4.4 (1.5)	7.0 (0.0)
Sighting	2.8 (1.3)	4.0 (1.6	4.4 (1.5)	3.8 (1.6)	7.0 (0.0)
Stock weld	3.2 (1.8)	4.4 (1.8)	4.4 (1.7)	4.2 (1.8)	6.8 (0.4)
Weapon Stability	3.2 (1.8)	4.6 (1.5)	4.4 (1.8)	4.6 (1.3)	7.0 (0.0)
Shooting	3.4 (2.1)	4.2 (1.6)	4.4 (1.7)	4.4 (1.5)	7.0 (0.0)
Change Magazines	4.6 (1.5)	4.8 (1.8)	5.2 (1.6)	5.0 (1.0)	7.0 (0.0)
Access Magazines	3.7 (1.2)	4.7 (1.5)	4.3 (1.5)	4.7 (1.2)	7.0 (0.0)
Clearing Stoppages	4.4 (1.3)	6.0 (0.8)	5.2 (1.6)	4.6 (1.7)	7.0 (0.0)
Ease of Movement	3.4 (1.7)	4.6 (1.7)	4.4 (1.8)	4.4 (1.7)	7.0 (0.0)
Speed of Movement	3.6 (2.0)	4.6 (1.7)	4.4 (1.8)	4.4 (1.7)	7.0 (0.0)
Overall Task Performance	3.4 (1.7)	4.4 (1.8)	4.4 (1.8)	4.4 (1.7)	7.0 (0.0)
Helmet Compatibility	4.6 (1.5)	4.6 (1.5)	5.2 (1.6)	5.0 (1.6)	7.0 (0.0)
Weapon Compatibility	3.6 (2.3)	4.6 (1.5)	4.8 (1.3)	4.2 (1.8)	7.0 (0.0)
Clothing Compatibility	4.8 (1.6)	5.2 (1.6)	4.0 (2.1)	5.0 (1.4)	7.0 (0.0)
Glove Compatibility	5.3 (1.5)	5.4 (1.5)	5.2 (1.6)	5.2 (1.6)	7.0 (0.0)
Overall Compatibility	4.4 (1.5)	5.0 (1.4)	4.4 (1.5)	5.0 (1.4)	7.0 (0.0)
Helmet Strap Stability	4.8 (1.6)	5.0 (1.9)	4.4 (1.5)	5.2 (1.6)	7.0 (0.0)
Overall Stability	4.4 (1.5)	5.0 (1.4)	4.4 (1.5)	4.6 (1.1)	7.0 (0.0)
Overall Shooting Compatibility	3.8 (2.2)	4.6 (1.5)	4.2 (1.6)	4.4 (1.5)	7.0 (0.0)
Adjustment	4.8 (1.6)	5.0 (1.2)	5.0 (1.2)	5.0 (1.2)	7.0 (0.0)
Weight	4.6 (1.5)	5.0 (1.2)	4.8 (1.1)	5.0 (1.2)	7.0 (0.0)
Volume	4.2 (1.3)	5.0 (1.2)	5.0 (1.2)	5.0 (1.2)	7.0 (0.0)
Irritation	4.2 (1.3)	5.0 (1.2)	4.8 (1.1)	5.0 (1.2)	7.0 (0.0)
Stiffness	4.2 (1.3)	5.0 (1.2)	4.8 (1.1)	5.0 (1.2)	7.0 (0.0)
Overall Physical Comfort	4.2 (1.3)	5.0 (1.2)	4.8 (1.1)	5.0 (1.2)	7.0 (0.0)
Overall Thermal Comfort	3.8 (1.6)	5.0 (1.2)	5.0 (1.2)	5.0 (1.2)	7.0 (0.0)

The CG634 was the most acceptable condition for tactical shooting, with significant differences to all mandible test conditions ($F(4,16)=8.42, MS=8.00, p<0.000$).

4.8 Exit Questionnaires

During the course of the trial the participants completed a mandible attachment exit questionnaire and upon completion of the trial a coverage questionnaires and a cut-out questionnaire. The results of the exit questionnaires are detailed below.

4.8.1 Coverage Results

At the conclusion of the trial all participants completed a trial exit questionnaire assessing the coverage of each helmet condition. Group A participants completed a questionnaire comparing helmet conditions 8, 10, and 12 to a SIHS condition (CS). Group B participants completed a questionnaire comparing helmet conditions 9, 11, and 13 to a different SIHS soft mandible condition (SL).

4.8.1.1 Group A Coverage Results

The prototype mandibles were assessed as being acceptable in only a few assessment area (see Table 16): looking down, compatibility with CG634, compatibility with nape protectors, compatibility with ballistic eyewear, and overall security. In most cases helmet condition 8 was the lowest rated condition with helmet condition 12 being the highest rated condition (not including the control condition).

Table 16: Coverage Exit Questionnaire Results - Group A

Criteria - mean (SD) (n=6)	8	10	12	CS
Rotating (standing)	1.5 (0.6)	2.3 (0.5)	2.7 (0.5)	3.0 (1.3)
Head tipped to side (standing)	1.7 (0.8)	2.5 (0.6)	2.7 (0.5)	3.0 (1.6)
Head tipped forward (standing)	1.5 (0.6)	2.5 (0.6)	2.7 (0.5)	3.2 (1.3)
Rotating (seated)	1.5 (0.6)	2.0 (0.6)	2.5 (0.65)	3.0 (1.3)
Head tipped to side (seated)	1.7 (0.8)	2.0 (0.6)	2.7 (0.5)	3.0 (1.6)
Head tipped forward (seated)	1.0 (0.0)	1.8 (0.8)	2.2 (1.0)	3.2 (1.2)
Ability to adopt normal firing position	1.3 (0.5)	2.5 (0.8)	2.2 (0.8)	3.7 (0.5)
Getting a proper sight picture	1.3 (0.8)	2.3 (1.0)	2.0 (0.9)	3.5 (0.8)
Stock Weld Compatibility	1.3 (0.5)	1.8 (0.4)	1.5 (0.8)	3.2 (1.2)
Ease of movement (Gun Fighter Pivot drills)	1.5 (0.8)	2.0 (0.6)	2.2 (1.0)	3.0 (1.4)
M72 Compatibility	1.0 (0.0)	1.2 (0.4)	1.3 (0.8)	2.3 (1.2)
C6 Compatibility	1.0 (0.0)	1.5 (0.8)	1.7 (1.0)	2.8 (1.6)
C9A2 Compatibility	1.0 (0.0)	1.5 (0.8)	1.7 (1.0)	3.0 (1.4)
Sighting Carl Gustav 84 mm SRAAW	1.2 (0.4)	1.7 (0.8)	1.7 (0.8)	2.5 (1.0)
Looking down	4.2 (2.0)	4.8 (1.7)	5.0 (1.4)	4.5 (1.4)
Looking to sides	2.7 (1.2)	3.2 (1.0)	3.8 (1.3)	2.3 (1.0)
Accessing Magazines	1.0 (0.0)	2.0 (1.7)	2.2 (2.4)	1.8 (1.6)
CG 634 Helmet	4.3 (2.0)	4.3 (2.0)	4.3 (2.0)	4.2 (2.0)
Nape protectors	4.0 (2.2)	4.0 (2.2)	4.0 (2.2)	3.3 (2.4)
TV with Gen III Fragmentation vest	3.7 (2.1)	4.0 (1.9)	3.8 (1.2)	3.0 (1.7)
Ballistic Eyewear	5.0 (1.1)	5.3 (0.8)	5.5 (0.8)	4.2 (1.3)
Compatibility with TCCS	1.2 (0.4)	1.2 (0.4)	2.2 (1.6)	2.3 (1.2)
Compatibility with PRR	2.0 (1.3)	2.3 (1.2)	2.8 (1.5)	3.5 (1.9)
Compatibility with Microphone	1.2 (0.4)	2.7 (2.1)	3.2 (2.2)	3.2 (1.9)
Mounted LAV tasks	1.7 (1.2)	2.3 (2.0)	2.2 (1.2)	2.3 (1.4)
Dismounted combat tasks	1.3 (0.5)	1.7 (0.8)	1.7 (0.8)	2.3 (1.0)
Overall Shape	2.0 (1.3)	3.3 (1.5)	3.0 (1.4)	2.0 (1.3)
Overall Protection	4.2 (2.5)	3.2 (2.1)	3.2 (2.1)	1.8 (1.2)
Overall Range of Motion	1.7 (0.5)	3.3 (1.2)	3.2 (1.0)	3.2 (1.5)
Overall Securement	4.2 (2.0)	4.0 (2.4)	4.2 (2.3)	2.7 (1.6)
Overall Stability	3.5 (2.6)	3.3 (2.5)	3.7 (2.2)	2.2 (1.2)
Overall Weapon Compatibility	1.2 (0.4)	2.2 (1.2)	1.5 (0.6)	2.8 (1.7)
Overall Field of View	2.2 (1.0)	2.7 (1.4)	3.3 (2.0)	2.2 (1.3)
Overall Equipment Compatibility	2.0 (0.9)	2.7 (1.5)	2.2 (0.8)	2.2 (1.0)
Overall Task Compatibility	1.2 (0.4)	2.2 (1.0)	1.5 (0.6)	2.0 (1.3)
Overall Physical Comfort	2.0 (1.7)	3.0 (1.7)	2.8 (1.7)	2.3 (1.0)
Overall Thermal Comfort	2.2 (1.5)	2.5 (1.2)	2.5 (1.2)	1.5 (0.6)
OVERALL ACCEPTANCE	1.3 (0.5)	2.5 (1.0)	2.3 (0.8)	2.5 (1.2)

A repeated measures ANOVA was conducted on the overall questions (last 12 in the table – highlighted in bold) to identify any statistically significant differences between mandible conditions. Of the 12 overall questions there were only statistically significant differences identified for overall weapon compatibility ($F(3,15) = 4.214$, $MS = 3.278$, $p = 0.024$) where the CS condition was significantly better than condition 8. There were no statistically significant differences between the mandible conditions 8, 10, and 12 for all of the overall criteria.

4.8.1.2 Group B Coverage Results

In a large number of the criteria (20 out of 38) all of the conditions were found to be unacceptable with ratings below 4 (borderline). In most cases all of the mandible conditions were rated similarly with not one condition outperforming the others consistently. Results from the questionnaire comparing mandible conditions 9, 11, and 13 to the SL condition are shown in Table 17.

Table 17: Coverage Exit Questionnaire Results - Group B

Criteria - mean (SD) (n=6)	9	11	13	SL
Rotating (standing)	4.5 (1.9)	4.5 (1.9)	4.5 (1.9)	4.2 (1.3)
Head tipped to side (standing)	4.7 (1.6)	4.7 (1.6)	4.8 (1.8)	4.2 (1.3)
Head tipped forward (standing)	4.3 (2.2)	4.3 (2.2)	4.4 (2.4)	4.2 (1.3)
Rotating (seated)	4.0 (2.0)	4.0 (2.0)	3.8 (2.0)	3.7 (1.2)
Head tipped to side (seated)	4.0 (2.0)	4.0 (2.0)	3.8 (2.0)	3.7 (1.2)
Head tipped forward (seated)	4.0 (2.0)	3.5 (2.4)	3.5 (2.4)	3.8 (1.5)
Ability to adopt normal firing position	2.5 (1.4)	2.7 (1.5)	2.8 (1.7)	4.0 (1.4)
Getting a proper sight picture	2.2 (1.3)	2.4 (1.5)	2.2 (1.3)	3.6 (1.1)
Stock Weld Compatibility	2.5 (1.2)	2.7 (1.4)	2.5 (1.2)	4.0 (1.4)
Gun Fighter Pivot drills	2.5 (1.2)	2.7 (1.4)	2.5 (1.2)	3.8 (1.2)
M72 Compatibility	1.5 (0.8)	1.5 (0.8)	1.5 (0.8)	3.0 (1.7)
C6 Compatibility	2.5 (2.0)	2.5 (2.0)	2.5 (2.0)	4.0 (0.9)
C9A2 Compatibility	2.3 (2.0)	2.3 (2.0)	2.3 (2.0)	4.0 (0.9)
Sighting Carl Gustav 84 mm SRAAW	2.5 (2.0)	2.3 (2.0)	2.3 (2.0)	3.8 (1.7)
Looking down	5.3 (1.9)	5.0 (2.4)	5.0 (2.4)	5.2 (1.9)
Looking to sides	4.0 (1.7)	4.0 (1.7)	4.0 (1.7)	2.7 (0.8)
Accessing Magazines	5.2 (2.0)	5.3 (1.9)	4.8 (1.8)	4.2 (2.3)
CG 634 Helmet	5.2 (1.5)	5.4 (1.5)	5.2 (1.5)	4.2 (2.1)
Nape protectors	5.5 (1.6)	5.8 (1.6)	5.5 (1.6)	4.7 (1.9)
TV with Gen III Fragmentation vest	4.8 (1.7)	5.0 (1.9)	4.8 (1.7)	4.5 (2.0)
Ballistic Eyewear	5.8 (1.5)	6.2 (1.3)	5.8 (1.5)	5.3 (1.5)
Compatibility with TCCS	1.2 (0.4)	1.2 (0.4)	1.2 (0.4)	3.3 (1.4)
Compatibility with PRR	3.2 (1.6)	3.2 (1.6)	3.2 (1.6)	4.7 (0.8)
Compatibility with Microphone	2.2 (1.6)	2.6 (1.8)	2.2 (1.6)	5.0 (1.6)
Mounted LAV tasks	3.2 (2.6)	3.2 (2.6)	3.2 (2.6)	3.2 (1.6)
Dismounted combat tasks	3.5 (1.9)	3.8 (1.9)	3.2 (2.1)	3.5 (1.9)
Overall Shape	2.5 (1.5)	3.6 (2.2)	2.0 (1.4)	2.7 (1.5)
Overall Protection	3.5 (1.5)	3.7 (1.5)	3.3 (1.4)	3.5 (1.4)
Overall Range of Motion	3.5 (1.9)	3.5 (1.8)	3.3 (1.8)	3.0 (1.4)
Overall Securement	3.7 (1.6)	3.3 (1.5)	3.5 (1.5)	3.2 (1.7)
Overall Stability	4.0 (2.0)	3.5 (2.1)	3.8 (2.1)	4.2 (2.1)
Overall Weapon Compatibility	2.3 (1.8)	2.3 (1.8)	2.3 (1.8)	3.5 (1.0)
Overall Field of View	4.3 (1.4)	4.2 (1.6)	4.0 (1.4)	2.5 (1.6)
Overall Equipment Compatibility	4.2 (1.5)	4.0 (1.6)	4.0 (1.6)	4.0 (0.9)
Overall Task Compatibility	3.7 (2.2)	3.5 (2.2)	3.5 (2.2)	4.0 (1.3)
Overall Physical Comfort	3.7 (1.8)	4.0 (2.1)	3.2 (2.1)	3.0 (1.7)
Overall Thermal Comfort	3.3 (1.6)	3.5 (1.9)	3.2 (1.8)	1.8 (1.3)
OVERALL ACCEPTANCE	3.3 (1.4)	3.7 (1.8)	3.2 (1.6)	2.7 (1.6)

A repeated measures ANOVA was conducted on the overall questions (last 12 in the table – highlighted in bold) to identify any statistically significant differences between mandible conditions. Of the 12 overall questions there were only statistically significant differences identified for overall weapon compatibility ($F(3,15)= 8.448$, $MS=2.042$, $p =0.002$), overall field of view ($F(3,15)=15.40$, $MS=4.278$, $p<0.000$), and overall thermal comfort ($F(3,15)= 4.088$, $MS=3.486$, $p=0.026$). In terms of overall weapon compatibility the control condition SL was significantly better than conditions 9, 11, and 13. In terms of overall field of view conditions 9, 11, and 13 were found to be significantly better than the control condition SL. For overall thermal

comfort condition 11 was found to be significantly better than the control condition SL. No statistically significant differences were detected between the mandible conditions 9, 11, and 13 for any of the overall criteria.

4.8.2 Cut-Out Questionnaire

At the conclusion of the trial all participants completed a trial exit questionnaire assessing the performance of the cut-out versus no cut-out mandibles. Group A participants completed a questionnaire comparing helmet conditions 8 and 8A. Group B participants completed a questionnaire comparing helmet conditions 9 and 9A.

In the vast majority of the criteria the cut-out (8A and 9A) conditions outperformed the non cut-out conditions (8 and 9). In only a few areas (overall stability, overall physical comfort) did a non cut-out-condition outperform the associated cut-out conditions. Results from the questionnaire comparing helmet conditions 8 and 9 to helmet conditions 8A and 9A are shown in Table 18. The majority of the ratings were found to unacceptable with condition 9A achieving the highest ratings for the majority of the criteria.

Table 18: Cut Out Exit Questionnaire Results - All

	Group A		Group B	
Criteria - mean (SD)	8 (1-6)	8A (1-6)	9 (7-12)	9A (7-12)
Rotating (standing)	2.0 (1.3)	2.8 (1.8)	4.7 (2.9)	4.8 (1.9)
Head tipped to side (standing)	2.7 (1.6)	3.2 (1.5)	4.2 (2.1)	4.8 (1.9)
Head tipped forward (standing)	1.7 (0.8)	2.5 (1.4)	4.3 (2.1)	4.5 (2.3)
Rotating (seated)	1.7 (0.8)	2.7 (1.4)	3.8 (2.3)	4.3 (2.3)
Head tipped to side (seated)	2.2 (1.2)	3.2 (1.3)	3.7 (2.2)	4.2 (2.5)
Head tipped forward (seated)	1.8 (1.0)	2.5 (1.9)	3.7 (2.0)	4.2 (2.3)
Ability to adopt normal firing position	1.5 (0.8)	2.8 (1.7)	2.5 (1.5)	4.0 (0.9)
Getting a proper sight picture	1.2 (0.4)	2.5 (1.4)	2.2 (1.2)	3.2 (1.7)
Stock Weld Compatibility	1.3 (0.8)	2.5 (1.6)	2.0 (0.7)	4.0 (1.6)
Gun Fighter Pivot drills	1.3 (0.5)	2.5 (1.4)	2.2 (1.0)	4.2 (1.5)
M72 Compatibility	1.3 (0.8)	2.2 (1.5)	1.8 (0.8)	3.0 (1.9)
C6 Compatibility	1.3 (0.5)	2.8 (1.7)	2.2 (1.2)	4.2 (1.2)
C9A2 Compatibility	1.5 (0.8)	3.0 (2.0)	2.2 (1.2)	4.2 (1.2)
Sighting Carl Gustav 84 mm SRAAW	1.3 (0.8)	2.2 (1.5)	2.2 (1.2)	3.8 (1.2)
Looking down	3.5 (2.17)	4.2 (1.7)	4.3 (2.0)	5.2 (1.6)
Looking to sides	3.0 (1.6)	3.8 (1.2)	4.2 (2.3)	4.3 (1.8)
Awareness of Target	2.5 (1.6)	3.5 (1.8)	3.8 (1.9)	4.5 (1.6)
CG 634 Helmet	2.8 (1.7)	3.7 (1.47)	4.7 (1.9)	4.8 (1.5)
Nape protectors	3.2 (1.8)	3.8 (1.2)	5.2 (1.7)	5.2 (1.5)
TV with Gen III Fragmentation vest	2.8 (1.57)	3.2 (1.2)	4.8 (1.7)	4.7 (1.6)
Ballistic Eyewear	4.2 (2.1)	4.3 (1.9)	5.3 (2.0)	5.2 (1.8)
Compatibility with TCCS	1.0 (0.0)	1.8 (1.6)	2.0 (2.4)	2.0 (2.0)
Compatibility with PRR	2.0 (1.6)	3.0 (1.9)	2.0 (1.1)	2.7 (1.5)
Compatibility with Microphone	1.2 (0.4)	1.8 (1.3)	2.5 (1.8)	2.7 (2.1)
Mounted LAV tasks	1.5 (0.8)	2.5 (1.4)	1.8 (1.3)	3.0 (1.8)
Dismounted combat tasks	1.5 (0.6)	2.7 (1.5)	2.8 (2.2)	3.2 (1.7)
Ease of Assembly	4.3 (1.6)	4.3 (1.6)	3.7 (1.4)	3.7 (1.4)
Overall Protection	4.7 (2.6)	4.5 (1.8)	3.7 (1.85)	3.7 (1.6)
Overall Range of Motion	1.5 (0.6)	2.3 (1.0)	3.5 (1.4)	4.0 (1.3)
Overall Retention	2.5 (1.6)	3.2 (1.3)	3.0 (2.1)	3.0 (2.1)
Overall Stability	4.0 (2.2)	3.8 (2.4)	3.0 (1.7)	2.8 (1.3)
Overall Weapon Compatibility	1.2 (0.4)	2.5 (1.9)	2.2 (2.0)	3.2 (1.2)
Overall Field of View	3.0 (1.8)	3.0 (1.2)	3.2 (1.2)	3.8 (1.2)
Overall Equipment Compatibility	2.2 (0.8)	2.7 (0.8)	3.3 (1.5)	3.8 (1.2)
Overall Task Compatibility	2.2 (0.8)	2.7 (1.0)	2.8 (1.9)	3.3 (1.5)
Overall Physical Comfort	3.2 (1.8)	3.0 (1.4)	3.3 (1.6)	3.7 (1.4)
Overall Thermal Comfort	2.3 (1.2)	2.8 (1.5)	2.3 (1.6)	3.2 (1.7)
OVERALL ACCEPTANCE	1.5 (0.8)	2.3 (1.5)	2.7 (1.4)	3.7 (1.4)

In general the cut-out conditions performed better than the continuous coverage conditions. The results indicate that mandible 9A may be the most promising candidate condition for further refinement.

4.8.3 Clips Questionnaire

During the course of the trial the participants completed a questionnaire assessing the AMMPHS and the latest SIHS mandible-helmet attachment systems. The ease of attaching and detaching the mandible was assessed both while wearing the helmet and when the helmet was off. As well the ease of attaching and detaching the mandible was assessed with gloves and bare handed.

In general the SIHS clip system out performed the AMMPHS attachment systems. A review of the results suggests that freedom from snagging may have been one of the major factors in the differences between the overall ratings of the attachment systems (participants rates the EVO substantially higher for this measure). However, when focusing on just the ease and speed of attachment and detachment the hinge only, and hinged and drop down systems were preferred over the ball joint and SIHS clip systems. The AMMPHS attachment systems were rated by the participants as being easier and quicker to detach when wearing gloves than the SIHS EVO clip. Results from the questionnaire comparing the four attachment systems are shown in Table 19. In terms of the criteria referencing ease and speed of attachment and detachment, all of the attachment systems had ratings that were between 'borderline' and 'completely acceptable'. For the remaining criteria the attachment systems were rated acceptable for the majority except for compatibility with the M72 and the communication headset where each of the attachment systems were rated as unacceptable, with the exception of the SIHS clip for compatibility with the M72.

Table 19: Clip Assessment Results

Criteria - mean (SD) (n=12)	Hinged and Drop Down	Hinge Only	Ball Joint	SIHS Clip
Ease of attachment – bare hands (helmet worn)	5.8 (1.2)	5.8 (1.3)	4.8 (1.8)	5.5 (1.1)
Speed of attachment – bare hands (helmet worn)	5.3 (1.2)	5.0 (1.7)	4.6 (1.5)	5.3 (1.1)
Ease of attachment – gloves (helmet worn)	5.1 (1.2)	4.8 (1.7)	4.3 (1.8)	4.9 (1.6)
Speed of attachment – gloves (helmet worn)	4.7 (1.6)	4.5 (1.5)	4.7 (1.5)	4.8 (1.5)
Ease of detachment – bare hands (helmet worn)	6.7 (0.6)	6.8 (0.4)	5.8 (1.4)	6.5 (0.7)
Speed of detachment – bare hands (helmet worn)	6.7 (0.6)	6.8 (0.4)	5.7 1.6)	6.5 (0.9)
Ease of detachment – gloves (helmet worn)	6.7 (0.5)	6.7 (0.5)	5.5 (1.6)	5.8 (1.9)
Speed of detachment – gloves (helmet worn)	6.7 (0.5)	6.7 (0.5)	5.3 (1.6)	5.7 (2.0)
Ease of attachment – bare hands (bare head)	6.6 (0.8)	6.5 (1.0)	5.6 (1.8)	6.3 (0.8)
Speed of attachment – bare hands (bare head)	6.4 (0.9)	6.3 (1.1)	5.5 (1.7)	6.2 (0.9)
Ease of attachment – gloves (bare head)	6.3 (1.1)	6.3 (1.2)	5.4 (1.9)	5.8 (1.1)
Speed of attachment – gloves (bare head)	6.3 (1.1)	6.3 (1.2)	5.8 (1.5)	5.7 (1.2)
Ease of detachment – bare hands (bare head)	6.8 (0.6)	6.8 (0.6)	5.8 (1.7)	6.6 (0.7)
Speed of detachment – bare hands (bare head)	6.8 (0.6)	6.8 (0.6)	5.7 (1.7)	6.5 (0.8)
Ease of detachment – gloves (bare head)	6.7 (0.9)	6.7 (0.9)	5.7 (1.8)	6.1 (1.2)
Speed of detachment – gloves (bare head)	6.7 (0.9)	6.7 (0.9)	5.9 (1.4)	6.0 (1.2)
Protection from snagging	5.3 (1.3)	5.2 (1.2)	4.7 (1.1)	6.2 (0.8)
Bulk	4.4 (1.4)	5.1 (1.0)	4.7 (1.2)	5.7 (1.2)
Robustness	5.2 (1.3)	5.3 (1.0)	3.4 (1.3)	4.5 (2.5)
Stability	4.8 (1.6)	5.1 (1.5)	3.4 (1.4	5.8 (1.5)
Inadvertent release	5.9 (1.0)	5.7 (1.4)	2.0 (0.7)	5.1 (1.9)
Ease of cleaning	4.3 (1.6)	4.5 (1.8)	4.0 (1.8)	4.8 (1.6)
CG634 Helmet	5.7 (1.0)	5.7 (1.0)	4.8 (1.5)	6.4 (0.4)
CG634 Helmet retention system	4.7 (1.6)	4.7 (1.6)	5.1 (1.1)	6.0 (1.2)
Helmet camouflage cover	4.7 (1.4)	4.8 (1.54)	4.6 (1.4)	5.5 (1.3)
Mandibles	4.5 (1.6)	4.5 (1.6)	4.5 (1.4)	5.2 (1.8)
Nape protector	5.2 (1.7)	5.1 (1.8)	5.2 (1.7)	5.3 (1.4)
C7A1/A2	4.9 (1.9)	4.9 (1.8)	4.8 (1.9)	5.0 (1.8)
C9A1	4.7 (1.9)	4.8 (1.8)	4.5 (1.8)	5.0 (1.8)
C6	4.7 (1.8)	4.8 (1.8)	4.6 (1.8)	5.3 (1.6)
Carl Gustav SHRAAW	4.3 (2.2)	4.4 (2.1)	4.3 (2.2)	4.7 (2.1)
M72	3.7 (2.2)	3.8 (2.1)	3.7 (2.2)	4.2 (2.2)
Communication headsets	2.8 (2.0)	2.8 (2.0)	3.0 (2.0)	3.4 (2.1)
Ballistic eyewear	6.3 (1.0)	6.3 (0.9)	6.3 (0.9)	5.7 (1.7)
Physical Comfort	6.2 (0.8)	6.0 (1.0)	6.0 (1.0)	6.4 (0.6)
Rotating head	6.1 (0.9)	6.1 (0.9)	6.0 (0.9)	6.2 (0.6)
Head tipped to side (ear touching shoulder)	5.7 (1.2)	5.7 (1.2)	5.7 (1.2)	6.1 (0.7)
Mounted LAV tasks	5.5 (1.4)	5.5 (1.4)	5.3 (1.4)	6.1 (0.7)
Dismounted combat tasks	5.5 (1.7)	5.5 (1.7)	5.3 (1.9)	5.9 (0.9)
Overall Acceptance	5.1 (1.3)	5.0 (1.5)	3.8 (1.5)	5.5 (1.1)

A repeated measures ANOVA was conducted on the overall acceptance criteria to identify any statistically significant differences between helmet attachment systems. A statistically significant difference was found ($F(3,33)=5.611$, $MS=5.903$ $p=0.003$) where the hinged and drop attachment, hinge only attachment, SIHS clip were significantly more acceptable than the ball joint attachment system (which was rated just below 'borderline').

The ball joint systems were reported by the participants as less acceptable than the hinge systems. The ability of the ball and socket mandible to freely rotate caused a number of issues when attempting to secure the mandible rapidly (system flipped upside down). Participants were also not supportive of rotating the mandible to the side; rather they wanted the mandible to rotate up out of the way similar to the Clothe-the-Soldier (CTS) visor Helmet Attachment Kit (HAK). In addition to rotating up so that the face and eyes were clear, they also identified the need for the ability to rotate the visor down by several degrees to gain access to the mouth.

Participants identified the need for guides to help properly align the mandible hinge into its receptor slots. The participants reported that the current HAK system required the user to "play around" when attaching the visor. The participants believed that too much time was required to attach the visor, especially in emergency situations.

Participants also identified the need to redesign the release button for the visor. Issues with the size of the release latch when using gloves were raised.

4.9 Focus Group Discussion

At the end of the trial the soldiers participated in a brief focus group discussion. In addition to discussions on the different types of visors assessed (coverage differences and efficacy of cut-outs) the participants also commented on the AMMPHS visor and associated nape guard.

When asked about their preference for protection, the majority of participants chose a mandible with medium levels of protection. Mandibles 8 and 9 with the highest levels of protection received less support than mandible 10, 11 and 12. Interestingly the participants reported that mandible 10, 11 and 12 were more compatible with the PRR and TCCCS headsets than the other mandible. Participants were not supportive of wearing a visor that provided only a little protection – "if you only have one inch protection then you might as well not have anything". Concerns were raised in that the mandible designs only protected the chin of the user and not underneath the neck.

During discussions on the efficacy of the cut-out designs, all but one participant rated the cut-out designs as being superior to their non-cut-out counterpart. Participants did acknowledge that the non-cut out designs provided more coverage but that cut-outs were better for rifle aiming tasks. Only one subject identified that they would rather have more protection than better C7 compatibility. Although 10 participants reported that the cut-out designs were superior for tactical shooting tasks than the non-cut out designs, the mandible were still not suitable for field employment. The participants believed that the fixed shape of the mandible cut-out design did not account for the variety of face and chin shapes.

Although the participants identified compatibility of the AMMPHS prototypes as a concern, the biggest issue with the designs was compatibility with TCCCS and PRR headsets. The ear-cups of the headsets clashed with the the geometry of the mandible as it extends to the edge of the helmet. The participants identified that future mandible development efforts should center on improving headset compatibility.

Although the participants reported that none of the AMMPHS prototypes were currently ready for fielding, the cut-out designs with a hinge attachment system were the most promising solutions. They recommended that AMMPHS development efforts should be focussed on the cut-out design options with the aim of improving C7 compatibility, headset compatibility and improvements to the attachment system. As well the participants noted that efforts should be made to maximize mandible compatibility for the different sized heads, chins, etc. found in a medium helmet.

A short discussion on the new prototype visor was also held. Participants noted that new visor had excellent compatibility with weapons; the visor did not clash while using the C7. Issues with the new visor were raised during discussions on mounted tasks. The participants noted that the visor had noticeable air gaps between the top of the visor and the helmet; they preferred a system without a gap. Although the participants recommended the use of a rubber gasket to seal the visor to the helmet, issues with ventilation, fogging and heat build up were mentioned. Participants with operational experience noted that dust may be an issue, and mentioned the possibility of sealing off the eyes. The participants believed that the system would be problematic in both dusty & sandy environments as well as cold environments. Participants believed that the AMMPHS visor was superior in design to the CTS visor.

Participants were also supportive of the AMMPHS armadillo style nape protector. The system provided good protection and did not limit head movement, even in the prone position. Issues with the nape protector were noted however when using the rucksack. The rucksack straps sometimes trapped the nape protector restricting head movement. One improvement suggested by the participants was the ability to curve the nape protector closer to the helmet (rather than flared out). The Scientific Authority for AMMPHS demonstrated to the participants that this functionality was already available to them by simply bending the nape support framework wires. This issue hi-lights the importance of refresher training on all protective systems in future evaluations.

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5. Discussion

The aim of this trial was to assess the acceptability of a number of different mandible protection systems that attach to the current in-service helmet on soldier mobility, survivability, and lethality through a series of tasks. AMMPHS mandible prototypes were evaluated concurrently during a SIHS helmet and mandible evaluation. Due to the presence of other trials (Integrated Soldier System (ISSP) and Modular Fighting Rig (MFR) trials) only 12 soldiers participated in the AMMPHS/SIHS evaluation. A full repeated measures evaluation of the AMMPHS prototypes was not possible given the presence of over 18 AMMPHS/SIHS helmet and mandible systems available for evaluation in the limited time available. In an effort to maximize feedback a split-block design was utilized for the AMMPHS helmet conditions. The participants were divided into to two groups and each evaluated a subset of the eight AMMPHS helmet designs plus the base-line in-service CG634 helmet. As a result the numbers of participants evaluating any one AMMPHS condition was limited; therefore caution is advised when interpreting the results.

As compared to the in-service CG634 helmet, the AMMPHS mandibles did limit head movement forward. In general, the different AMMPHS maxillo-facial protector designs limited forward cervical range of motion by 7 degrees on average. As expected, the mandibles did not obstruct participants from rotating their heads back. The AMMPHS mandibles also limited lateral head movement to the right and left. Although the cut-out designs (8A and 9A) would appear to allow for greater head movement to the right side over their full protection counter parts (8 and 9), the lower edge profiles of the mandible were the same and thus the cut-out designs had no greater ROM to the right. Excluding the cut-out designs, the mandible limited head movement to the right by approximately 4.5 degrees. Although objective reductions in the ranges of motion with the AMMPHS prototypes were measured, participant feedback after the obstacle course and dynamic vehicle tasks did not identify significant concerns. Participants appeared able to accommodate the minor reductions in ranges of motion. It should be noted however that the mobility results of the static stand and dynamic stands were not reflected in the exit questionnaire; range of motion was generally acceptable during the dynamic task assessments but unacceptable in the exit questionnaire.

The AMMPHS mandibles limited vision directly down and obliquely to the left side when compared to the baseline in-service CG634 helmet, by an average of 40.56 cm (min=23.2 cm, max=48.5 cm). Cut-outs improved vision to the lower right quadrant. Although objective reductions in the field of view with the AMMPHS prototypes were measured, participant feedback after the obstacle course and dynamic vehicle tasks also did not identify significant concerns. Participants appeared able to accommodate the minor reductions in field of view.

Compatibility issues were identified in the C7, M72 and headset static compatibility stands. The AMMPHS mandibles were not viewed as being completely compatible with the C7 rifle, even those with a cut-out. Issues with the C7 in the standing position were a particular concern. Except for isolated cases (ballistic eyewear with conditions 8 and 13, rucksack with conditions 9, 9A, 12, and 13), all of the AMMPHS prototypes performed less acceptably than the in-service helmet condition. Significant issues were also observed with the compatibility of the AMMPHS prototypes with the TCCCS headset and with the M72. Even though mandible 12 was designed to try to specifically address the TCCCS vehicle headset, soldier acceptance was still poor. This is just one example of many results in this trial that highlight the need for accurate 3D models of the head form covering the full range of head shapes and sizes in the wearer population to support head

borne equipment design. In this case, one such model was used but it appears that the specific head form used modelled was not appropriate for any of the 12 participants in this study. A slight change in shape or size of the head and in positioning of the equipment can lead to a clash. The result is not a progressive degradation in compatibility but rather a binary "it works or it doesn't".

An analysis of the 1997 anthropometric survey (Chamberland et al, 1997) for personnel who would fit in a medium helmet (head circumference (550-590mm, head length (170-205mm and head breath 130-160mm) identified the following head /chin shape variability within the survey population: Menton – Sellion (100-137mm – see Figure 27; Bizygomatic breadth (119-153 mm) – see Figure 28; and Bitragion chin arc (276-361 mm) – see Figure 28.

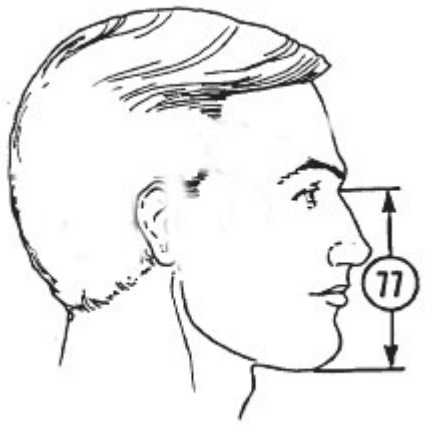

Figure 27: Head dimensions (menton-sellion)

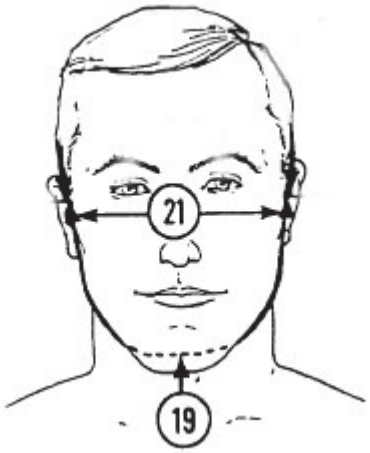

Figure 28: Head dimensions (bizygomatic breadth (21) and bitragion chin arc (19))

Given the variability in head shapes for a given size of helmet, it appears necessary to utilize multiple head forms that highlight population extremes for unique design dimensions.

Interestingly, the AMMPHS conditions were all rated as being acceptable for static compatibility with crew positions in the LAV III vehicle. While minor cases of vision and physical clash interference were noted, the participants believed performance was still acceptable. This may be surprising given the various conditions in the vehicle whose use is dependent on range of motion and close compatibility with the face (e.g. the sights). Previous trials however have hi-lighted the fact that during static compatibility assessments subjects typically view any clash as unacceptable and thus rate the performance of the system against a bare-headed condition. Conversely in dynamic tests subjects assess the degree of clash against their ability to perform the assigned task and thus minor issues of clash that can be overcome are often perceived not as severe as they previously were in the simple static tests.

Although issues with TCCCS headset were noted in the static and dynamic assessments, the general degree of acceptance for mandible compatibility in other areas improved in the dynamic vehicle assessments. It appears that although participants noted clash in the static stands, they were

able to overcome the compatibility issues in the dynamic tests. Issues identified in the obstacle course dynamic task focused on perceptions that the mandible caused thermal comfort and stability problems. Given the small sample size and variation in user response caution is strongly advised in drawing any conclusions outside of headset compatibility issues from this task stand.

Although the subjective static and dynamic acceptance ratings for mandibles compatibility with C7 were mixed, the objective live fire results did not demonstrate any discernable drop in shooting performance. Although static and live fire task subjective results indicated compatibility issues with the mandibles and the C7 rifle, they were not observed to the same extent in the dynamic vehicle task results. In the dynamic vehicle tasks it appeared as if the soldiers could accommodate, for the most part, the limited amount of helmet clash experienced. When the objective results of the live fire task are examined, no significant difference in performance was observed. Soldiers could shoot as accurately (and in the majority of cases better) with a mandible as without. Given the limitations of this trial, further testing (capturing shooting error and time to hit data) should be conducted to confirm these preliminary results.

While it is acknowledged that there was clash between the AMMPHS mandible condition and the C7 firing task, the degree of interference may be less than subjectively perceived by many. Whether it was a case that soldiers were poor shots to begin with; the fact they knew there was clash and thus had to focus on getting a good sight picture; took more time to shoot since they were not accustomed to the mandibles; or the fact that they had to merely move the mandible slightly, the rationale why the objective results were contrary to some of the subjective results is not known. Although participants did state that they could not achieve an adequate cheek weld with a number of the conditions, the objective results did not support this argument. The relative poor shooting performance may also be attributed to the inexperience of some of the participants. A number of the soldiers were fresh from Battle School and thus theoretically may be weaker shooters. The performance of the participants with the mandible conditions could improve with more practice as the use of a mandible requires soldiers to alter their natural shooting style, head position, etc. It is possible that more live fire training exposure with the mandible conditions may improve objective performance, i.e. the soldiers will learn to accommodate. Although objective results were obtained in the run-down tests, objective data was unfortunately not captured in the tactical shooting test. Given the emphasis of speed of engagements and accuracy, the tactical shooting tests may have been a better objective test of the impact of mandible class on shooting performance.

In the exit questionnaire the ratings for the different AMMPHS mandible conditions were lower than the in-service baseline condition. Given that the in-service condition does not provide protection, these results were not unexpected. What was unexpected was the drop in acceptability as compared to the task questionnaire results. AMMPHS conditions 9A and 11 outperformed the other AMMPHS mandible conditions receiving respectively a barely unacceptable (3.3) to borderline acceptance rating (3.7) in the final exit questionnaire assessment. Caution is advised when it is observed that participants are noticeably raising or lower ratings in the exit questionnaire as compared to daily task questionnaires. The exit questionnaire ratings in this trial were lower than the equivalent ratings that were compiled during the trial (e.g. overall weapon compatibility vs. live fire (tactical shooting and run downs). This has been witnessed in other evaluations when participants exhibited bias in trying to eliminate some systems from contention or select a definitive winner. Given the discrepancy, the reliability of the exit questionnaire results in this development project are questionable. It should be noted however, that in formal bid evaluations, the final exit questionnaire is usually the basis for bid acceptance. In this instance participants are asked to summarize the performance of the item in question and task questionnaires are used post-

hoc to help identify differences in system performance. The lower scores may also be due to the fact that in the final exit questionnaire participants have had a chance to calibrate their acceptance ratings of the conditions.

In an effort to compare protection approaches, i.e. soft versus rigid, the AMMPHS mandibles were compared to the SIHS mandibles in the final exit questionnaire. The participants believed that the rigid mandible designs were superior to the soft SIHS mandible designs. Issues with security, field of view and comfort were noted with the CS and SL SIHS designs.

Although not the focus of this trial, the participants were supportive of the new AMMPHS double curved visor which was based on the SIHS short visor design. The new design was form fitting and did not cause any clash issues with the in-service helmet. Issues with air leakage between the visor and helmet should be investigated to improve performance in sandy and dusty environments while also addressing fogging which will likely be exacerbated by sealing the visor to the helmet rim.

Despite misgivings about wearing any protective mandible, the participant's believed that a cut-out design with a hinge attachment system was the one system recommended for further refinement. They recommended that AMMPHS development efforts should be focussed on the cut-out mandible 9A design option with the aim of improving C7 compatibility, headset compatibility and attachment system. As well, the participants noted that efforts should be made to maximize mandible compatibility for the different sized heads, chins, etc. found in a medium helmet.

6. Recommendations

The results of this trial suggest that some of the perceived compatibility issues with the prototype mandibles may not have been as serious as initially believed; many participants successfully overcame clash issues in dynamic situations. Given the potential benefit in providing improved user protection, mandible development efforts should be continued.

The results of this preliminary trial suggest that mandible design 9A with a cut-out to improve compatibility with the C7 rifle and other small arms is the most promising way forward for the AMMPHS mandible program. Development efforts should also be focussed on improving TCCCS and PRR headset compatibility issues.

It is also recommended that a hinged mandible attachment design with the ability to rotate the mandible up out of the way should be pursued. The mandible attachment system should be designed to allow the mandible to be lowered to a limited degree as well.

Participants were very supportive of the new AMMPHS visor and nape protector designs. Optically correct visors should be produced for further evaluations.

The participants expressed concern with their ability to differentiate between all the different mandible designs. Future mandible assessments should limit the number of designs so that participants can properly differentiate between the different designs. Issues with the number of AMMPHS mandibles available, number of subjects available and the time available limited this trial to a split-block design. Efforts should be made so that a full repeated measures and balanced experimental design approach is possible. The low sample size in this trial limited interpretation of the results. A power analysis of the cut-out exit questionnaire identified the need for a minimum of 22 participants (Mu0=2.7, Mu=3.7, Sigma=1.37, Alpha=.05, power goal=.90) if condition 9 was compared to 9A. It is recommended that a future trial be undertaken with 24 participants to ensure proper power and results interpretation. Focusing on fewer options should allow increased numbers of each concept to be produced to support the trial.

Future trials should also be structured to reduce learning effects and to improve participant knowledge of how the different mandible designs affect shooting, mobility, etc. Participants should be given increased time on task with the mandible conditions to accommodate unique design effects. A dedicated trial to investigate the influence of adaptation and learning on the acceptability (rated and measured objectively) of a new item with the same complexity of interaction with the soldier system, physiology, and usability would be worthwhile.

Although compatibility issues with C7 rifles were noted in this trial, objective shooting performance did not support participant subjective concerns. Further live fire and or simulator testing should be under taken to confirm that soldiers could “work through” any compatibility issues. In addition to recording soldier accuracy performance in run down tasks, soldier performance in tactical shooting tasks should be recorded. If possible shot timing data should be captured to identify any delays in engagement caused by the soldiers having to adjust for mandible clash.

The results of this trial highlighted the importance of dynamic task assessment. Although static clash assessments identified instances of clash, the ability of the soldiers to cope with clash was only discovered in the dynamic vehicle tasks. The participants reported that the dynamic vehicle task involving a mounted patrol and dismounted attack was one of the better tools for assessing

mandible performance. The use of blank rounds as opposed to WES or simunition type systems made it difficult for participants to effectively judge the effects of different mandible conditions on their performance. Future assessments should focus on mounted vehicle tasks and if possible mounted target engagements.

The AMMPHS mandibles are designed to be compatible with eCG634 in0-service helmet and the new AMMPHS helmet. The AMMPHS helmet system includes a new suspension liner. A draft plan to evaluate an improved mandible design with the two potential helmet systems is included in Annex B.

7. References

1. Chamberland, A., Carrier, R., Forest, F., and Hachez, G. (1997). Anthropometric Survey of the Land Forces, Defence R&D Canada Technical Report, DCIEM Report No. 98-CR-15.
2. Tack, D., McKee, K., Kelly, A. and Nakaza, E. (2010). SIHS TDP: Final Functional Phase Summary Report, SIHS Technology Demonstration Project, Defence R&D Canada Technical Report, DRDC 2010-XXXX (*in press*)

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Annex A: Questionnaires

The following questionnaires were utilized in this trial:

- Subject Information
- Dynamic vehicle
- Obstacle course
- Live Fire
- Attachment system exit
- Cut-out mandible exit
- Coverage exit
    - (2 questionnaires)

Appendix 1: Subject Information

Veuillez fournir l'information demandée dans les espaces prévus à cette fin:

Nom	Numéro Matricule	GPM

Genre	Âge	Grade	Régiment	Section / Peloton / Compagnie	Unité
$ Homme $ Femme					

Anthropométrie:					
Poids	livres	Taille	pi/po	Grandeur du Casque	Pet ○ Moy ○ Grd ○

Oeil de Tir		Êtes-vous droitier ou gaucher	
$ Gauche	$ Droite	$ Gauche	$ Droite

Sur une échelle de 1 à 10, fournissez S.V.P. une estimation de votre capacité / l'expérience à utiliser des dispositifs de la massagerie tels que PDA, telephones intelligents, Blackberry, etc.
Note:_____

Sur une échelle de 1 à 10, fournissez S.V.P. une estimation de votre capacité à parler / écrire en anglais et en français. (1 = seulement français; 10 = parfaitement bilinque)	
Parler:_____	Écrit:_____

Durée de service (Régulière et Réserve)	
Années dans la Force régulière:	Années dans la Force de réserve:

Expérience opérationnelle (par théâtre) & Durée (en mois) (eg. Afghanistan 12 mois)

Veste pare-éclats
Avez-vous l'expérience avec les vestes pare-éclats? ○ Oui ○ Non Si oui, répondez svp à ce qui suit : Combien de fois avez-vous porté une veste anti-fragmentation? ○ 1-5 exercices d'entraînement ○ 6-10 exercices d'entraînement ○ > 10 exercices d'entraînement

Nombre de mois depuis le dernier Test d'Armes Personnel												
<1	2	3	4	5	6	7	8	9	10	11	12	>12
$	$	$	$	$	$	$	$	$	$	$	$	$

Vision
Portez-vous des lunettes ou verres de contact? O Oui, lunettes O Oui, verres de contact O Non
Ouïe
Subissez-vous une perte de l'audition? O Oui O Non --- Si oui, décrivez svp vos symptômes
Souffrez-vous d'acouphène dans l'une ou les deux orreille(s) ? O Oui, Oreille gauche O Oui, Oreille droit O Oui, Les deux oreilles O Non
Indiquez le ou les modèle(s) de veste(s) tactique(s) que vous utilisez presentement:

TAV, Chest Rig, etc.	TAV, Chest Rig, etc.	TAV, Chest Rig, etc.

Appendix 2: Dynamic Vehicle Questionnaire

DONNEÉS PERSONNELLES Écrivez clairement votre nom, numéro du sujet et gendre de protection dans l'espace fourni.

NUMÉRO DE SUJET : _____ **Date / Heure:** _____

Casque: **CG 634** O **ALPHA** O **ECHO 1** O **ECHO 2** O

SIHS protège menton: **S1**O **S2**O **S3**O **S4**O **S5**O **S6**O **S7**O **S8**O

AMMPHS protège menton: **8**O **8a**O **9**O **9a**O **10**O **11**O **12**O **13**O

AMMPHS protège nuque: **1 morceau** O **2 morceaux** O

DIRECTIONS:

- En employer l'échelle ci-dessus fournissez un taux d'acceptation de la manoeuvrabilité, facilité à tirer et de movement, compatibilité, confort, stabilité, réglage, et approbation global de les gendre de protection dans la performance générale d'entraînement de peloton.

COMMENTAIRES:

Tâches Montées

Manoeuvrabilité	☹ 1 2 3 4 5 6 7 ☺
Vitesse de mouvement	$ $ $ $ $ $ $
Agilité	$ $ $ $ $ $ $
Flexibilté	$ $ $ $ $ $ $
Manoeuvrabilié d'ensemble	$ $ $ $ $ $ $
Concordance de Véhicule	☹ 1 2 3 4 5 6 7 ☺
Monter/Sortir en condition normale	$ $ $ $ $ $ $
Monter/Sortir en condition d'urgence	$ $ $ $ $ $ $
Mouvement à l'intérieur	$ $ $ $ $ $ $
Rangement (stowage)	$ $ $ $ $ $ $
Volume (trop grand?)	$ $ $ $ $ $ $
S'accrocher à l'équipement (snagging)	$ $ $ $ $ $ $
Capacité de completer toutes les tâches assignees	$ $ $ $ $ $ $
Concordance générale du véhicule	$ $ $ $ $ $ $
Concordance d'equipment	☹ 1 2 3 4 5 6 7 ☺
Veste tactique	$ $ $ $ $ $ $
Casque	$ $ $ $ $ $ $
Vest pare-éclats Gen III	$ $ $ $ $ $ $
PRR	$ $ $ $ $ $ $

Combat Montées	☹ 1 2 3 4 5 6 7 ☺
Balayage / Couverture des arcs de tir	$ $ $ $ $ $ $
Tirer l'arme personnelle	$ $ $ $ $ $ $
Changement de chargeurs, boites de munition de la C6 et C9	$ $ $ $ $ $ $
Tirer M72s et 40mms/ lancer de grenade	$ $ $ $ $ $ $
Engagement des cibles en utilisant l'arme montée sur le véhicule (pintle mount)	$ $ $ $ $ $ $
Engagement des cibles en utilisant l'arme du véhicule	$ $ $ $ $ $ $
Combat démonter	$ $ $ $ $ $ $
Concordance globale en condition monter	$ $ $ $ $ $ $
Vision	☹ 1 2 3 4 5 6 7 ☺
• Champ de vision inférieure	$ $ $ $ $ $ $
• Champ de vision périphérique	$ $ $ $ $ $ $
Confort	☹ 1 2 3 4 5 6 7 ☺
Volume (trop grand?)	$ $ $ $ $ $ $
Poids sur la tête	$ $ $ $ $ $ $
Irritation de la peau	$ $ $ $ $ $ $
Confort physique globale	$ $ $ $ $ $ $
Confort thermique globale	$ $ $ $ $ $ $
	$ $ $ $ $ $ $

AN/PRC 521 (radio légère de combat)	$ $ $ $ $ $ $		$ $ $ $ $ $ $
Casque d'écoute dans les véhicules	$ $ $ $ $ $ $	**Stabilité**	☹ ☺ ☺ 1 2 3 4 5 6 7
Protège nuque	$ $ $ $ $ $ $	Stabilié du casque	$ $ $ $ $ $ $
Gants	$ $ $ $ $ $ $	Stabilité de la mandibule	$ $ $ $ $ $ $
L'armes	$ $ $ $ $ $ $	**Stabilité globale**	$ $ $ $ $ $ $
S'accrocher à l'équipement (snagging)	$ $ $ $ $ $ $		$ $ $ $ $ $ $
Concordance globale	$ $ $ $ $ $ $		$ $ $ $ $ $ $
Performance d'ensemble	$ $ $ $ $ $ $	**Pertinence globale pour l'usage en campagne**	$ $ $ $ $ $ $

Appendix 3 : Obstacle Course Questionnaire

NUMÉRO DE SUJET : _____ Date / Heure: _____

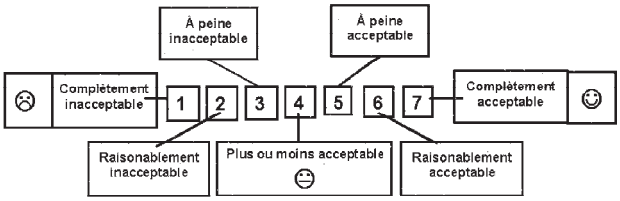
Casque: **CG 634** O **ALPHA Hybrid**O **ECHO 1** O **ECHO 2** O

SIHS Protège Menton: **S1**O **S2**O **S3**O **S4**O **S5**O **S6**O **S7**O **S8**O

AMMPHS Protège Menton: **8** O **8a** O **9** O **9a** O **10** O **11** O **12** O **13** O

AMMPHS Protège Nuque **1 Morceau** O **2 Morceaux** O

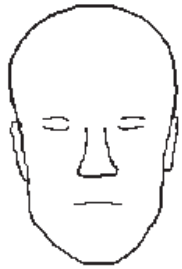
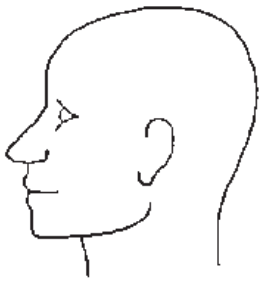
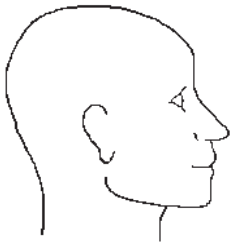
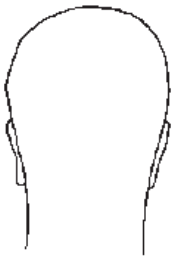
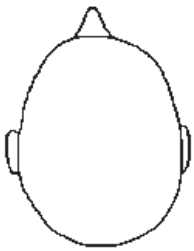
Veuillez évaluer l'acceptabilité des caractéristiques suivantes du casque en utilisant l'échelle à sept points ci-contre.



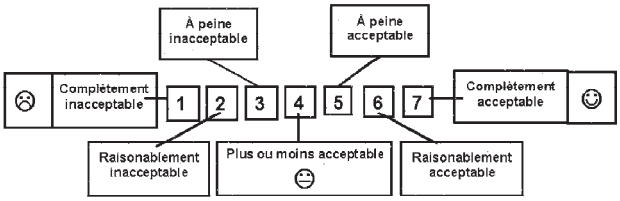
CONFORT THERMIQUE DU CASQUE	1 2 3 4 5 6 7
Ventilation	O O O O O O O
Points chaud	O O O O O O O
Gestion de la sueur	O O O O O O O
L'accumulation de la chaleur	O O O O O O O
Utilisation en temps froid (-10°C to -30°C)	O O O O O O O
Utilisation en temps fraîche (0°C to -10°C)	O O O O O O O
Utilisation en temps chaud (20°C to 30°C)	O O O O O O O
Utilisation en temps trés chaud (> 30°C)	O O O O O O O
Utilisation en conditions poussiéreuses	O O O O O O O
Évaluation globale du confort thermique	**O O O O O O O**

VENTILATION ACTIVE DU CASQUE *Répondez aux quatre (4) questions suivantes au sujet des casques "Echo 1" ou "Echo 2".*	☹ ☺ ☺ **1 2 3 4 5 6 7**
Efficacité du ventilateur	O O O O O O O
Niveau de bruit du ventilateur	O O O O O O O
Facilité d'utilisation du ventilateur	O O O O O O O
Évaluation globale de la ventilation active	**O O O O O O O**
VENTILATION PASSIVE DU CASQUE *Répondez aux trois (3) questions suivantes au sujet du casque "*Alpha*" seulement.*	☹ ☺ ☺ **1 2 3 4 5 6 7**
Efficacité des trous/canaus d'aération	O O O O O O O
Niveau de bruit des trous/canaus d'aération	O O O O O O O
Évaluation globale de la ventilation passive	**O O O O O O O**

En utilisant les différentes positions de la tête indiquées ci-dessous, notez les endroits inconfortables (confort thermique). Indiquez le niveau d'inconfort en utilisant l'échelle de droite.	Neutre 1	Chaleur légère 2	Chaleur notable 3	Chaud 4	Très chaud 5

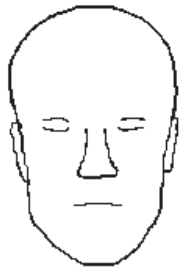
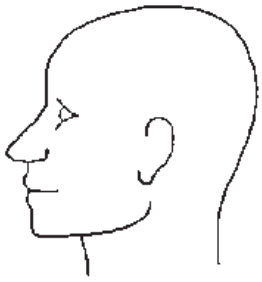
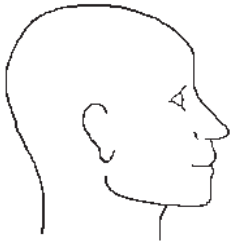
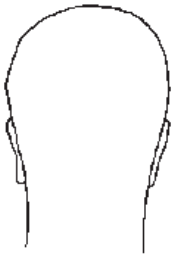
Face	Côté gauche	Côté droit
		
Dos	**Haut**	**Commentaires**
		

Veuillez évaluer l'acceptabilité des caractéristiqu suivantes du casque en utilisant l'échelle à sept p ci-contre.



	☹ 1	2	3	😐 4	5	6	☺ 7
CHAMP DE VISION							
Drois devant	O	O	O	O	O	O	O
De gauche à droite	O	O	O	O	O	O	O
Vers le haut	O	O	O	O	O	O	O
Vers le bas	O	O	O	O	O	O	O
Évaluation globale pour champ de vision	**O**	**O**	**O**	**O**	**O**	**O**	**O**
STABILITY DU CASQUE	☹ 1	2	3	😐 4	5	6	☺ 7
Stabilité du casque – penché gauche/droit	O	O	O	O	O	O	O
Stabilité du casque – penché par en avant/par en arrière	O	O	O	O	O	O	O
Stabilité du casque rotation de la tête gauche/droit	O	O	O	O	O	O	O
Sécurité des composantes supplémentaires	O	O	O	O	O	O	O
Évaluation globale pour de la stabilité	**O**	**O**	**O**	**O**	**O**	**O**	**O**
CONFORT PHYSIQUE	☹ 1	2	3	😐 4	5	6	☺ 7
Inconfort des points de pression	O	O	O	O	O	O	O
Poids sur la tête	O	O	O	O	O	O	O
Irritation de la peau	O	O	O	O	O	O	O
Évaluation globale du confort physique	**O**	**O**	**O**	**O**	**O**	**O**	**O**

En utilisant les différentes positions de la tête indiquées ci-dessous, notez les endroits inconfortables (confort physique). Indiquez le niveau d'inconfort en utilisant l'échelle de droite.	Neutre 1	Léger inconfort 2	Inconfort notable 3	Douleur 4	Douleur extrême 5

Face	Côté gauche	Côté droit
		
Dos	**Haut**	**Commentaires**
		

Commentaires additionnels

Appendix 4 : Live Fire Questionnaire

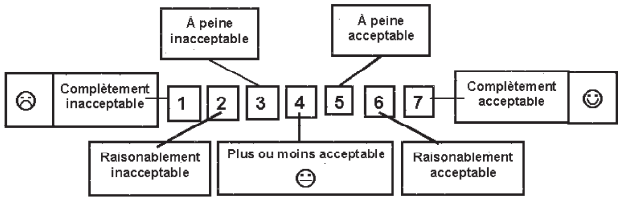
NUMÉRO DE SUJET : _____ **Date / Heure:** _____ **Tâche** _____

Casque (Baseline): **CG 634** O

SIHS Mandibule: CL O CS O SL O SS O

AMMPHS Mandibule: 8 O 8a O 9 O 9a O 10 O 11 O 12 O 13 O

Veuillez évaluer la condition du Casque ou de la mandibule selon les critères suivants en utilisant l'échelle à sept points ci-dessous.



Évaluez le niveau d'acceptabilité pendant le tir réel:	1	2	3	4	5	6	7	
En adoptant la position de tir couchée	O	O	O	O	O	O	O	'
En adoptant la position de tir à genoux	O	O	O	O	O	O	O	'
En adoptant la position de tir debout	O	O	O	O	O	O	O	'
En courant	O	O	O	O	O	O	O	'
En regardant à travers le télescope (Sighting)	O	O	O	O	O	O	O	'
Compatibilité avec le stock de fusil	O	O	O	O	O	O	O	'
Stabilité de l'arme	O	O	O	O	O	O	O	'
Tir	O	O	O	O	O	O	O	'
Manipulation pour charger / décharger	O	O	O	O	O	O	O	'
Accès aux chargeurs / Boitiers de la C9	O	O	O	O	O	O	O	'
Mesures correctives d'enrayages (clearing Stoppages) si applicable	O	O	O	O	O	O	O	'
Facilité des mouvements	O	O	O	O	O	O	O	'
Vitesse des mouvements	O	O	O	O	O	O	O	'
Performance générale des tâches	O	O	O	O	O	O	O	'

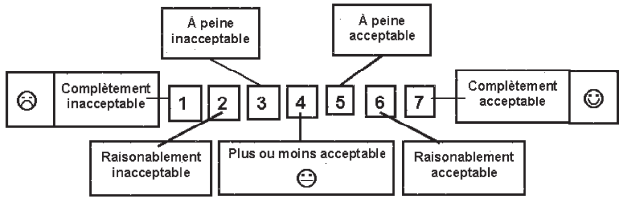
Compatibilité avec l'équipement	☹ 1 2 3 4 5 6 7 ☺	**N/A**	**Confort**	☹ 1 2 3 4 5 6 7 ☺	**N/A**
Casque	$ $ $ $ $ $ $	'	Ajustement	$ $ $ $ $ $ $	'
Arme	$ $ $ $ $ $ $	'	Poids	$ $ $ $ $ $ $	'
Vêtements	$ $ $ $ $ $ $	'	Volume	$ $ $ $ $ $ $	'
Gants	$ $ $ $ $ $ $	'	Irritation	$ $ $ $ $ $ $	'
Compatibilité générale avec l'équipement	$ $ $ $ $ $	'	Raideur	$ $ $ $ $	'

	$			$ $	
Stabilité des attaches de casque	$ $ $ $ $ $ $	'		$ $ $ $ $ $ $	'
Stabilité générale	$ $ $ $ $ $ $	'	**Confort physique général**	$ $ $ $ $ $ $	'
COMPATIBILITÉ GÉNÉRALE LORS DU TIR	$ $ $ $ $ $ $	'	**Confort thermique général**	$ $ $ $ $ $ $	'

Appendix 5 : Attachment System Exit Questionnaire

Numéro de sujet# : _____ **Date / Heure:** _____

Utilisant le barème prévu, indiquent l'acceptabilité des fonctionnalités suivantes pour les quatre (4) systèmes de fixation



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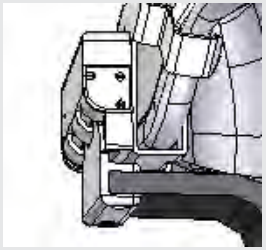
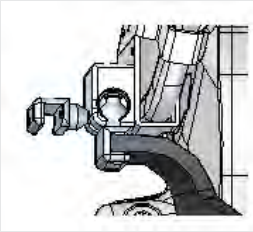
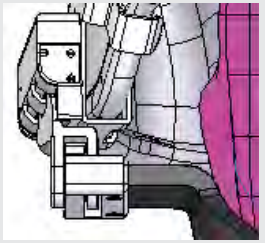
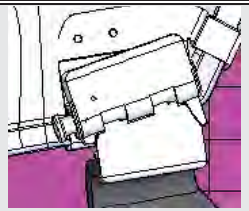
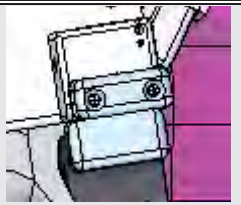
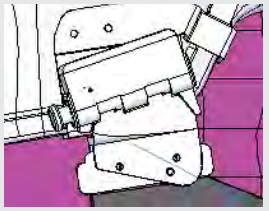
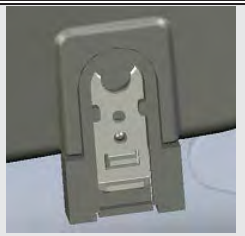
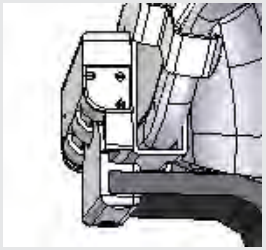
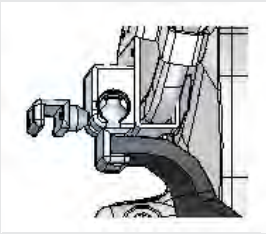
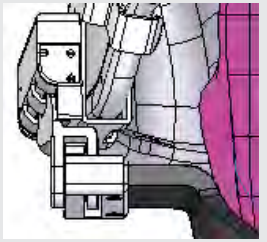
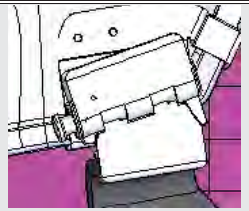
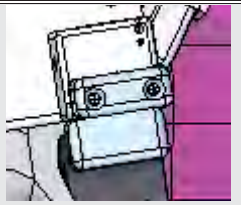
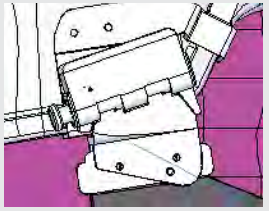
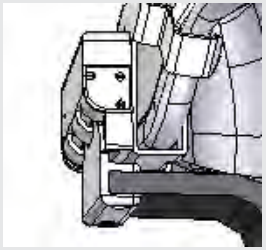
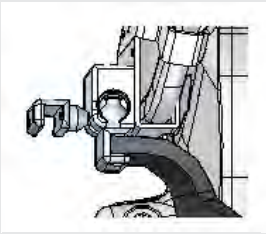
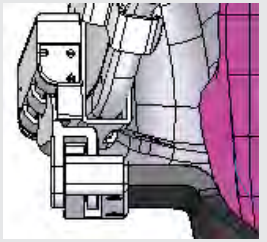
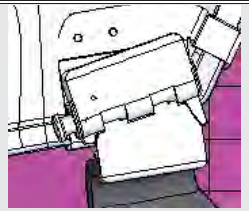
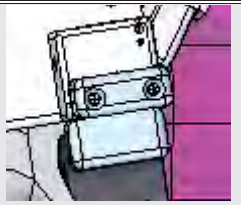
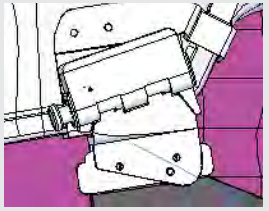
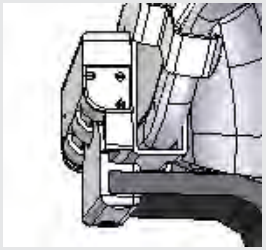
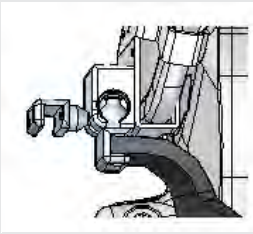
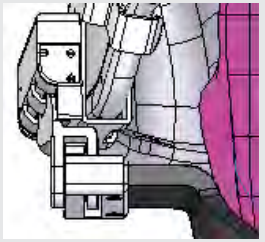
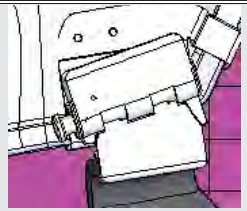
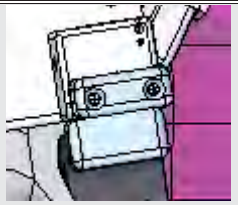
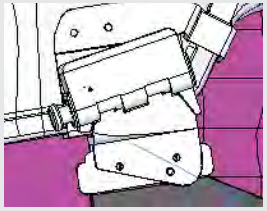
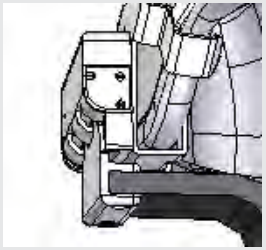
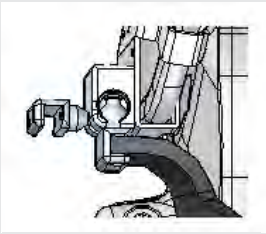
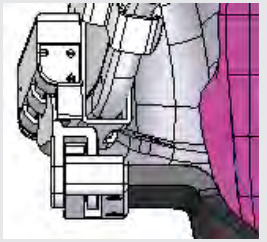
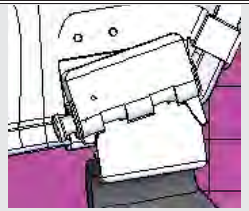
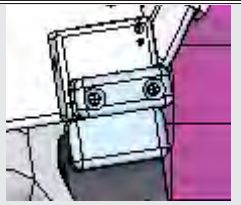
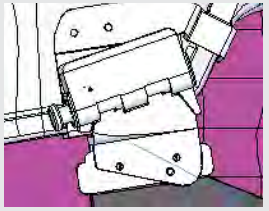
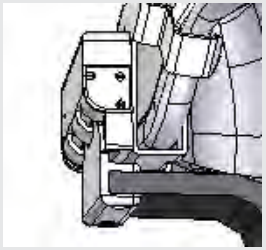
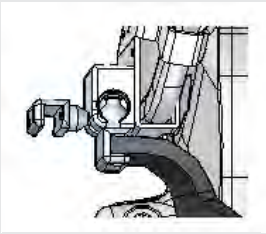
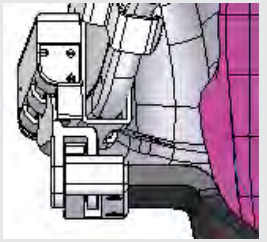
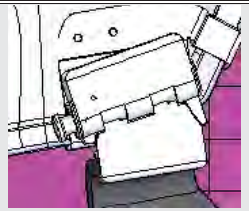
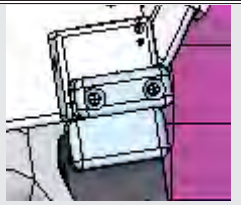
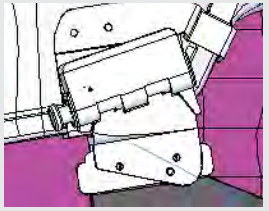
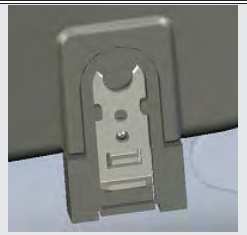
				
				

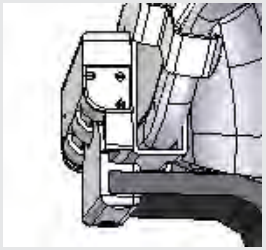
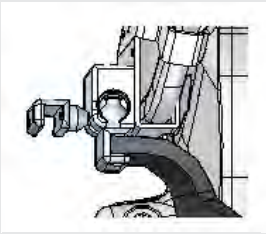
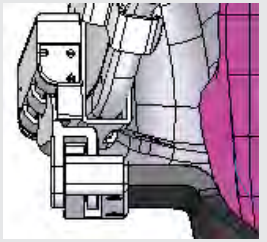
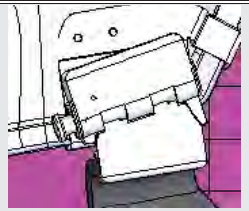
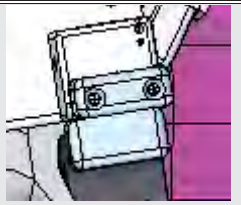
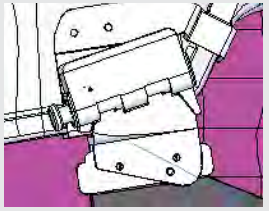
	Penture seulement`	Rotule`	Penture et pivot`	Evo Clip
				
				
Protège menton – **CASQUE PORTÉS**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**
Facilité d'attachment – mains nues	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Vitesse d'attachment – mains nues	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Facilité d'attachment – gants	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Vitesse d'attachment – gants	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Protège menton – **CASQUE PORTÉS**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**
Facilité de détachement – mains nues	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

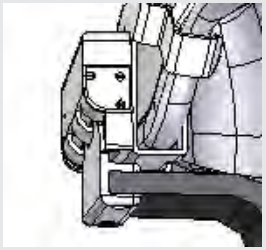
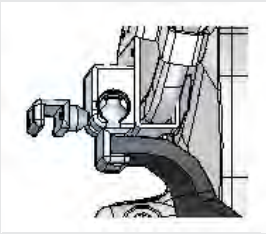
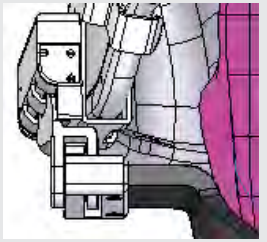
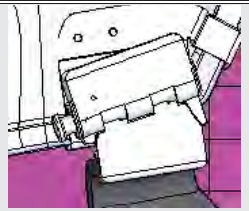
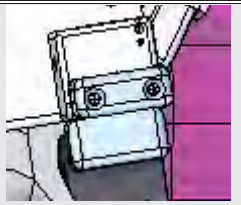
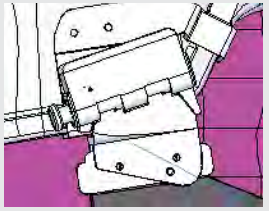
	Penture seulement`	Rotule`	Penture et pivot`	Evo Clip
				
				
Vitesse de détachement – mains nues	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Facilité de détachement – gants	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Vitesse de détachement – gants	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Protège menton **– NUS TÊTE**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**
Facilité d'attachment – mains nues	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Vitesse d'attachment – mains nues	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Facilité d'attachment – gants	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Vitesse d'attachment – gants	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

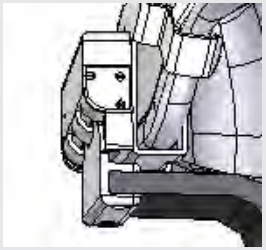
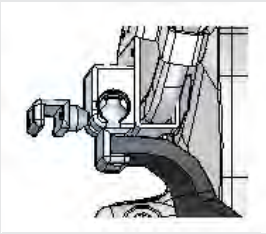
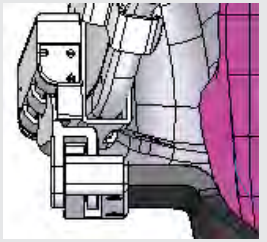
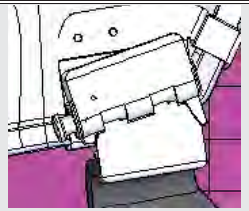
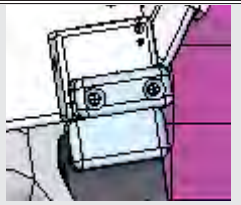
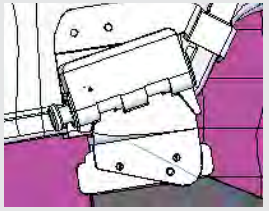
	Penture seulement`	Rotule`	Penture et pivot`	Evo Clip
				
				
Protège menton – **NUS TÊTE**	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7
Facilité de détachement – mains nues	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Vitesse de détachement – mains nues	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Facilité de détachement – gants	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Vitesse de détachement – gants	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
CONCEPTION	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7
S'accroche à l'équipement (snagging)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

	Penture seulement`	Rotule`	Penture et pivot`	Evo Clip
				
				
Volume (trop grand?)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Robustesse	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Stabilité	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Détache trop facilement	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Facilité de nettoyage	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
COMPATIBILITÉ AVEC	☹ ☺ 1 2 3 4 5 6 7	☹ ☺ 1 2 3 4 5 6 7	☹ ☺ 1 2 3 4 5 6 7	☹ ☺ 1 2 3 4 5 6 7
Casque CG634	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Système de retention du casque	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

	Penture seulement`	Rotule`	Penture et pivot`	Evo Clip
				
				
Casque camouflage	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Protège Menton	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Protecteur du nuque	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
C7A1/A2	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
C9A1	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
C6	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Carl Gustav SHRAAW (H)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
ERYX	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

	Penture seulement`	Rotule`	Penture et pivot`	Evo Clip
				
				
M72	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Casque d'écoute dans les véhicules	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Lunettes ballistique	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Masque a Gaz C4	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
CONFORT	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**
Physique	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

	Penture seulement`	Rotule`	Penture et pivot`	Evo Clip
				
				
ÉTENDUE DE MOUVEMENT	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7
Rotation de la tête	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Tête de droit à gauche (flexion latérale)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
COMPATIBILITÉ AVEC LES TACHÊ	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7
Facilité d'effectuer les tâches d'infanterie motorisée	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Facilité d'effectuer les tâches d'infanterie à pied	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

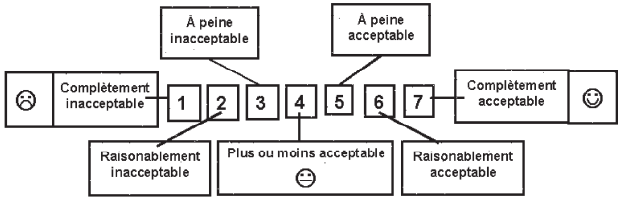
	Penture seulement`	Rotule`	Penture et pivot`	Evo Clip
				
				
ÉVALUATION GLOBAL DU SYSTÈME	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7
ÉVALUATION GLOBAL DU SYSTÈME	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

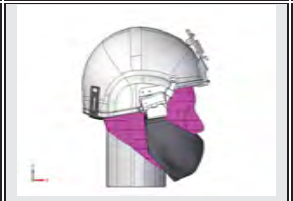
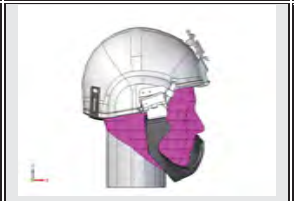
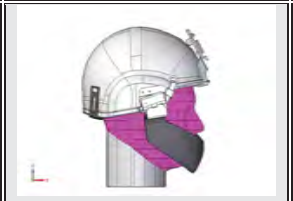
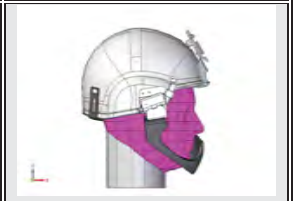
Commentaires additionelles

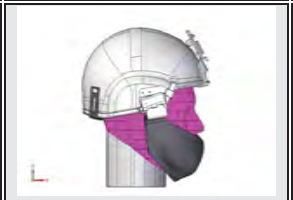
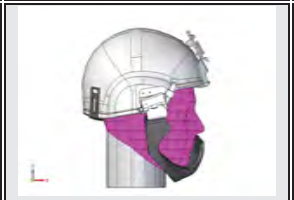
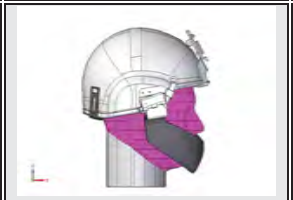
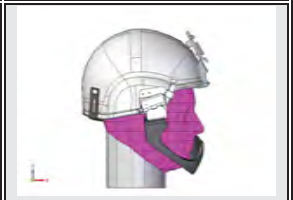
Appendix 6 : Cut-out Mandible Exit Questionnaire

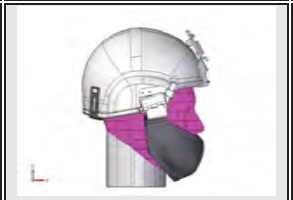
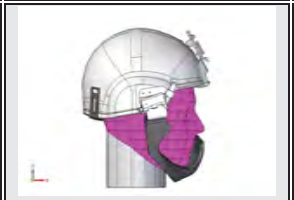
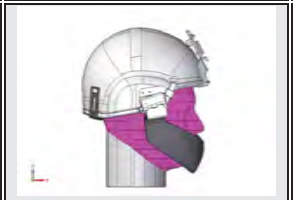
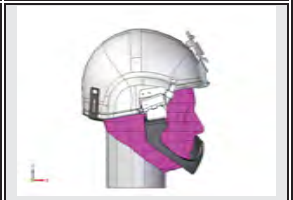
NUMÉRO DE SUJET : _____ **Date / Heure: _____**

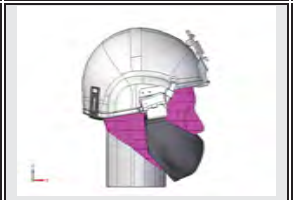
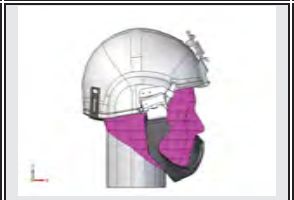
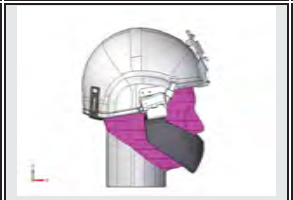
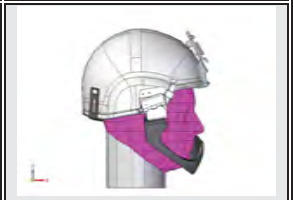
Veuillez évaluer les condition du protège–menton selon les critères suivants en utilisant l'échelle à sept points ci-contre.

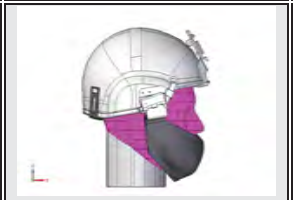
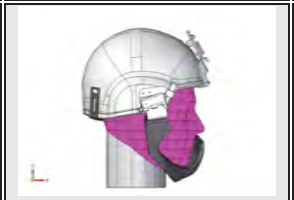
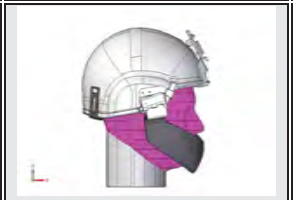
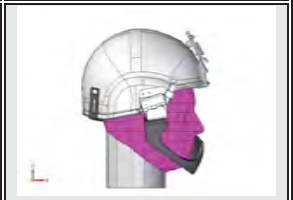


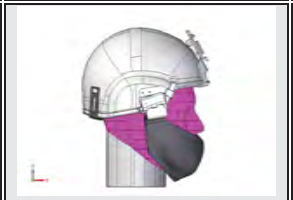
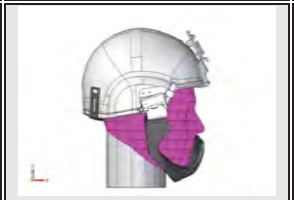
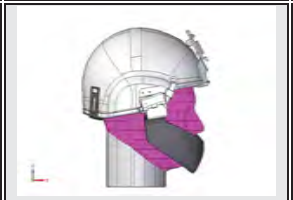
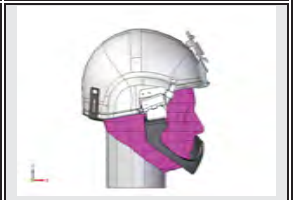
	Protège Menton #8	Protège Menton #8A	Protège Menton #9	Protège Menton #9A
				
				
ÉTENDUE DE MOUVEMENT (STANDING)	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7
Rotation de la tête	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

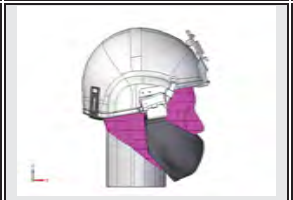
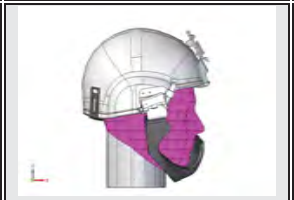
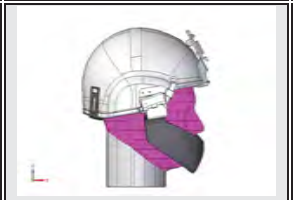
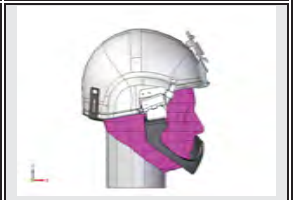
	Protège Menton #8	Protège Menton #8A	Protège Menton #9	Protège Menton #9A
				
				
Tête de côté (flexion latérale)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Tête en avant (flexion)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
ÉTENDUE DE MOUVEMENT (SEATED)	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**
Rotation de la tête	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Tête de côté (flexion latérale)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
ÉTENDUE DE MOUVEMENT (SEATED)	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**
Tête en avant (flexion)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

	Protège Menton #8	Protège Menton #8A	Protège Menton #9	Protège Menton #9A
				
				
COMPATIBILITÉ AVEC L'ARMES	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**
En adoptant la position de tir (normale)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
En regardant à travers le télescope (Sighting)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Compatibilité avec le stock de fusil	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Facilité pour tirer et facilité de mouvement (Gun Fighter Pivot drills)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Compatibilité avec le M72	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Compatibilité avec le C6	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

	Protège Menton #8	Protège Menton #8A	Protège Menton #9	Protège Menton #9A
				
				
Compatibilité avec le C9A2	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Compatibilité avec le Carl Gustaf 84 mm SRAAW	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
CHAMPS DE VISION	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**
Drois devant	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
De gauche à droite	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
CHAMPS DE VISION	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**
Conscience des cibles	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

	Protège Menton #8	Protège Menton #8A	Protège Menton #9	Protège Menton #9A
				
				
COMPATIBILITÉ AVEC L'ÉQUIPEMENT	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**
Casque CG 634	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Protecteur de la nuque	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Vest pare-éclats Gen III	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Lunettes de protection ballistique	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Casque d'écoute dans les véhicules	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Casque d'écoute de PRR	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Microphone	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

	Protège Menton #8	Protège Menton #8A	Protège Menton #9	Protège Menton #9A
				
				
COMPATIBILITÉ AVEC LES TACHÊ	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7
Facilité d'effectuer les tâches de l'infanterie motorisée	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Facilité d'effectuer les tâches de l'infanterie à pied	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
ÉVALUATION GÉNÉRALE	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7
Facilité d'assemblage	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Acceptabilité de la protection	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Étendue de mouvement du cou	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

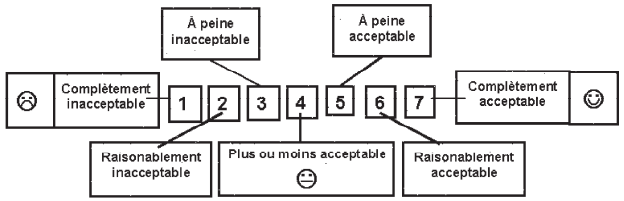
	Protège Menton #8	Protège Menton #8A	Protège Menton #9	Protège Menton #9A
				
				
Rétention	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Stabilité	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Compatibilité avec l'armes	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Champs de vision	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Compatibilité avec l'equipments	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Compatibilité avec les tâches	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Confort physique	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Confort thermique	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Évaluation globale du système	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

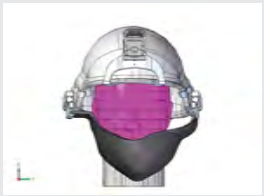
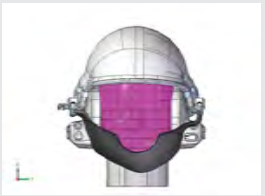
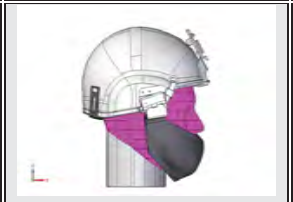
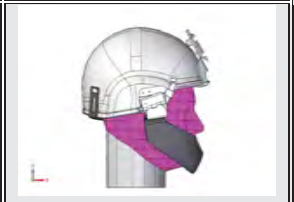
Commentaires

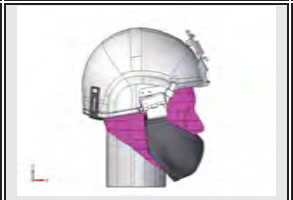
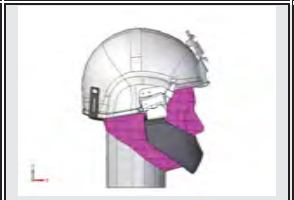
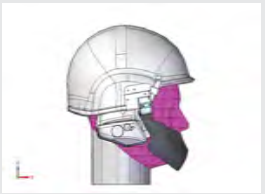
Appendix 7 : Coverage Exit Questionnaires

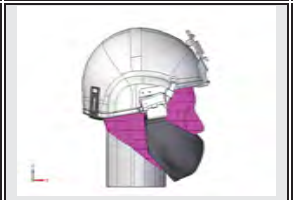
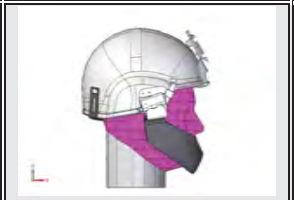
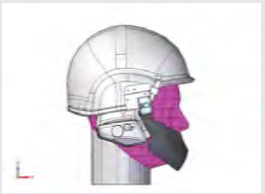
NUMÉRO DE SUJET # : _____ Date / Heure: _____

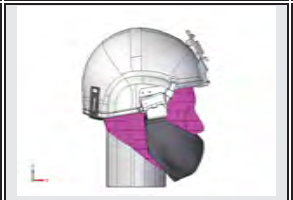
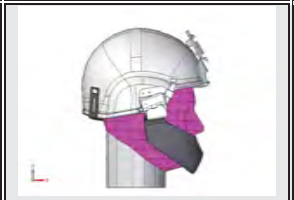
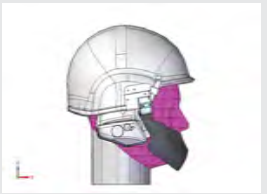
Veuillez évaluer les condition du protège–menton selon les critères *suivants en utilisant l'échelle à sept points ci-contre*.

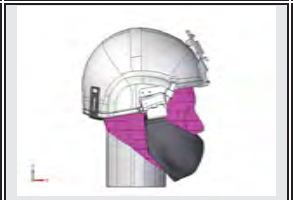
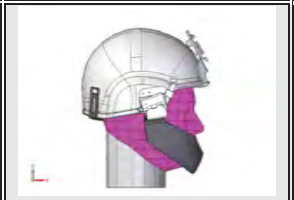
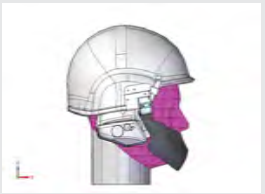


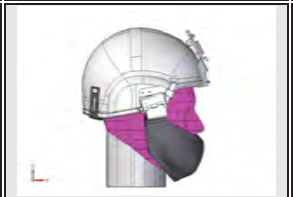
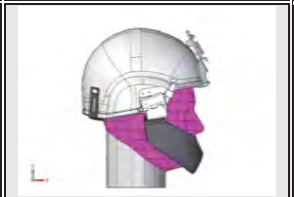
	Protège Menton #8	Protège Menton #10	Protège Menton #12	Protège Menton #CS
				
				
ÉTENDUE DE MOUVEMENT (DEBOUT)	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7
Rotation de la tête	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Tête de côté (flexion latérale)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

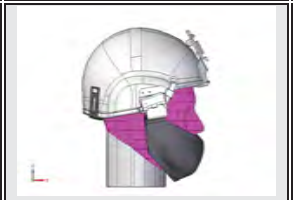
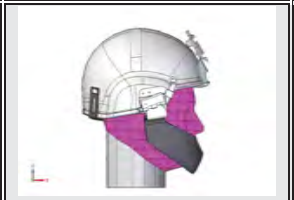
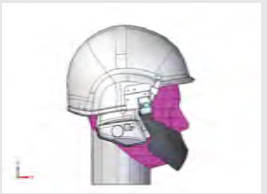
	Protège Menton #8	Protège Menton #10	Protège Menton #12	Protège Menton #CS
				
				
Tête en avant (flexion)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
ÉTENDUE DE MOUVEMENT (ASSIS)	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**
Rotation de la tête	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Tête de côté (flexion latérale)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
ÉTENDUE DE MOUVEMENT (ASSIS)	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**
Tête en avant (flexion)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

	Protège Menton #8	Protège Menton #10	Protège Menton #12	Protège Menton #CS
				
				
COMPATIBILITÉ AVEC L'ARMES	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7
En adoptant la position de tir (normale)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
En regardant à travers le télescope (Sighting)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Compatibilité avec le stock de fusil	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Facilité pour tirer et facilité de mouvement (Gun Fighter Pivot drills)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Compatibilité avec le M72	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Compatibilité avec le C6	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Compatibilité avec le C9A2	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

	Protège Menton #8	Protège Menton #10	Protège Menton #12	Protège Menton #CS
				
				
En regardant à travers le télescope (Sighting) Carl Gustaf 84 mm SRAAW	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
CHAMPS DE VISION	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**
Drois devant	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
De gauche à droite	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
CHAMPS DE VISION	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**
Accès aux chargeurs	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

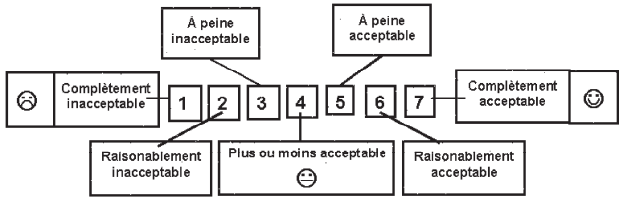
	Protège Menton #8	Protège Menton #10	Protège Menton #12	Protège Menton #CS
				
				
COMPATIBILITÉ AVEC L'ÉQUIPEMENT	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7
Casque CG 634	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Protecteur de la nuque	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Vest pare-éclats Gen III	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Lunettes de protection ballistique	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Casque d'écoute dans les véhicules	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Casque d'écoute de PRR	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Microphone	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

	Protège Menton #8	Protège Menton #10	Protège Menton #12	Protège Menton #CS
				
				
COMPATIBILITÉ AVEC LES TACHÊ	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7
Facilité d'effectuer les tâches de l'infanterie motorisée	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Facilité d'effectuer les tâches de l'infanterie à pied	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
ÉVALUATION GÉNÉRALE	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7
Forme	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Acceptabilité de la protection	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Gamme de mouvement	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

	Protège Menton #8	Protège Menton #10	Protège Menton #12	Protège Menton #CS
				
				
Facilité de mise en place/enlèvement (casque)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Stabilité	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Compatibilité avec l'armes	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Champs de vision	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Compatibilité avec l'equipments	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Compatibilité avec les tâches	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Confort physique	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Confort thermique	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Évaluation Globale du système	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

NUMÉRO DE SUJET # : _____ **Date / Heure:** _____

Veuillez évaluer les condition du protège–menton selon les critères *suivants en utilisant l'échelle à sept points ci-contre.*



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		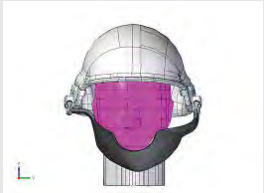	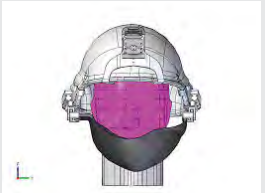	
	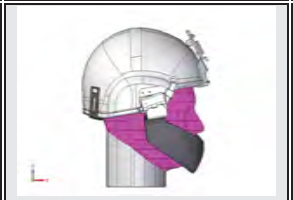	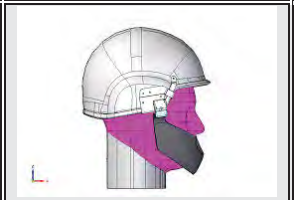	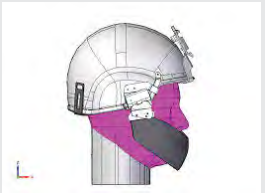	
ÉTENDUE DE MOUVEMENT (DEBOUT)	☹ 1 2 3 4 5 6 7 ☺	☹ 1 2 3 4 5 6 7 ☺	☹ 1 2 3 4 5 6 7 ☺	☹ 1 2 3 4 5 6 7 ☺
Rotation de la tête	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Tête de côté (flexion latérale)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Tête en avant (flexion)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

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		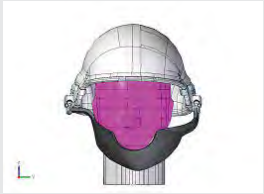	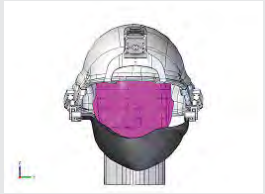	
	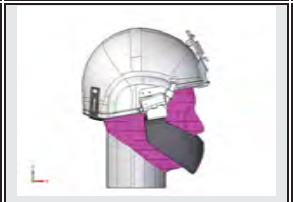	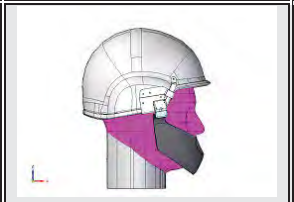	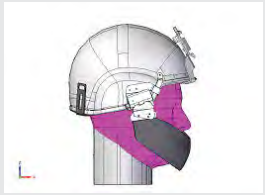	
ÉTENDUE DE MOUVEMENT (ASSIS)	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7
Rotation de la tête	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Tête de côté (flexion latérale)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
ÉTENDUE DE MOUVEMENT (ASSIS)	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7
Tête en avant (flexion)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
COMPATIBILITÉ AVEC L'ARMES	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7	☹ 1 2 3 ☺ 4 5 6 7
En adoptant la position de tir (normale)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
En regardant à travers le télescope (Sighting)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

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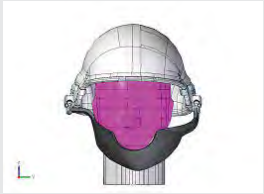
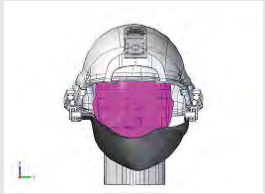
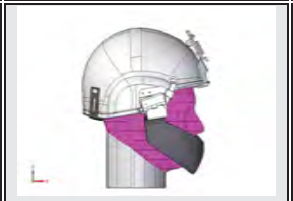
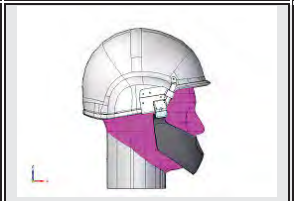
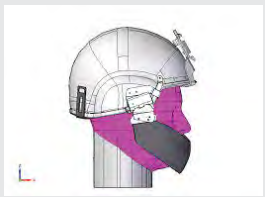
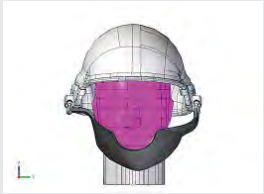
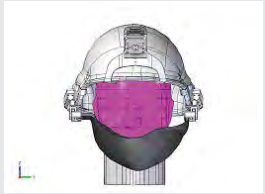
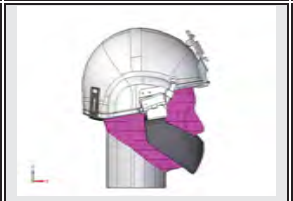
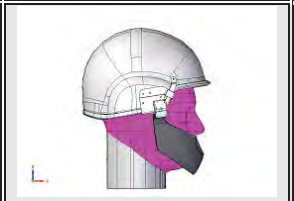
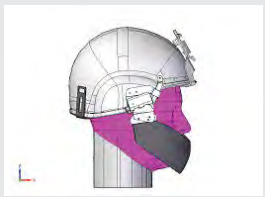
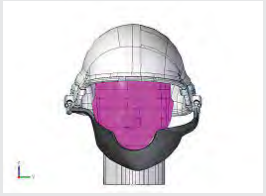
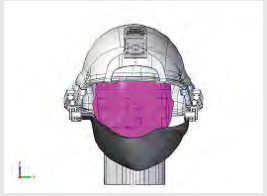
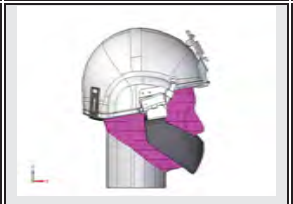
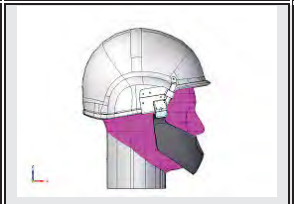
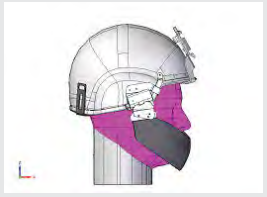
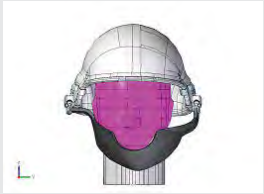
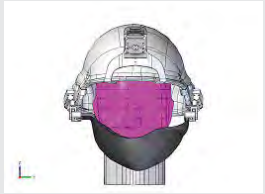
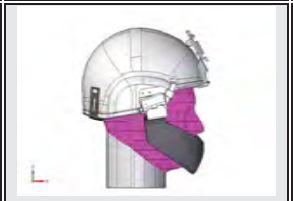
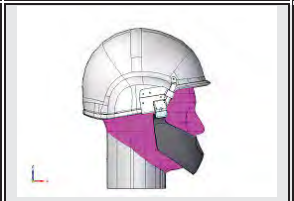
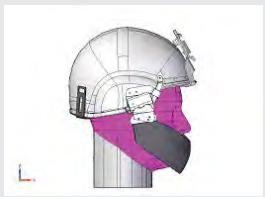
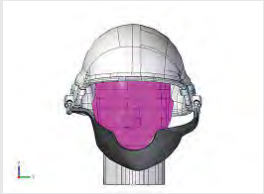
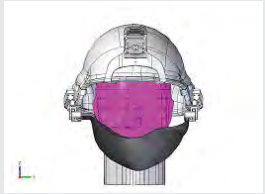
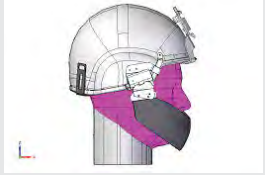
				
				
Compatibilité avec le stock de fusil	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Facilité pour tirer et facilité de mouvement (Gun Fighter Pivot drills)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Compatibilité avec le M72	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Compatibilité avec le C6	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Compatibilité avec le C9A2	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
En regardant à travers le télescope (Sighting) Carl Gustaf 84 mm SRAAW	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
CHAMPS DE VISION	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**
Drois devant	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

	Protège Menton #9	Protège Menton #11	Protège Menton #13	Protège Menton #SL
				
				
De gauche à droite	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
CHAMPS DE VISION	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7
Accès aux chargeurs	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
COMPATIBILITÉ AVEC L'ÉQUIPEMENT	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7	☹ 😐 ☺ 1 2 3 4 5 6 7
Casque CG 634	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Protecteur de la nuque	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Vest pare-éclats Gen III	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Lunettes de protection ballistique	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

	Protège Menton #9	Protège Menton #11	Protège Menton #13	Protège Menton #SL
				
				
Casque d'écoute dans les véhicules	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Casque d'écoute de PRR	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Microphone	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
COMPATIBILITÉ AVEC LES TACHÊ	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**
Facilité d'effectuer les tâches de l'infanterie motorisée	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Facilité d'effectuer les tâches de l'infanterie à pied	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
ÉVALUATION GÉNÉRALE	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**	☹ 😐 ☺ **1 2 3 4 5 6 7**
Forme	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

	Protège Menton #9	Protège Menton #11	Protège Menton #13	Protège Menton #SL
				
				
Acceptabilité de la protection	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Gamme de mouvement	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Facilité de mise en place/enlèvement (casque)	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Stabilité	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Compatibilité avec l'armes	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Champs de vision	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Compatibilité avec l'equipments	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Compatibilité avec les tâches	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Confort physique	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O
Confort thermique	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

	Protège Menton #9	Protège Menton #11	Protège Menton #13	Protège Menton #SL
				
				
Évaluation Globale du système	O O O O O O O	O O O O O O O	O O O O O O O	O O O O O O O

Commentaires

Annex B: Future Trial Plan

AMMPHS Trial Plan

Third User Trial in the Evaluation of Advanced Modular Multi-threat Headwear System

By:

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On behalf of
DEPARTMENT OF NATIONAL DEFENCE

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March 2010

Table of Contents

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Figures

Tables

1 Background

The Advanced Modular Multi-threat Headwear System (AMMPHS) Technology Demonstrator (TD) project was initiated by Defence Research and Development Canada (DRDC) to explore protective solutions to increase soldier survivability against emerging threats, in particular Improvised Explosive Devices (IEDs). The AMMPHS project builds on the work completed under the Solider Integrated Headwear System (SIHS) TD by supporting a much more in-depth investigation of protection system design, material selection, manufacturability, and performance assessment than was possible under SIHS. The project is exploring both upgrades to the in-service combat helmet to increase coverage as well as a new modular helmet design featuring a split impact/ballistic shell, mandible guard, visor, and nape protector. The designs for the various components are inspired by the SIHS add-on and Alpha helmet concepts as well as the ballistic, blast, and impact studies performed in support of the SIHS conceptual design. Lessons learned through user studies and helmet integration work performed by SIHS (e.g. integrated sensors, sensor selection, displays, augmented hearing) are also being used to drive the geometry of the protective components although protective performance is prioritised in the AMMPHS concepts.

In conjunction with a SIHS trial, prototype AMMPHS mandible systems were assessed on a number of static and dynamic stands. The 10 day fit and prototype evaluation trial was conducted at Canadian Forces Bases (CFB) Valcartier from September 28 to October 9, 2009. Although 26 participants passed through the range of motion and field of view test stands, a subset of 12 soldiers were screened to participate in the SIHS and AMMPHS trials (the remaining 14 participants took part in another concurrent experiment). Personnel were required to undertake a battery of human factors tests while wearing the current in-service helmet (CG634) or one of the new helmets with a prototype mandible in a blocked repeated measures design. During each test, the order of conditions was only partially balanced due to the lack of available resources and mandible prototypes. Human factors tests included assessments of fit, comfort, range of motion, field of view, performance of select battle tasks, and equipment, vehicle and clothing compatibility. Data collection included anthropometric measurements, range of motion measurements, field of view measurements, questionnaires, focus groups, live fire performance measures, and Human Factors (HF) observer assessments.

Universally, the ratings for the different AMMPHS mandible conditions were lower than the in-service baseline condition. While the in-service CG634 was rated reasonably to completely acceptable across nearly all evaluation criteria, the AMMPHS conditions were rated completely unacceptable to borderline in acceptance. AMMPHS conditions 9A and 11 outperformed the other AMMPHS mandible conditions receiving an exit acceptance rating of barely unacceptable to borderline. Clinical tests with the AMMPHS mandibles identified reductions in head movement forward and lateral head movement to the right and left. Although objective reductions in the ranges of motion with the AMMPHS prototypes were measured, participant feedback after the obstacle course and dynamic vehicle tasks did not identify significant concerns. Participants appeared able to accommodate the minor reductions in ranges of motion. The AMMPHS mandibles also limited vision directly down and obliquely to the left side. Cut-outs improved vision to the lower right quadrant. Participants appeared able to accommodate the minor reductions in field of view. Compatibility issues were identified in the C7, M72 and headset static compatibility stands. The AMMPHS systems were all rated as being acceptable for static

compatibility with crew positions in the LAV III vehicle. While minor cases of vision and physical clash interference were noted, the participants believed performance was still acceptable. Although the subjective static and dynamic acceptance ratings for mandibles compatibility with C7 were mixed, the objective live fire results did not demonstrate any discernable drop in shooting performance. Given the small sample size and variation in user response caution was strongly advised in drawing any conclusions from this limited evaluation.

The participants believed that the rigid mandible designs were superior to the soft SIHS mandible designs evaluated in parallel. Although not the focus of this trial, the participants were supportive of the new AMMPHS double curved visor. Despite misgivings about wearing any protective mandible, the participant's believed that a cut-out mandible design formed the best basis for further refinement. The participants recommended that AMMPHS development efforts should be focussed on improving C7 compatibility, headset compatibility and refinements to the attachment system. As well the participants noted that efforts should be made to maximize mandible compatibility for the different sized heads and face morphologies.

From this initial trial, recommendations for further study were given. The participants expressed concern with their ability to differentiate between all the different mandible designs. Future mandible assessments should limit the number of designs so that participants can easily differentiate between the different designs. Issues with the number of AMMPHS mandibles available, number of subjects available and the time available limited this trial to a split-block design. Efforts should be made so that a full repeated measures and balanced experimental design approach is possible. The low sample size in this trial limited interpretation of the results. A power analysis of the cut-out exit questionnaire identified the need for a minimum of 22 participants (Mu0=2.7, Mu=3.7, Sigma=1.37, Alpha=.05, power goal=.90) if system 9 was compared to 9A. It is recommended that a future trial be undertaken with 24 participants to ensure proper power and results interpretation. Focusing on fewer options should allow increased numbers of each concept to be produced to support the trial.

Future trials should also be structured to reduce learning effects and to improve participant knowledge of how the different mandible designs affect shooting, mobility, etc. Participants should be given increased time on task with the mandible systems to accommodate unique design effects. A dedicated trial to investigate the influence of adaptation and learning on the acceptability (rated and measured objectively) of a new item with the same complexity of interaction with the soldier system, physiology, and usability would be worthwhile.

Although compatibility issues with C7 rifles were noted in this trial, objective shooting performance did not support participant subjective concerns. Further live fire and or simulator testing should be under taken to confirm that soldiers could "work through" any compatibility issues. In addition to recording soldier accuracy performance in run down tasks, soldier performance in tactical shooting tasks should be recorded. If possible shot timing data should be captured to identify any delays in engagement caused by the soldiers having to adjust for mandible clash.

The results of this trial highlighted the importance of dynamic task assessment. Although static clash assessments identified instances of clash, the ability of the soldiers to cope with clash was only discovered in the dynamic vehicle tasks. The participants reported that the dynamic vehicle task involving a mounted patrol and dismounted attack was one of the better tools for assessing mandible performance. The use of blank rounds as opposed to WES or simunition type systems made it difficult for participants to effectively judge the effects of different mandible conditions on

their performance. Future assessments should focus on mounted vehicle tasks and if possible mounted target engagements.

2 Aim

The aim of this trial is to build on the results of the initial user trial and provide guidance for the further refinement of the AMMPHS prototypes. An AMMPHS prototype will be compared to the in-service CG634 helmet to examine soldier performance and system compatibility.

3 Method

A seven day trial will be undertaken at CFB Valcartier in the late summer, early fall of 2010. A minimum of 24 Canadian Forces (CF) personnel will be required to undertake a battery of human factors tests while wearing four test conditions. Assessments will include anthropometry, Field of View (FOV), Range of Motion (ROM), static compatibility testing of weapons, communications equipment, clothing and equipment, and vehicles, dynamic vehicle course, jungle lane, obstacle course, shoot house, live fire rundown and tactical shooting range.

The first day of the trial will be used to brief the participants, conduct anthropometry assessments, and training. The briefing will include project background, trial aim, methods, measures, their responsibilities, and schedule. Participants will be trained on any equipment to be used during the trial, to include the Weapons Effects System (WES), any new communications equipment, and Tactics, Techniques, and Procedures (TTPs) such as the tactical shooting Gunfighter drills. The second through fifth days of the trial will expose each participant to each condition in a standardized protocol. Participants will be issued a mandible/helmet condition and use it throughout the day. The primary focus will be on mounted operations and a day long "patrol" with distinct test stands will be used. Day's two to five will be repeated in a balanced order of presentation (i.e. some participants will begin with condition A, others B, C etc. Every participant will assess every mandible/helmet condition. Day six will be a consolidated live fire range day, with both a standard run down range and a tactical shooting range. Day seven will be for debriefing participants, equipment return, and clean-up, as well as to allow for contingency.

3.1 Participants

A minimum of twenty four (24) CF personnel from regular force infantry units to participate will be needed to participate in the trial. The sample size is derived from statistical power analysis of results from previous trials. Furthermore, a slightly larger sample is recommended to account for potential participant limitations (e.g. unable to complete run downs) and participant drop-out. Participants should represent the Land Force (LF) in terms of experience, rank, and demographics. It is recommended that a platoon of four (4) Light Armoured Vehicles (LAV III) with crews be included in the participant sample to facilitate trial procedures. Each vehicle crew should consist of a crew commander, driver, gunner and three to four personnel in the rear (air sentries). Participants will be screened based on anthropometric measures, and possibly shooting handedness, for suitability to participate in the trial.

3.2 Trial Conditions

Four trial conditions are envisioned - see Table 20. The two control conditions will be the CG634 with attached mandibular protection and the in-service CG634 with no add-on protection. The experimental AMMPHS helmet with and without mandibular protection will be the other two conditions. In this way the impact of helmet and mandibular protection can be isolated in the data. Additional factors such as attachment clips, visors, and cut-outs may be added; however, they are likely to have adverse impacts on the number of participants required, the trial schedule, and the quality of data captured.

Table 20: Trial Conditions

		Helmet	
		CG634	AMMPHS
Mandibular Protection	Yes	1	3
	No	2	4

3.3 Protocol

All participants will be screened prior to commencement of the study and again screened at the beginning of the study to ensure proper sized head measurements. Only participants with appropriate head sizes, i.e. fit the medium helmet will be used to conduct the trial. Participants will be given an orientation briefing on the overall study, its objectives, and test activities prior to the onset of the trial. Questionnaire briefings will explain the standard rating scale, the data scoring methods, and rules of questionnaire completion. Following the orientation and prior to the start of any testing, the participants will be provided with instruction on how to conduct each of the tasks. Tasks to be performed over the course of the trial include:

13. Anthropometry
14. Range of Motion
15. Field of View
16. Static Compatibility: Clothing/Equipment/Weapons, Vehicle
17. Mandible Ease of Use
18. AMMPHS Helmet Ease of Use (TBC)
19. Mounted Target Detection
20. Convoy Ambush
21. Vehicle Emergency Dismount/Mount-
22. Dismounted Attack (Jungle Lane)
23. Dismounted Attack (Shoot House)
24. Obstacle Course (TBC)
25. Live Fire: Rundowns, Tactical Shooting

Following the completion of each task, the participants will be required to provide a rating of acceptance or complete a questionnaire for the trial condition they are assessing. At the end of each day, participants will complete a daily exit questionnaire for the condition tested that day and

following completion of the trial, participants will fill out an overall trial questionnaire. A focus group will be held at the end of the trial to further discuss participant assessments.

7.1.1 Anthropometry

Eight different anthropometric measurements will be taken from each soldier prior to the start of the trial. (Note if other head measures are required by the mandible developers they could added). Measurements will be taken using an anthropometer or using a tape measure. Each anthropometric measurement will be recorded three times and the average of the three used. A detailed description of how the measurements will be taken is presented below:

- **Neck Length Front-** The distance between the sternal notch and the submandibular landmark measured using a tape measure.
- **Neck Length Side-** The distance between the lateral aspects of the base of the neck measured using a tape measure.
- **Neck Length Back-** The distance between the C7 prominence to the occipital protuberance measured using a tape measure.
- **Head Circumference-** The maximum circumference of the head above the attachment of the ears to the head measured with a tape passing just above the ridges of the eyebrows and around the back of the head.
- **Bitragion Chin Arc-** The surface distance between the right and left tragion landmarks across the chin landmark at the tip of the chin measured with a tape while the subject is seated with their head in the Frankfort plane.
- **Bitragion Coronal Arc-** The surface distance between the right and left tragion landmarks across the top of the head measured with a tape measure while the subject is seated with their head in the Frankfort plane.
- **Head Breadth-** The maximum horizontal breadth of the head above the attachment of the ears measured while the subject is seated.
- **Head Length-** The distance from the glabella landmark between the browridges to the opisthocranion measured using a spreading caliper while the subject is seated.

7.1.2 Range of Motion

Range of motion measurements will be taken using a combination of an inclinometer, goniometer and a digital level. The following ranges of motion will be measured:

- **Neck Flexion-** With the participants head in a neutral position (Frankfort plane), instructed to tilt their head forward until resistance is felt. The angular displacement is then measured.
- **Neck Extension-** With the participants head in a neutral position (Frankfort plane), instructed to tilt their head backward until resistance is felt. The angular displacement is then measured.
- **Neck Lateral Flexion (right/left) -** With the participants head in a neutral position (Frankfort plane), instructed to tilt their head to each side until resistance is felt. The angular displacement to each side is then measured.

7.1.3 Field of View

Field of view is measured by having the participant place their chin on a standardized platform (i.e. a tripod) to ensure repeatability. Participants are instructed to move only their eyes while keeping their head stationary and facing forward. The maximum horizontal, vertical, and diagonal field of view is evaluated by sliding an object along 5 different tape measures (horizontal, vertical up, vertical down, 45° diagonally down to the left, and 45° diagonally down to the right) until the point when the participant can no longer see the object, as shown in Figure 16.

Figure 29: Horizontal (left) and Vertical (right) FOV

7.1.4 Static Compatibility

Static Clothing/Equipment/Weapons Compatibility

Static compatibility with clothing, equipment, and weapons will be collected in this trial. Data will be collected at different static test stands over the course of the vehicle patrol. Participants will be instructed to perform the required drills and HF observers will collect participant ratings on compatibility. Participants will be encouraged to adjust the trial condition to the best of their ability to accommodate the test clothing, equipment and weapons prior to each test. Participants will be evaluated individually while under the supervision of an HF observer.

The static compatibility test stands will be comprised the following pieces of equipment (TBC):

Clothing:	Gloves, Gen III Fragmentation Vest, Ballistic Eyewear, Rucksack
Equipment:	Tactical Command, Control and Communications System (TCCCS) headset, Personal Role Radio (PRR) headset, AN/PRC 522 headset
Weapons:	C7A1/A2 Rifle with C79 sight (prone, kneeling, standing), C9A1 LMG with C79 sight, C6 MMG with iron sights, M72 SRAAW, and Carl Gustav

Participants will be required to rate the compatibility of each of the trial conditions with the selected weapons, equipment, and clothing at each test stand. HF observers will measure clothing and equipment stand-off and note instances of compatibility clash and difficulty.

Static Vehicle Compatibility

At the end of the vehicle patrol the test conditions will be evaluated for compatibility with the LAV III. Participants will be divided into smaller groups to perform the required drills. Specific evaluations included:

e) **Access/Egress:** Participants will be required to rate the ease of access and egress of vehicle hatches and doors. HF observers will evaluate soldiers entering and exiting vehicles for any postural, range of movement, and vehicle obstruction effects.

f) **Vehicle Operation:** Participants will be required to rate the estimated ease of driving the vehicle in each condition. HF observers will evaluate participants during vehicle operation for any postural, range of movement, and crew station obstruction.

g) **Air Sentry and Observer Tasks:** Participants will be required to rate the estimated ease of performing air sentry tasks in the LAV III. HF observers will evaluate participants during air sentry and observer tasks for any postural or range of movement obstructions.

h) **Commander and Gunner Tasks:** Participants will be required to rate the estimated ease of performing commander and gunner tasks in the LAV III. HF observers will evaluate participants during commander and gunner tasks for any postural, range of movement, and crew station obstruction.

Participants will be required to rate the compatibility of the test conditions noting restrictions on movements with the assigned vehicle. HF observers will note instances where certain tasks could not be performed due to the presence of the trial condition.

7.1.5 Vehicle Patrol (Mounted Target Detection)

During the course of the day long vehicle patrol participants will be required to participate in a mounted target detection exercise. The vehicle gunner and air sentries will be required to search for targets while moving at typical patrol speeds. The route will last approximately 15 minutes, and will have 3 to 5 targets (per side) equipped with WES receivers (if possible). Two soldiers will scan the right and two soldiers will scan the left side of the road. Objective measurements consist of the number of targets seen, number of targets engaged, number of targets hit and the number of targets missed. Subjective measurements will consist of a questionnaire designed to assess target detection ability in the visual periphery during forward body movement and side-to-side head movements. Targets will be moved each day to control for learning effects and the counterbalanced order of completion will control for any differences in difficulty. Following completion of the target detection task scores will be collected from the WES system and participants will complete a task questionnaire.

7.1.6 Vehicle Patrol (Emergency Mount and Dismount)

During the course of the day long vehicle patrol participants will be required to participate in an emergency mount and dismount exercise. The vehicle crews will be required to dismount the LAV III as rapidly as possible. The vehicle commander, gunner and driver will be required to dismount externally while the air sentries will be required to use the rear door hatch (NB – not ramp). The time taken to dismount will be recorded. The crews will then be required to perform a quick mount of the vehicle. Again timing data will be recorded. Subjective measurements will consist of a questionnaire designed to assess the impact of head worn conditions on visual periphery, ROM, clash, etc. Following completion of the task participants will complete a task questionnaire.

7.1.7 Mandible (Mount and Dismount)

During the course of the day long vehicle patrol participants will be required to participate in a mandible mount and dismount exercise (if so equipped). The vehicle crews will be required to mount the mandibles as rapidly as possible (with and without gloves). The time taken to mount

and dismount the mandible will be recorded. Subjective measurements will consist of a questionnaire designed to assess the mounting clip design.

7.1.8 AMMPHS Helmet (Ease of Assembly) – (TBC)

If the AMMPHS helmet is a modular design then ease of assembly could be evaluated during the course of the day long vehicle patrol. The vehicle crews will be required to assemble the modular helmet (with and without gloves). The time taken to assemble will be recorded. Subjective measurements will consist of a questionnaire designed to assess helmet assembly.

7.1.9 Convoy Ambush Course

The dynamic convoy ambush course will be a group activity of approximately one section at a time. The LAV will be driving through a bush lane where pop-up target enemy forces have been set up with WES receivers. Participants will be required to engage the targets as they appear using blank ammunition with the WES system while continuing to drive down the bush lane (e.g. to fight through the ambush). During the last enemy attack the participants will be instructed to perform a rapid dismount and engage an enemy position.

Participants will be required to utilize one of the following crew stations:

- Dismounts (only utilized during the dismount portion of the vehicle patrol),
- Air sentry,
- Turret,
- Driver,
- Crew commander, or
- Gunner.

At the conclusion of the vehicle patrol participants will be required to complete a task questionnaire. Data collection will include number of rounds fired, numbers of targets hit, and engagement timing.

7.1.10 Dismounted Attack (Jungle Lane)

During the course of the day long vehicle patrol participants will be required to participate in a dismounted lane clearing exercise. The dismounted attack (jungle lane) exercise will begin as a group event. The vehicle crew will rapidly debus the LAV III and pairs of individuals (TBC) will be required to clear a lane. Four lanes will be prepared at the vehicle disembarkation point radiating from a central site (participants will utilize alternate lanes for other conditions). The participants will be required to detect and engage pop-up targets fitted with WES receivers (double tap). Targets will be at 10 to 75 meters from the participant, partially occluded, time limited, and off-axis. Four separate jungle lanes will be set up to facilitate timely completion of the task and reduce participant learning effects. Objective measurements consist of the number of targets seen, number of targets engaged, number of targets hit, time to hit, etc.) Any differences in lanes will be counterbalanced through the experimental design. Following completion of the jungle lane task target engagement scores will be collected from the WES system and participants will complete a task questionnaire.

7.1.11 Dismounted Attack (Shoot House)

During the course of the day long vehicle patrol participants will be required to participate in a dismounted building clearing exercise. The dismounted attack (shoot house) exercise will begin as a group event. The vehicle crew will rapidly debus the LAV III and pairs of individuals will be required to clear a building. The shoot house exercise will be a small team's event in which soldiers will progress through a Fighting In Built-Up Areas (FIBUA) building and engage targets fitted with WES receivers in each room. Targets will be scattered at strategic points throughout the building to simulate an enemy force defending the building. Participants will need to quickly detect and engage each target. Targets will be moved each day to control for learning effects and the counterbalanced order of completion will control for any differences in difficulty. Following completion of the shoot house task target engagement scores will be collected from the WES system and participants will complete a task questionnaire.

7.1.12 Obstacle Course (TBC)

A standard or improvised urban obstacle course (TBC) will be conducted to assess headwear stability, thermal and physical comfort, and FOV impacts on dynamic movement. In fulfilling this test task, the permanent obstacle at CFB Valcartier may be used or an improvised obstacle course set up through the FIBUA village (e.g. windows, walls, mouse holes) and LAV (e.g. interior movements, climbing on top, crawling beneath). Obstacles will be selected to emphasize dynamic head movement, FOV requirements, and movement through constricted spaces. Following completion of the obstacle course, participants will complete a task questionnaire.

7.1.13 Live Fire

All participants will complete a number of live fire exercises to evaluate the compatibility of the different trial conditions while shooting live ammunition. The live fire exercises will be broken down into two separate phases; run downs and tactical shooting.

Rundowns

During the rundown exercise participants will begin in the prone condition, 300 m from the target. The following table outlines the sequence of events during the live fire rundown task – see Table 1. Participants begin with a total of 34 rounds in 2 separate magazines (28 in first, 6 in second). In all cases the targets will be 2 figure 11 targets except for the 100m engagement while standing where only a single figure 11 target is exposed. Participants will complete a live fire questionnaire for each trial condition and shooting performance will be scored.

Table 21: Live Five Run Down Sequence of Events

Range (m)	Rounds	Description	Instruction	Position	Scoring
300		Prep stage –firer in prone position with 2 magazines with 28 rd magazine loaded, observe target area	With a 28 magazine, load. When the target appears the shooter moves to the 200m firing point. Watch and shoot.		
200	8	At the 200m engages each target with 4 rds from prone position	When the shooter reaches the 200m firing point adopts the prone position and engages each target with 4 rounds each	Prone	1 point per hit 45 sec exposure
200		Upon completion, shooter stands	shooter adopts the standing alert position		
200	4	At the 200m engage target in kneeling	When the target appears the shooter adopts the kneeling position and engages each target with 2 rounds each	Kneeling	1 point per hit 5 sec exposure
200		Upon completion, shooter stands	Shooter adopts the standing alert position		
200	4	At the 200m engage target in prone	When the target appears the shooter adopts the prone position and engages each target with 2 rounds each	Prone	1 point per hit 5 sec exposure
200		Upon completion, shooter remains prone	Shooter remains in the prone position		
200		Rundown from 200m to 100m	When the target appears the shooter moves to the 100m firing point and adopts the kneeling position. Watch and shoot.		
100	8	Engage target in kneeling position	Shooter engages each target with 4 rounds each	Kneeling	1 point per hit 45 sec exposure
100		Upon completion, shooter stands.	Shooter adopts the standing alert position	Standing	
100	4	At the 100m engage target in kneeling	When the target appears the shooter adopts the kneeling position and engages each target with 2 rounds each	Kneeling	1 point per hit 5 sec exposure
100		Change magazine	With an 8 rd magazine reload	Kneeling	

Range (m)	Rounds	Description	Instruction	Position	Scoring
100	4	At the 100m engage target in kneeling	When the target appears the shooter adopts the kneeling position and engages each target with 2 rounds each	Kneeling	Not timed 1 point per hit 5 sec exposure
100		Upon completion, shooter stands.	Shooter adopts the standing alert position	Standing	
100	2	At the 100m engage target in standing	When the target appears the shooter engages the left target in the standing position with 2 rounds	Standing	1 point per hit 5 sec exposure

Tactical Shooting

Participants will complete a number of tactical shooting drills from a number of different distances (5 – 50 metres). Drills will include controlled pair, Mozambique drills (2 shots to the body, 1 shot to the head), 90° pivots from the left and the right, 180° pivots with a forward move, and speed reload. Two figure 11 targets will be used and participants will fire a total of 32 rounds during this exercise. Engagement performance will be scored by counting total hits to the target. Participants will also complete a live fire questionnaire.

Table 22: Live Five Tactical Shooting Sequence of Events

Range (m)	Drill	Rounds per Target	Position	Iterations	Total Rds	Time (sec)
50m	Controlled Pair	2	Standing alert to kneeling (engage first tgt standing and then adopt kneeling position and engage 2nd tgt)	1	4	8
25	Mozambique/Box Drill (Body armour drill) (2 rds to center of mass and one rd to head)	3	Standing (alert)	1	6	12
25-15	Controlled Pair (2 x Fig 11)	2	Fwd Movement (from standing alert – move fwd and engage) Change mag after 2 rounds	1	4	NA
15	90° Pivot R Mozambique (Failure to stop drill)	3	Standing From alert position with right shoulder facing tgt pivot to right and engage tgt.	1	6	5

Range (m)	Drill	Rounds per Target	Position	Iterations	Total Rds	Time (sec)
15	90° Pivot L Mozambique (Failure to stop drill)	3	Standing From alert position with left shoulder facing tgt pivot to left and engage tgt.	1	6	4
15-10	180° Pivot left – move fwd and Mozambique	3	Fwd Movement From alert position facing away from tgt – pivot to left and face tgt and moving fwd engage tgt.	1	6	NA
10	Speed Reload - Controlled Pair (2 x Fig 11)	2	Standing to Kneel (engage 1st tgt standing and then adopt kneeling position change mags and engage 2nd tgt) Change mag after 2 rounds	1	4	8
10	90° Pivot R (controlled pair drill)	2	Standing From alert position with right shoulder facing tgt pivot to right and engage tgt.	1	4	4
10	90° Pivot L (controlled pair drill)	2	Standing From alert position with left shoulder facing tgt pivot to left and engage tgt.	1	4	4
10-5	180° Pivot right– move fwd and Mozambique	3	Fwd Movement From alert position facing away from tgt – pivot to right and face tgt and moving fwd engage tgt.	1	6	NA

7.2 Data Measures

Anthropometry: Various anthropometric measurements of the participants were taken. The measurements will be used to confirm the head sizes of the participants and ensure they all have correctly sized helmets.

Range of Motion: Neck ranges of motion will be taken for each trial condition. This data will be used to identify any deficiencies in neck range of motion caused by the trial conditions.

Field of View: Each participant's FOV will be measured while wearing each of the trial conditions. This data will identify if any of the trial conditions significantly restrict the participants' view.

Target Engagement Scores: For a number of tasks, the participant's ability to engage targets will be objectively measured. During the dynamic vehicle course, jungle lane, and shoot house WES equipment will be used to capture target engagement scores. During both the tactical shooting and rundown live fire ranges, shooting scores will be kept to objectively quantify target engagement with each of the trial conditions.

Observer Assessments: Trained HF observers will be on site for the duration of the trial, overseeing test activities and collecting data. The HF observers provide assessment notes following the trial. HF observer assessments could include, but are not limited to, compatibility clash, difficulty in performing certain tasks, or restrictions.

Ratings and Questionnaires: Participants will provide individual ratings and complete a number of questionnaires to reveal their perceptions of the trial conditions.

During the static testing, HF observers will solicit individual ratings of various pieces of equipment and tasks of the participants. The 7-point scale (Figure 15), where 1 was *completely unacceptable*, 4 was *borderline*, and 7 *completely acceptable* will be used.

A standard task questionnaire will be used for the majority of test tasks to solicit participant feedback on the performance of the trial conditions. The task questionnaire will also use the 7-point scale and provide space for written comments.

A customized live fire questionnaire will be used during the two live fire tasks, with questions tailored to weapons compatibility and shooting related criteria. Again the 7-point scale will be used and space provided for written comments.

A specialized discomfort questionnaire will be administered at the end of each day to collect any sources, locations , and types of discomfort. Using a 5-point thermal discomfort scale, where 1 is neutral, 3 is warm and 5 is very hot, participants will rate thermal discomfort of the trial conditions on the drawings of the front, back, sides, and top of the head - see Figure 25. Discomfort could include, but is not limited to, contact irritation or pressure points. HF staff will investigate any reports of physical discomfort through photographs and interviews with affected participants. Similarly, using a 5-point physical discomfort scale, where 1 is neutral, 3 is noticeable discomfort and 5 is extreme pain, participants will rate physical discomfort of the trial conditions. Discomfort could include, but is not limited to, hot spots or chaffing. HF staff will investigate any reports of thermal discomfort through photographs and interviews with affected participants.

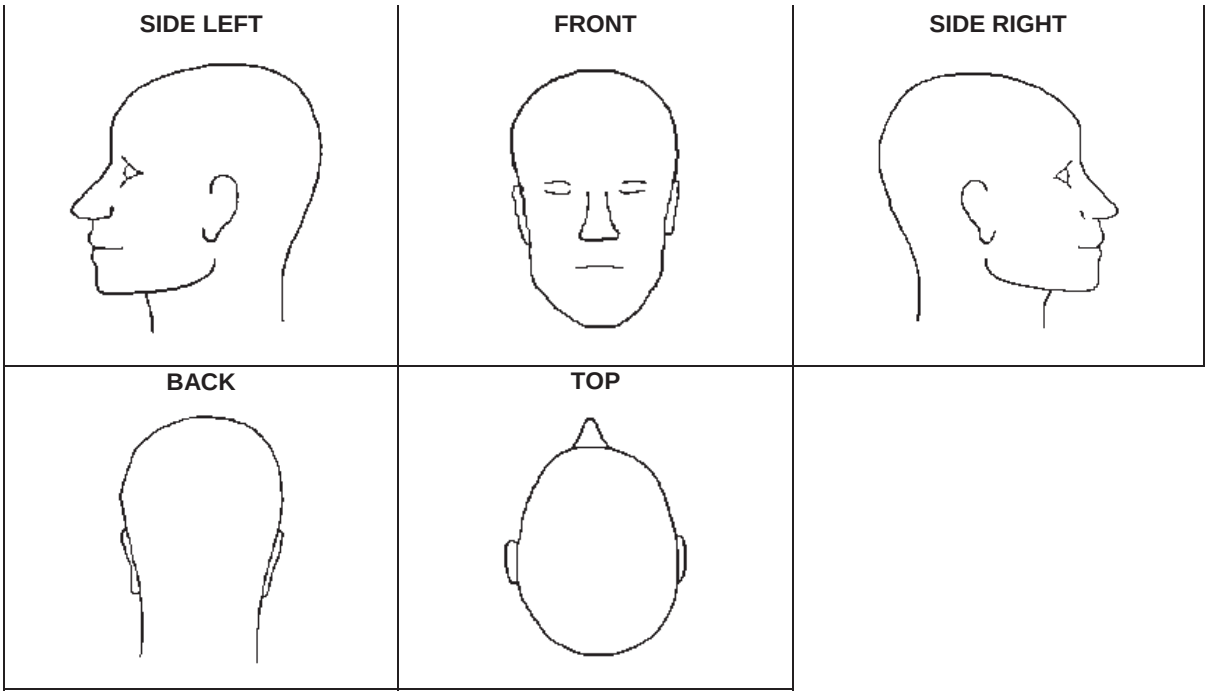

Figure 30: Discomfort Locations

Exit questionnaires will be competed at the end of days 2 through 5 to summarize the participant's experience with a give trial condition and give overall ratings. A final trial exit questionnaire will

be administered on the final day of the trial using a computerized data collection system, to facilitate rapid data analysis for the focus group.

Focus Group: Following the completion of the trial, participants will take part in a guided focus group. Issues stemming from the trial evaluation of the AMMPHS helmet and mandibular protection designs will be discussed in a session facilitated by an HF expert.

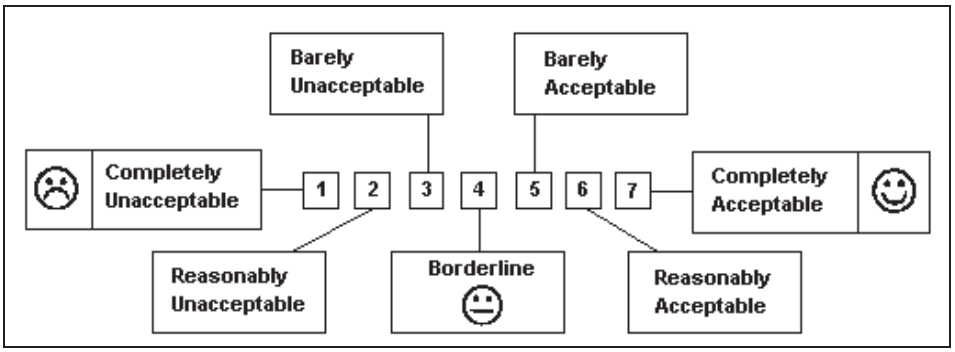

Figure 31: Standard Rating Scale

4 Trial Schedule

Table 23 presents generalized trial schedule which would be tailored to the available resources and specifics of the trial closer to date of conduct.

Table 23: Trial Schedule

	Day 1	Days 2 - 5	Day 6	Day 7
AM	Initial Briefing Trial Methods Briefing Anthro Measures & Fitting	Issue ROM and FOV Begin vehicle patrol • Mounted target detection • Static stand #1 • Emergency mount dismount • Static stand #2 • Dismounted attack (jungle lane) • Mandible mount/dismount// helmet assembly	Tactical Shooting Live Fire Range	Final Questionnaires Focus Group
PM	WES Training Gunfighter Training Comms Equipment Training	• Convoy ambush • Static #3 • Dismounted attack (shoot house) • Static #4 • Obstacle Course (TBC)	Rundown Live Fire Range	Contingency
PM		Daily exit questionnaire		

The following meetings will occur during the trial:

Initial Briefing: Initially, participants will be welcomed and introduced to the trial team. Participants will be briefed on the trial schedule and data collection methods (i.e. questionnaires, focus groups, etc.). Questionnaire briefings will explain the standard rating scale, the data scoring method and rules of questionnaire completion. The trial conditions will be introduced and participants will be provided with a demonstration of assembly, adjustment, and features of the new systems.

Final Questionnaires: On the last trial day, participants will be issued an Exit Questionnaire. Participants will be required to rate the acceptability of all conditions during the trial. Following the completion of all questionnaires, a focus group discussion will be held.

5 Resources

The following resources are requested for this trial.

5.1 Troop Requirements

Approximately 28 CF personnel (minimum 24) will be required. 4xLAV crews (drivers and commanders as a minimum) are requested as part of the participant personnel.

5.2 Facility Requirements

1. **Classroom:** A classroom facility/lecture theatre facility for briefings and focus group discussions. Room to handle up to 40 personnel.
2. **Drill Hall:** A drill hall, gymnasium, vehicle bay, or tent facility to house the static compatibility test stands.
3. **Vehicle Park:** A vehicle park with sufficient room to accommodate the vehicles during the static vehicle compatibility test exercises is required.

5.3 Training Areas

1. **Obstacle Course:** Access to a standard obstacle course, confidence course, or urban terrain suitable for an improvised urban obstacle course for the entire trial.
2. **Wooded Training Area / Dismounted Fire and Movement Area:** A suitable training area to evaluate soldier effectiveness in dismounted fire and movement activities.
3. **FIBUA Village / Shoot House:** FIBUA village or equivalent for shoot house exercises.
4. **Mounted Manoeuvre Area:** A suitable training area to evaluate soldier effectiveness in mounted contact drills.

5.4 Equipment Requirements

For the performance of the trial, the following equipment will be required:

- Anthropometry Measurement Equipment (protractor, inclinometer, Wells-Dillon sit-reach apparatus, measuring tapes)*
- Static Infantry Pop-up targets (with spare batteries) x 80
    - Convoy ambush x 12
    - Mounted target detection x 12
    - Jungle lane x 48
    - MOUT x 8
- Figure 11 targets x 80
- WES gear
    - SIT target x 80 (receivers only)
    - Participants x 30
- WES controllers x 4
- Trial Conditions
    - AMMPHS helmets x 15
    - AMMPHS mandibles x 15
- Audience response system*
- Sample communications equipment for compatibility testing, including:
    - PRR (it may be possible to use the Quiet Pro headsets for vehicle comms)
    - TCCCS
    - AN/PRC 522 headset

- Sample clothing and equipment for compatibility testing
- Each participant to bring:
    - Uniform
    - CG634 Helmet
    - Gloves
    - Ballistic Eyewear
    - Personal Weapon (C7, C8, or C9) with BFA and magazines
    - Marching Order (Summer) as per Unit SOP Load Carriage Equipment
    - Tactical Assault Vest
    - Small Pack / Patrol Pack
    - Rucksack

* Equipment provided by Humansystems

5.5 Vehicles

LAV III (4): Operational vehicles are requested for vehicle compatibility testing, dynamic vehicle course, and improvised obstacle course. Preference is for a total of 4 LAV III.

Support vehicles x 3 (to move targets, battery recharge, meals, etc.)

5.6 Personnel:

In addition to the participants, the following personnel are required to support this trial:

- Trial Support Officer / NCO: Require unit support officer / NCO for unit.
- Support staff x 4. Note support staff will need valid 404s.
- Medical Support Staff (including Ambulance): Required for obstacle course, vehicle patrol, and FIBUA.
- WES 4 x Target Operators: Required for dynamic vehicle course, jungle lanes, and shoot house.
- Live Fire Range Personnel: Required to conduct live fire ranges.

5.7 Weapons and Combat Load

Participant will be required to have the standard fighting order load.

Table 24: Weapons Requirements

Weapons	Number
C7A2 with BFA and magazines	All to bring
M203 with dummy rounds	4
C8 Carbine with magazines	4
C9A1 with dummy rounds	4
9mm Pistol and magazines	4
C6 with dummy rounds	4
Carl Gustav with dummy round	4
Dummy M72	4
C13 Training Grenade	28
Pintle mount C6/C9 for LAVs	4

5.8 Ammunition

The following ammunition will be required for the trial.

Table 25: Ammunition Requirements

Ammunition	Weapon	Tasks	Quantity per Soldier per Iteration	Personnel	Iterations	Total Required
5.56mm Blank	C7A2	Vehicle Course, Jungle Lane, Shoot House	120 rounds	28	4	1340
5.56mm Ball	C7A2	Live Fire Rundowns, Tactical Shooting	80 rounds	28	4	8960

5.9 Rations

Rations: Lunch rations and coffee are requested for the duration of the trial.

Table 26: Ration Requirements

Item	Description	Daily	Total x 7 days
Lunch	Box lunch	40 (TBC)	280

6 Statistical Analyses

Descriptive statistics will be used to summarize and present all data collected. Repeated measures analysis of variance will be undertaken for select questionnaire acceptability scale and performance results. Differences will be identified at $p<0.05$.

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(U) A total of eight different AMMPHS prototype mandible systems were assessed as part of a SIHS helmet trial held at Canadian Forces Bases (CFB) Valcartier from September 28 to October 9, 2009. Twelve participants were required to undertake a battery of human factors tests while wearing the current in−service helmet (CG634) or one of the AMMPHS prototype mandibles in a blocked repeated measures design. During each test, the order of conditions was only partially balanced due to the lack of available resources and mandible prototypes. Human factors tests included assessments of fit, comfort, range of motion, field of view, performance of select battle tasks, and equipment, vehicle and clothing compatibility. Data collection included anthropometric measurements, range of motion measurements, field of view measurements, questionnaires, focus groups, live fire performance measures, and Human Factors (HF) observer assessments.

(U) Au total, huit prototypes de systèmes de mandibules du Système de casque de protection modulaire multi−menaces perfectionné (AMMPHS) ont été évalués dans le cadre des essais pour les casques intégrés pour le soldat (CIS) qui ont eu lieu à la base des Forces canadiennes (BFC) Valcartier du 28 septembre au 9 octobre 2009. Une batterie d'essais de facteurs humains a été effectuée à l'aide de douze participants, selon un protocole de mesures répétées par blocs, pendant qu'ils portaient le casque actuellement en usage (CG634) ou un des prototypes des mandibules du AMMPHS. Au cours de chaque essai, l'ordre des conditions était seulement partiellement équilibré à cause du manque de ressources et de prototypes de mandibules disponibles. Les essais de facteurs humains comprenaient une évaluation de l'ajustement, du confort, de l'amplitude des mouvements, du champ de vision, de l'exécution de tâches de combat sélectionnées et de la compatibilité avec l'équipement, les véhicules et les vêtements. La collecte de données incluait des mesures anthropométriques, des mesures de l'amplitude des mouvements, du champ de vision et de rendement de tir réel, ainsi que des questionnaires, des groupes de consultation et des évaluations d'observateurs de facteurs humains.

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(U) Military helmets; AMMPHS; Mandible protection; facial impact protection; SIHS; CG 634

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