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Exposed Crew Throat Protector Human Factor Usability Trial

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Abstract

A four day field trial was conducted at Canadian Forces Base (CFB) Valcartier from November 19 to November 23 2007 to evaluate the usability of a new throat protector design. The aims of the trial were to confirm that one size effectively covered off the 5th to 95th percentile of the Canadian Forces (CF) male population and to assess the functional impact of the proposed throat protector design on the ability of Land Forces personnel to perform their day-to-day tasks. Twenty-six soldiers completed a battery of human factors tests while wearing either no throat protector (baseline condition) or the new throat protector. A progressive testing protocol was used that included static stands; anthropometry assessment of fit, range of motion, compatibility with weapons and vehicles, and dynamic military tasks; firing range, obstacle course, mounted vehicle ambush and combat dismount, dismounted section attack, and FIBUA. Data collection included fit assessments, range of motion assessments, acceptability ratings following the tasks, thermal and physical discomfort ratings, daily and exit questionnaires, and guided focus groups. The results of this trial indicated that the throat protector design fit the male population and was acceptable for the majority of participants. The trial participants also suggested minor design modifications. Design changes to improve the throat protector design are discussed in the report.

Résumé

Un essai d'une durée de quatre jours s'est déroulé à la Base des Forces canadiennes (BFC) Valcartier du 19 au 23 novembre 2007 en vue d'évaluer la facilité d'utilisation de la conception du nouveau protège-gorge. Le test avait pour objectif de confirmer que la taille unique couvre effectivement la population des hommes des Forces canadiennes (FC) du 5^{e} au 95^{e} percentile et d'évaluer l'impact fonctionnel de la conception du protège-gorge proposé sur la capacité du personnel de la force terrestre à effectuer ses tâches quotidiennes. Vingt-six soldats ont complété une batterie de tests d'ergonomie en ne portant aucun protège-gorge (condition de départ) ou en portant le nouveau protège-gorge. Un protocole d'essai progressif a été utilisé en position statique, à savoir des évaluations anthropométriques de l'ajustement, de l'amplitude des mouvements, de la compatibilité avec les armes et les véhicules, ainsi que des tâches militaires dynamiques, à savoir sur les champs de tir, les parcours du combattant, les embuscades de véhicules montées et la descente au combat, les attaques de section légère et le combat dans les zones bâties. La collecte des données comprenait les évaluations des ajustements, les évaluations des amplitudes des mouvements, les cotes d'acceptabilité à la suite des tâches, les cotes d'inconfort thermique et physique, des questionnaires quotidiens et de sortie ainsi que des groupes cibles dirigés. Les résultats de cet essai ont indiqué que la conception du protège-gorge s'ajustait bien à la population des hommes et était acceptable pour la majorité des participants. Les participants à l'essai ont également suggéré des modifications de conception mineures. Les changements de conception pour améliorer la conception du protège-gorge sont élaborés dans le présent rapport.

Executive Summary

A four day field trial was conducted at CFB Valcartier from 19 to 23 November 2007 to evaluate the usability of a new throat protector design. The aims of the trial were to confirm that one size effectively covered off the 5th to 95th percentile of the Canadian Forces (CF) male population, and assess the functional impact of the proposed throat protector design on the ability of Land Forces personnel to perform their day-to-day tasks. Twenty-six male soldiers took part in the user trial and conducted a battery of human factors tests while wearing either no throat protector or the new throat protector. Participant's mean length of service in the regular forces was 4.4 years (SD=3.7, max=12). The mean age of the participants was 25.4 years (SD=4.9, max=37, min=18).Over half (16 of 26) of the participants had no operational experience.

A progressive testing protocol was used that included: anthropometry measurements, assessment of fit, static range of motion, static compatibility with weapons and vehicles, dynamic military tasks, thermal load, and physical comfort. Data collection included acceptability ratings following the tasks, thermal and physical discomfort ratings, range of motion assessments, fit assessments, daily and exit questionnaire acceptability ratings, and guided focus groups.

Day one consisted of the participants getting their anthropometrics and range of motion measurements taken by the researchers. Days two and three assessed the compatibility of the throat protector design with various weapons, vehicles and during vehicle inspections with the researchers recording acceptability ratings for each condition. Furthermore, participants completed obstacle, FIBUA and vehicle patrol ambush tasks on day two and three, and a live fire exercise on day four.

The results of the trial indicated the throat protector design was acceptable to greater than 80 percent of participants for all the task compatibility ratings, thermal and physical discomfort questionnaire ratings, weapon and vehicle compatibility ratings, and daily and exit questionnaire acceptability ratings.

The participants support the notion of wearing a throat protector for increased protection and it appears a single size throat protector will be sufficient for the majority (5th to 95th percentile) of Canadian Forces males. Furthermore, the throat protector did not cause new or amplify existing problems in performing day-to-day tasks for the trial participants.

In the final focus group discussions, participants suggest two small modifications with the current throat protector design to improve acceptance of design:

- Improve the material of the throat protector where it touches the throat to improve comfort, and
- Improve the adjustability of the throat protector with extra snap buttons.

Sommaire

Un essai de quatre jours s'est déroulé à la BFC Valcartier du 19 au 23 novembre 2007 en vue d'évaluer la facilité d'utilisation de la conception du nouveau protège-gorge. Le test avait pour objectifs de confirmer que la taille unique couvre effectivement la population des hommes des Forces canadiennes (FC) du 5^{e} au 95^{e} percentile et d'évaluer l'impact fonctionnel de la conception du protège-gorge proposé sur la capacité du personnel de la force terrestre à effectuer ses tâches quotidiennes. Vingt-six soldats, tous des hommes, ont complété une batterie de tests d'ergonomie en ne portant aucun protège-gorge (condition de départ) ou en portant le nouveau protège-gorge. La durée moyenne de service des participants dans les forces régulières était de 4,4 ans (ET=3,7, max.=12). L'âge moyen des participants était de 25,4 ans (ET=4,9, max.=37, min.=18). Plus de la moitié (16 de 26) des participants n'avaient aucune expérience opérationnelle.

Un protocole d'essai progressif a été utilisé, à savoir des évaluations anthropométriques, des évaluations de l'ajustement, de l'amplitude des mouvements statiques, de la compatibilité statique avec les armes et les véhicules, ainsi que des tâches militaires dynamiques, l'apport thermique et le confort physique. La collecte des données comprenait les cotes d'acceptabilité à la suite des tâches, les cotes d'inconfort thermique et physique, les évaluations des amplitudes des mouvements, les évaluations des ajustements, des questionnaires quotidiens et de sortie ainsi que des groupes cibles dirigés.

Lors du premier jour, les chercheurs ont pris les mesures anthropométriques et d'amplitude de mouvement des participants. Les jours deux et trois ont servi à évaluer la compatibilité de la conception du protège-gorge avec des armes et des véhicules divers et pendant les inspections des véhicules alors que les chercheurs ont noté les cotes d'acceptabilité pour chaque condition. De plus, les participants ont effectué des tâches de parcours d'obstacles, de combat dans les zones bâties, des embuscades de véhicules montées puis un exercice de tir réel le quatrième jour.

Les résultats de ce test ont indiqué que la conception du protège-gorge était acceptable à plus de 80 pourcent des participants pour toutes les cotes de compatibilité des tâches, les cotes des questionnaires sur l'inconfort thermique et physique, les cotes de compatibilité avec les armes et les véhicules ainsi que les questionnaires quotidiens et de sortie.

Les participants soutiennent la notion du port d'un protège-gorge pour une protection accrue et il semble qu'une taille unique sera suffisante pour la majorité (du 5^{e} au 95^{e} percentile) des hommes des Forces canadiennes. De plus, le protège-gorge n'a pas causé de nouveaux problèmes ni amplifié des problèmes existants dans la réalisation des tâches quotidiennes pour les participants au test.

Au cours des discussions finales des groupes cibles, les participants à l'essai ont également suggéré deux modifications de conception mineures au protège-gorge actuel pour améliorer son acceptation :

- Améliorer le tissu du protège-gorge, où il y a contact avec la peau de la gorge, afin d'améliorer le confort, et
- Améliorer la capacité d'ajuster le protège-gorge en ajoutant des boutons à pression supplémentaires.

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1 Introduction

Due to an increased threat of blast and fragmentation damage resulting from the proliferation of improvised explosive devices (IEDs), there is a requirement for increased protection for the throat area on the in-service fragmentation vest for soldiers on deployed operations. The current Clothe the Soldier (CTS) Fragmentation Vest has a collar that covers the back of the throat but there is no protection for the front or sides of the throat. There is a need to provide increased protection to the throat region of soldiers because this area is currently unprotected. DLR 3 is proposing a new exposed crew throat protector to fulfill this requirement.

An exposed crew throat protector is being introduced into the Land Forces to provide operational soldiers with an increased level of throat protection. The purpose of the throat protector is to provide some level of protection to the throat due to the large amount of critical arteries and sensor nerves that are located in this region. If these arteries or nerves are compromised, there is a high degree of possibility that the soldier will succumb to the injury or suffer long lasting and possibly debilitating scarring and disfigurement.

The purpose of the throat protector is to provide improved blast and fragmentation protection to the throat area. The throat protector attaches to the front of the fragmentation vest using a Velcro pad and snaps on the shoulder pads (see figure 1). It provides the same level of fragmentation protection as the soft armour of the vest. The throat protector is designed to minimize any restrictions to throat range of motion and reduce snagging during mounted operations while at the same time adding sufficient blast and fragmentation coverage to prevent any major injury to the throat.

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2 Aim

The aims of this trial were to perform a human factors evaluation of a prototype throat protector to:

- Determine if the current one sized throat protector design would adequately cover the entire range of fragmentation vest sizes of CF Land Forces personnel, and
- Assess the impact of the throat protector design on the ability of Land Forces personnel to perform their day-to-day tasks.

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3 Method

3.1 Participants

A four day field trial was conducted at CFB Valcartier from 19 to 23 November 2007 to evaluate the usability of a new throat protector design. Twenty-six soldiers (6 reserve and 20 regular force soldiers) were originally recruited for the trial with 24 soldiers completing the full 4-day trial. Some participants had to withdraw due to other training and operational requirements.

The participants were recruited from 2eR22R, 5 RALC, 3eR22R, Q6 56BMC, 62 Rflc, and 12eRBC. The mean age of the participants was 25.4 years (SD = 4.9, max = 37, min = 18 years). Participant's mean length of service in the regular forces was 4.4 years (SD=3.7, max=12). Over half (16 of 26) of the participants had no operational experience.

3.2 Conditions

There were two conditions in the trial; the control condition (no throat protector) and the throat protector condition. A single sized throat protector design was evaluated in this trial. The throat protector attaches to the front of the fragmentation vest using Velcro and wraps around the front and sides of the throat attaching to the collar of the fragmentation vest using snaps (see Figure 1). The throat protector provides the same level of protection as the soft armour of the fragmentation vest.

This trial was conducted in conjunction with an introductory trial of two nape protector designs. Therefore, while each participant completed the tasks with the throat protector they were also wearing one of two prototype nape protector designs. Each participant completed all tasks with the following conditions:

- No throat protector and no nape protector
- Throat protector and nape protector A

In order to avoid the interaction effect of the nape systems on the throat protector results, only the results with the throat protector with nape protector A and the no throat protector with no nape conditions were utilized. For simplicity, the conditions will be referred to as with the throat protector, and with no throat protector in the remainder of this report.

Figure 1: CF Fragmentation Vest with Throat Protector.

3.3 Experimental Procedures

A progressive testing protocol was employed in this trial. The tests progressed from static stands in stage 1 and 2 to dynamic stands in stage 3. The following figure describes the progressive testing protocol – See Figure 2.

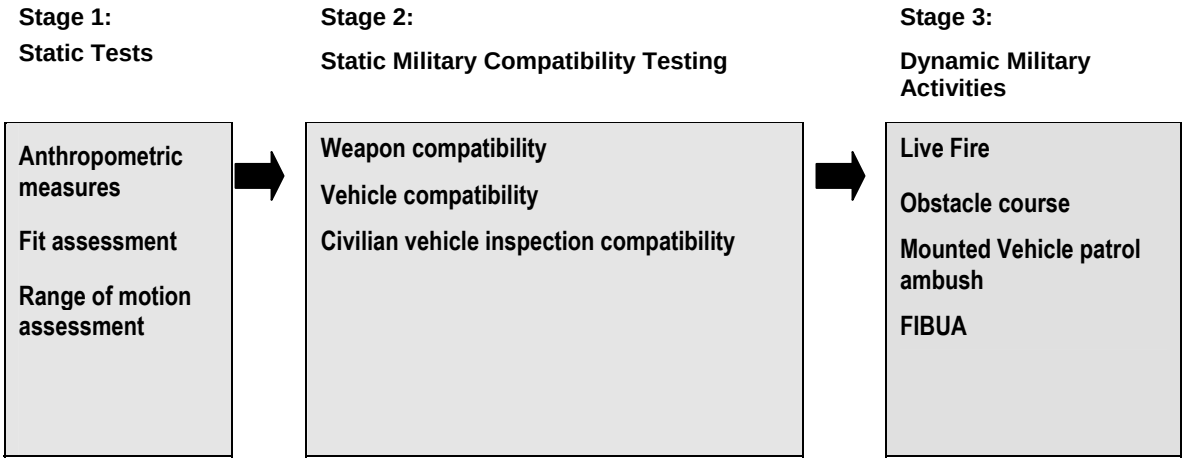

Figure 2: Progressive Testing Protocol

Static tests were completed during day 1. Static and dynamic military activities were completed concurrently during days 2, 3 and 4.

3.4 Weather Conditions

The throat protectors were evaluated during winter weather conditions at CFB Valcartier, Valcartier, Quebec. The weather conditions recorded by Environment Canada are described below in Table 1:

Table 1: Valcartier Weather Conditions

Day	Max °C	Min °C	Mean °C	Snow
Day 1, November, 19, 2007	-1.5	-11.3	- 6.6	none
Day 2, November, 20, 2007	-1.3	-7.3	-3.2	Snow
Day 3, November, 21, 2007	0.6	-3.5	-1.1	Snow
Day 4, November, 22, 2007	0.1	-2.7	-0.9	Moderate Snow

Because the throat protectors were evaluated in winter conditions thermal comfort issues from the increased coverage of the protection could not be adequately evaluated.

3.5 Questionnaires

Participants completed a number of questionnaires that were designed to elicit their perceptions about the throat protector design.

Participants completed several task compatibility, feature and daily exit questionnaires at different points throughout the trial and a final exit questionnaire. Using a 7-point scale, participants rated the acceptability of throat protector on a wide range of different criteria. The rating scale used was,

- 1 = completely unacceptable
- 4 = borderline
- 7 = completely acceptable

In addition, participants were asked to rate the acceptability of the throat protector on a wide range of thermal discomfort criteria using a 5-point thermal discomfort scale. The rating scale used was,

- 1 = neutral
- 3 = warm
- 5 = very hot

Participants also rated physical discomfort of the throat protector design using a 5-point physical discomfort scale. Participants rated the acceptability of the throat protector using the following scale,

- 1 = neutral
- 3 = noticeable discomfort
- 5 = extreme pain

Finally participants were asked to rate the fit of the throat protector design using a 5-point fit sizing scale.

- 1 = short, small and tight
- 3 = acceptable
- 5 = long, large and loose

Focus Group: Following the completion of the trial, participants took part in a guided focus group. They discussed different issues of the throat guard. The goal was to collect information that can be used in the improvement of the current throat guard designs.

3.6 Data Measures

3.6.1 Anthropometry

Anthropometric information was measured from each soldier prior to the start of the trial. There were four relevant throat anthropometric measurements taken for each soldier (3 circumferences and 1 length). A detailed description of how the measurements were taken is presented below:

- **Throat Circumference**: The circumference of the throat at the level of the infrathyroid landmark (Adam's apple) was measured with a tape. The plane of the measurement was perpendicular to the long axis of the throat. The subject stands erect with the head in the Frankfort plane. The shoulders and upper extremities were relaxed.
- **Throat Circumference (base):** The circumference of the base of the throat was measured by a tape passing over the drawn lateral and anterior throat landmarks. The subject stands erect with the head in the Frankfort plane. The shoulders and upper extremities were relaxed.
- **Throat Length**: The length of the throat was measured by a ruler from the surface of the participants shoulder to the tragus of the ear. The subject stands erect with arms relaxed to their sides.
- **Stature:** The vertical distance from the floor to the top of the head was measured with a retracting tape measure. The subject stands erect with the head in the Frankfort plane. The heels are together with the weight distributed equally on both feet. The shoulders and upper extremities were relaxed. The measurement was taken at the maximum point of quiet respiration.

The length measurement was taken using a self-retracting pocket tape measure and the circumference measurements were taken using a plastic tape measure. Each anthropometric measurement was recorded three times and the average of the three was used for our analyses.

3.6.2 Fit

Each participant was required to assess the fit of the throat protector. The participants were given a throat guard and instructed on how to attach the throat protector properly to their fragmentation vest. After the initial fitting, participants were required to perform selected head movements to assess their fit.

Upon completion of adjustment and head movements, the participants completed a fit questionnaire. Participants rated the acceptability of the throat protector on a wide range of different fit criteria using the 5-point fit acceptance scale.

3.6.3 Coverage

Each participant had two photos taken to assess coverage of the throat protector (outside the scope of this trial). A side and front photo were taken using a digital camera and measurements were captured with a metal scale. Each photo can be used for further analyses of coverage if required – see Figure 3.

Figure 3: Example of Throat Coverage Photos

3.6.4 Range of Motion

The following ranges of motion were measured while wearing the throat protector and while the participants wore no throat protection. The no throat protection measures were used as a baseline to which the throat protector measurements were compared. A detailed description of how the measurements were taken is presented below:

- **Neck Flexion (Forward):** With the participants standing erect they are requested to rotate their head forward by attempting to touch their chin to their chest while keeping their back straight.
- **Neck Flexion (Lateral):** With the participants standing erect they are requested to flex their head to the side by attempting to touch their ear to their shoulder while keeping their arms relaxed and in the down position.

The ranges of motion measurements were taken using an inclinometer or goniometer. Each range of motion measurement was recorded three times and the average of the three was used for our analyses.

3.6.5 Weapon Compatibility

Throat protector compatibility with weapons was evaluated at several static test stands. Participants completed the static stands intermittently during the first 3 days of the trial. Participants were stationed in a straight line in front the HF observer and performed a series of weapon drills – see Figure 4.

The static weapon compatibility test stands comprised the following five weapons:

- C9A1 LMG
- C6 MMG
- M72 SRAAW
- Carl Gustav and
- M-67 Grenades

The HF observers collected participant ratings on compatibility for each of the selected weapons and noted instances during weapons handling of any postural and range of movement obstruction.

Figure 4: Weapon Compatibility

3.6.6 Vehicle Compatibility

Throat protector compatibility with vehicles was evaluated at several static vehicle test stands.

The static vehicle compatibility test stands comprised of LAV III, Coyote and Bison vehicles. Vehicle compatibility activities included access and egress, vehicle operation tasks, and inspection of the vehicle controls.

Participants were required to rate the estimated ease of performing the following crew stations:

- Driver
- Air sentry (only for LAV III and Coyote)
- Crew commander (CC) (only for Bison) and
- Turret (only for LAV III and Coyote)
  - Crew commander and
  - Gunner

Participants were required to rate the compatibility of the throat protector noting restrictions on movements with each of the assigned vehicles – see Figure 5. The researchers collected participant ratings on compatibility and noted instances of any postural, range of movement, or crew station obstruction during vehicle operation.

Figure 5: Vehicle Compatibility

3.6.7 UN Vehicle Inspection

These drills were designed to simulate the vehicle inspection procedures required during peacekeeping roadblock checkpoints. Inspection activities included a standing inspection of the exterior bodywork, kneeling inspection of a wheel well, prone inspection of the car underside below the trunk, and stooped/crouched inspection of the passenger seat area – See Figure 6.

Figure 6: Vehicle Inspection

The participants were required to rate the ease of vehicle inspection activities. HF observers evaluated inspection effectiveness and noted any postural concerns

3.6.8 Dynamic Military Activities Performance

Throat protector compatibility with specific dynamic military activities was evaluated in the following three activities:

- Obstacle course
- Mounted patrol ambush and combat dismount and
- FIBUA (Fighting in Built Urban Area)

The obstacle course assessed the stability of the throat protector during typical field movements. Participants were instructed to perform manoeuvres so that the head would be oriented in a wide range of postures.

The mounted patrol ambush with combat dismount and FIBUA were performed to simulate the movement demands of patrolling and contact engagements with an enemy force. Given the importance of head movement, compatibility with mounted patrol and FIBUA warfare was simulated and assessed. Participants performed FIBUA and mounted patrol activities in full fighting order.

The participants completed the dynamic military tasks three times, twice while wearing the throat protector with each of the two prototype nape protectors and once while wearing no throat protection.

a) Obstacle Course. The following obstacles were undertaken consecutively as part of a single obstacle course (see Figure 7 to 14):

- **Crawl Obstacle:** Perform a Leopard crawl while traversing a 10m low wire obstacle;

Figure 7: Crawl Obstacle

- **Short Wall Obstacle:** Run 3m and climb (unassisted) over a 1.5m high wall;

Figure 8: Short Wall Obstacle

- **Tall Wall Obstacle:** Run 3m and climb (assisted) over a 2.4m high wall;

Figure 9: Tall Wall Obstacle

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

Figure 10: Short Pit Obstacle

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

Figure 11: Over and Under Obstacle

- **Mouse Hole Obstacle:** Crawl through a square, concrete mouse hole shaft for 1m;

Figure 12: Mouse Hole Obstacle

- **Low Wire Obstacle:** Step over five successive low wire obstacles mounted approximately 0.5m above the ground; and

Figure 13: Low Wire Obstacle

- **Maze Obstacle:** Weave in and out a series of pre-determined aisles.

Figure 14: Maze Obstacle

b) Mounted Patrol: Participants completed a short vehicle patrol ending in an ambush. The patrol consisted of one LAV III and one Coyote. Participants were required to engage targets with Simunition®, change magazines etc. from the crew hatches and then they exited the vehicle and proceeded tactically through a wooded area engaging the enemy targets.

Figure 15: Vehicle Patrol

c) FIBUA House Clearing: Participants were required to participate as a member of a section in a two storey single house clearing simulation. Targets placed within the building simulated enemy positions. All participants were issued Simunition®. The attacking section entered the building through open doors on the ground level and then cleared the house, room to room, one floor at a time.

Figure 16: Section House Clearing

At the completion of each serial, participants were required to complete a task questionnaire and HF observer assessments were collected.

3.6.9 Range Firing

Throat protector compatibility while firing personal weapon was evaluated at small arms range.

The daylight live fire assessed the compatibility and acceptability of the throat protector during typical C7A1/A2 rifle live fire. Using a small arms range, participants performed the following personal weapons test serials with the C7A1/A2 rifle – see Figure 17.

Serial 1: Grouping and zeroing at 50m (prone).

Serial 2: Fire and Movement starting in the prone position at 200m.

a) Move to 100m (prone unsupported, Figure 11s).

b) Move to 50m (standing unsupported, Figure 11s).

c) Move to 25m (standing unsupported, Figure 11s)

Serial 3 and 4: Fire and Movement starting in the prone position at 100m due to heavy snowfall that limited visibility.

a) Move to 50m (standing unsupported, Figure 11s);
b) Move to 25m (standing unsupported, Figure 11s).

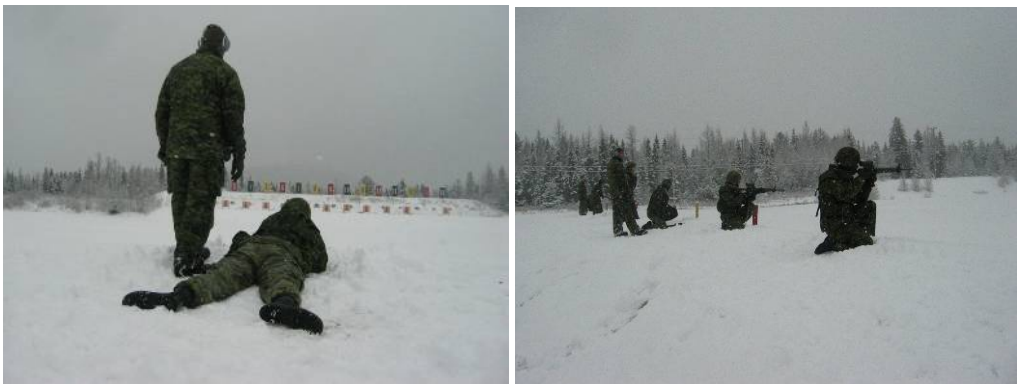

Figure 17: Live Fire

At the completion of range firing, participants were required to complete a live fire task questionnaire for the condition. HF observers evaluated compatibility issues associated with firing and collected live fire scores.

3.6.10 Throat Protector Features Functionality and Durability Acceptance:

At the end of the trial, participants were required to rate the suitability of throat protector features for functionality and durability.

Subjects rated the throat protector features such as its method of attachment and coverage area.

These features were discussed in detail during the exit focus group to identify problem areas and suggestions for improvement.

3.6.11 User Acceptance

Participants were required to rate their overall acceptance of the throat protector, including their perceived level of protection, comfort, and the general appearance of the garment, using an exit questionnaire.

3.6.12 Physical Discomfort

At the conclusion of each day, participants were required to complete a physical discomfort questionnaire. This questionnaire was comprised of drawings of the front, back, and side of the head and shoulder region. Participants were required to indicate the body location and rate the extent of physical discomfort using a five point rating scale.

Subject also rated throat protector acceptability using the seven point rating scale on the following:

- Pressure points
- Chaffing and
- Overall physical comfort

3.6.13 Thermal Discomfort

At the conclusion of each day, participants were also required to complete a thermal discomfort questionnaire. This questionnaire was comprised of drawings of the front, back, and side of the head and shoulder region. Participants were required to indicate the body location and rate the extent of thermal discomfort using the five point rating scale.

Subject also rated throat protector acceptability using the seven point rating scale on the following:

- Hot spots
- Ventilation and
- Overall thermal comfort

3.7 Statistical Analysis

Descriptive statistics analysis for the throat protector was undertaken for the percentage of participants that rated the throat protector acceptable for all scale assessments.

Previous studies (Angel, H.A. and Vilhena, P.G.S. 2003 and Angel, H.A., Kumagai, J.K. and Paul Vilhena 2004) defined "most soldiers" as a minimum of 80% shall rate a given criteria as acceptable. Acceptable scale assessment was defined as follows:

- When using the standard seven point scale of acceptance, criteria rated greater than or equal to four ("borderline") was considered acceptable,
- When using the standard five point scale of fit acceptability, criteria rated equal to 3 ("acceptable") was considered acceptable fit,
- When using the standard five point scale of physical discomfort, criteria rated less than three ("noticeable discomfort") was considered acceptable,
- When using the standard five point scale of thermal discomfort, criteria rated less than three ("noticeably warm") was considered acceptable.

Furthermore, a repeated measure ANOVA for both range of motion and live fire analysis for throat protector effects was undertaken for all measured assessments. Differences were identified at $p < 0.05$. For the remaining subjective measures no statistical analysis was performed. The throat protector was either rated acceptable or unacceptable depending on whether 80% or more of the participants rated it as 'borderline' or better. No comparison was made to the baseline measures. The statistical plan was as follows:

Measure	Assessment Approach	Analysis Approach
Range of Motion	Angle measurement by inclinometer or goniometer • Throat lateral flexion • Throat forward flexion	ANOVA for specific throat ranges of motion: - Throat protector (2) - Criteria (2)
C7 Live Fire Range Questionnaire	Subjective task assessment by participant	Percentage acceptable for each task question: - Throat protector (1) - Criteria (39)
C7 Live Fire Range	Engagement accuracy	ANOVA for overall range score: - Throat protector (2)
Vehicle Patrol Questionnaire	Subjective assessment by participant	Percentage acceptable for each task question: - Throat protector (1) - Criteria (35)
Dismounted Section FIBUA Questionnaire	Subjective assessment by participant	Percentage acceptable for each task question: - Throat protector (1) - Criteria (32)
Obstacle Course Questionnaire	Subjective assessment by participant	Percentage acceptable for each task question: - Throat protector (1) - Criteria (43)
Physical Discomfort Questionnaire	Subjective assessment by participant	Percentage acceptable for each region : - Throat protection (1) - Criteria (3)
Physical Discomfort Questionnaire – Discomfort mapping	Subjective assessment by participant	Percentage acceptable for each task question: - Throat protector (1) - Region (2)
Thermal Discomfort Questionnaire	Subjective assessment by participant	Percentage acceptable for each task question: - Throat protector (1) - Criteria (3)
Thermal Discomfort Questionnaire – Discomfort mapping	Subjective assessment by participant	Percentage acceptable for each task question: - Throat protector (1) - Region (2)
Feature Functionality and Durability	Subjective assessment by participant	Percentage acceptable for each task question: - Throat protector (1) - Criteria (5)
Daily exit questionnaire	Subjective assessment by participant	Percentage acceptable for each task question: - Throat protector (1) - Criteria (26)
Final exit questionnaire	Subjective assessment by participant	Percentage acceptable for each task question: - Throat protector (1) - Criteria (26)

Note 1: Variation of the participant size because some participants had to withdraw due to other training and operational requirements

Note 2: Missing data points for questionnaires because some participants did not complete questionnaires fully due to lack of experience or task exposure.

4 Results

In the following sections, means and standard deviations are presented for the anthropometric and range of motion data. Furthermore, in the following sections, percentage of participants rating the items greater than or equal to 4 (“borderline”) for acceptability rating, items equal to 3 (“acceptable”) for fit sizing rating, items less than 3 (“noticeable discomfort”) for physical discomfort rating, and items less than three (“noticeably warm”) for thermal discomfort rating are presented from the questionnaire data.

The questionnaires included participant’s assessment of the following areas:

- Fit
- Tasks
    - Obstacle
    - Vehicle patrol
    - FIBUA
    - Live fire
- Daily Exit
- Thermal Discomfort
- Physical Discomfort
- Features and
- Final Exit

At the end of each day, the participants were required to complete a series of acceptability and discomfort questionnaires about the throat protector condition.

Using the standard 7-point scale of acceptance, participants rated the throat protector condition in the context of the task. In addition, using the standard five point scale of fit sizing, participants rated the acceptability of fit sizing; using the standard five point scale of physical discomfort, participants rated the acceptability of physical discomfort; and using the standard five point scale of thermal discomfort, participants rated the acceptability of thermal discomfort. In addition to ratings using the scale, participants were given the opportunity to make comments.

Following the completion of four days of tasks, the researcher led a focus group to generate discussion on different aspects of the throat protector condition.

Of the 26 participants recruited from the Canadian Forces, only 24 participants completed the full 4-day trial because:

- Some participants had to withdraw due to other training and operational requirements, and
- Some participants did not complete questionnaires fully due to lack of experience or trial exposure.

4.1 Anthropometry

At the beginning of the study anthropometric data was collected on each participant. The data collected included throat circumferences and throat length and stature lengths. Additionally photographs of throat coverage were taken for further analysis if required (outside the scope of this trial).

Participants were measured using a self-retracting pocket tape and a plastic tape. The mean values with standard deviation (SD) of the anthropometric measurements indicate how the participants related to the 1997 Land Forces (LF) anthropometric survey shown below in Table 2.

The participants ranged in throat circumference from 351 mm to 475 mm which accommodates the 1st%ile male to the 99th %ile male (from the values in the 1997 Anthropometry Survey of the Land Forces Survey). In terms of throat circumference at the base of the throat participants ranged from 362 mm to 485 mm which accommodates less than the 1st %ile male to the 98th %ile male – See Table 2. Throat length was taken from the top of the participants shoulder to the tragus area of the ear. Throat length ranged from 105 mm to 150 mm, with an average length of 129.5 mm. There is no comparable data within the 1997 Anthropometry Survey of the Land Forces Survey to compare these measurements but it does provide a good indication of the total range of throat length among soldiers that represent the complete anthropometric spectrum in other measures. Each participant's stature was measured and compared to the 1997 Anthropometry Survey of the Land Forces. The participants ranged in stature from 1650 mm to 2033 mm which accommodates the 5th%ile male to greater than the 99th%ile male – See Table 2.

Table 2: Anthropometric Measurements of Participants

Measurement (n=26)	Min (%)	Max (%)	Avg. (SD)
Throat Circumference (mm)	351 (1)	475 (99)	389 (29)
Throat Circumference (Base) (mm)	362 (<1)	485 (98)	398 (30)
Throat Height (mm) (note 1.)	105	150	129.5 (11)
Stature (mm)	1650 (5)	2033 (>99)	1790 (95)
Note: 1. not in the 1997 Land Forces (LF) anthropometric survey			

The participants represented the breadth of the Male CF population for stature as represented in the 1997 Land Forces (LF) anthropometric survey.

4.2 Fit Results

On the first day, each participant completed a fitting assessment to evaluate fit of the throat protector.

The percentage of participants rating the items greater than or equal to four ("borderline") are shown below in Table 3 and items equal to 3 ("acceptable") for fit rating in Table 4.

The results indicated that most participants (greater than 90%) rated "borderline" or better for fit. In addition, all participants achieved an "acceptable" final fit with the throat protector.

Table 3: Fit Acceptability Questionnaire Percentage 'Borderline' or More Acceptability Results

Fit Acceptance	User Acceptance Rating ≥ 4 (n=26)
Throat Protector Height	100.0%
Throat Protector Girth	100.0%
Final Fit	100.0%

Table 4: Fit Questionnaire Percentage 'Acceptable' Sizing Fit Results

Fit Sizing	User Fit Rating = 3 (acceptable) (n=26)
Throat Protector Height	92.3%
Throat Protector Girth	92.3%
Final Fit	100.0%

4.3 Ease of Use and Coverage Results

On the first day, each participant completed an ease of use and coverage assessment to evaluate ease of use and coverage of the throat protector.

The percentage of participants rating the items greater than or equal to four ("borderline") are shown below in Table 5.

The results indicated that most participants (greater than 90%) rated "borderline" or better for ease of use, and coverage acceptance.

Table 5: Ease of Use and Coverage Questionnaire Percentage 'Borderline' or More Acceptability Results

Ease of Use Acceptance	User Acceptance Rating ≥ 4 (n=26)
Ease of Attachment	96.2%
Ease of Donning	100.0%
Ease of Doffing	100.0%
Coverage Acceptance	
Front of Throat (Standing)	92.3%
Side of Throat (Standing)	96.2%
Front of Throat (Sitting)	92.3%
Side of Throat (Sitting)	92.3%

4.4 Range of Motion Measurements

All participants were measured for neck range of motion (lateral flexion, and extension) while wearing throat protection and while wearing no throat protection.

The mean values with standard deviation (SD) for range of motion measurements are shown below in Table 6.

A repeated measures ANOVA indicated that the presence of the throat protector, with respect to neck range of motion, only had a significant effect during forward flexion.

Table 6: Throat Protector Throat Range of Motion

Range of Motion (n=26)	Throat Protector Mean (SD)	No Throat Protector Mean (SD)
Neck Lateral Flexion (°) – p-value= 0.88	124 (5.4)	124 (5.5)
Neck Forward Flexion (°) – p-value= 0.01	61.8 (7.7)	67 (8.9)

The throat protector did not affect the ability of the participant to look from side to side.

4.5 Weapon and Vehicle Compatibility

The compatibility section prompted participants to give an acceptability rating of the throat protector for the following weapons and vehicles:

- Weapons
  - C9A1 LMG,
  - C6 MMG,
  - M72 SRAWW,
  - Carl Gustav (No. 1 and 2 positions), and
  - M-67 Grenades.
- Vehicles
  - LAV III,
  - Coyote, and
  - Bison.

Using the standard seven point scale of acceptance, participants rated the acceptability of throat protector compatibility with different weapons and vehicles crew positions. The percentage of participants rating the items as acceptable are shown below in Table 7.

Table 7: Weapons and Vehicle Compatibility Percentage 'Borderline' or More Acceptability Results

Compatibility	User acceptance rating ≥ 4	n
Weapons Compatibility		
C9A1 LMG	90.5%	21
C6 MMG	96.2%	25
M72 SRAWW	100%	26
Carl Gustav No. 1	100%	25
Carl Gustav No. 2	100%	25
Dummy M-67 Grenades throw	100%	25
Vehicle Crew Station Compatibility		
LAV III Driver	88.0%	25
LAV III Turret	84.0%	25
LAV III Air Sentry	100%	25
Coyote Driver	88.5%	26
Coyote Turret	80.8%	26
Coyote Air Sentry	100.0%	26
Bison Driver	84.0 %	25
Bison CC	88.0 %	25
Vehicle Inspection Compatibility		
Vehicle Inspection Compatibility	91.3%	23

Greater than 90 percent of the participants found the throat protector to be acceptable for compatibility with all of the weapon systems evaluated. In addition, greater than 80 percent of the participants found the throat protector to be acceptable for compatibility with the different vehicle crew positions assessed. Greater than 90 percent of the participants found the throat protector to be acceptable for compatibility with vehicle inspection tasks.

4.6 Obstacle, Vehicle Patrol and FIBUA Fire Task Questionnaires Results

The task information is shown below for the following three tasks.

- Obstacle,
- Vehicle patrol, and
- FIBUA.

At the end of each task, participants completed a task questionnaire for throat protector condition.

Using the standard seven point scale of acceptance, participants rated the acceptability of the throat protector with the different activities. The percentage of participants rating compatibility with the task assessment elements as acceptable are detailed in Table 8

Table 8: Obstacle, Vehicle Patrol and FIBUA Questionnaire Percentage 'Borderline' or More Acceptability Results

	Activities		
	Obstacle (n=23)	Vehicle Patrol (n=22)	FIBUA (n=21)
Features	User Acceptance Rating ≥ 4	User Acceptance Rating ≥ 4	User Acceptance Rating ≥ 4
Physical Comfort	100.0%	100.0%	100.0%
Stability	95.7%	95.5%	100.0%
Thermal Comfort	87.0%	100.0%	100.0%
Weight	100.0%	100.0%	100.0%
Equipment Compatibility	100.0%	90.9%	100.0%
Weapon Compatibility	100.0%	100.0%	100.0%
Clothing Compatibility	100.0%	100.0%	100.0%
Ease of Movement	87.0%	100.0%	90.5%
Overall Rating for this Task	100.0%	100.0%	100.0%

As the above table shows, over 85 percent of the participants rated compatibility of the throat protector with obstacle, vehicle patrol and FIBUA tasks as acceptable. The throat protector did not cause or amplify existing problems in the dynamic military tasks evaluated.

4.7 Live Fire Task Questionnaires Results

Participants completed range firing drills at a small arms range. While the original live range firing took the form of grouping and zeroing at 50m, fire and movement from the 200m, and fire and movement from the 100m. Snow conditions (poor visibility) forced a change with the second relay; after zeroing, the second relay started at the 100m only. Each participant evaluated the use of the throat protector and the no throat protector conditions during range firing. At the conclusion of each serial every participant completed a questionnaire which specifically asks for ratings on different criteria on the specific throat protector. Range scores were recorded for each participant.

4.7.1 Range Score Results

A total of 26 participants completed some or all (23) of the range firing tests. The range scores for the throat protector and the no throat protector conditions varied from one hit to 49 hits (note the

maximum score was 50). The mean number of hits varied from 30.2 with the throat protector to 33.7 for the no throat protector condition – see Table 9

Table 9: Range Scores

Condition	Score – Avg (SD) (n=26)
Throat Protector	30.2 (8.0)
No Throat Protector	33.7 (8.3)

A repeated measures ANOVA was performed on the data and it was found that there were no significant differences for live fire range scores (p-value= 0.08).

4.7.2 Range Task Questionnaire Results

Upon completion of each firing serial participants completed a task questionnaire.

Using the standard seven point scale of acceptance, participants rated the acceptability of the throat protector with the different activities. The percentage of participants rating compatibility with the live fire task assessment elements as acceptable are detailed in Table 10.

Table 10: Live Fire Questionnaire Percentage 'Borderline' or More Acceptability Results

Ratings of Acceptability for Live Fire Task	User Acceptance Rating ≥ 4 (n=25)
Task Performance	
Adopting Prone Fire Position (if applicable)	92.0%
Adopting Kneeling Fire Position (if applicable)	92.0%
Adopting Standing Fire Position (if applicable)	96.0%
Sighting	92.0%
Weapon Stability	96.0%
Firing	96.0%
Loading / Unloading / Handling	96.0%
Accessing Mags / Drums n=22	95.5%
Clearing Stoppages (if applicable) n=21	95.2%
Sling Compatibility (if applicable) n=21	90.5%
Ease of Throat/Head Movement	88.0%
Speed of Throat/Head Movement	88.0%
Overall Task Performance	92.0%
Equipment Compatibility	
Weapon	96.0%
Fragmentation Vest	96.0%
Helmet	96.0%
Clothing	96.0%
Gloves	96.0%
Overall Equipment Compatibility	96.0%
Comfort	
Fit	96.0%
Weight	96.0%
Bulk	96.0%
Chaffing	92.0%
Stiffness	88.0%
Physical comfort	96.0%
Thermal comfort	96.0%
Stability	
Side Attachment Stability During Live Fire	96.0%
Front Attachment Stability During Live Fire	96.0%
Overall Stability	96.0%
Overall	
Compatibility During Live F ire	100.0%

As the above table shows, greater than 85 percent of the participants found the throat protector to be acceptable for the live fire activities. The throat protector did not cause or amplify existing problems in the live fire tasks.

4.8 Daily Exit Questionnaire Results

At the end of each day all participants completed a daily exit questionnaire to evaluate adjustments, comfort, equipment compatibility, task compatibility, range of motion and overall acceptability. While the same questions were answered by the 24 participants, a number of participants indicated that they could not answer a number of questions due to lack of experience or trial exposure with the equipment.

Using the standard seven point scale of acceptance, participants rated the acceptability of the throat protector with the different activities.

Table 11: Daily Exit Percentage 'Borderline' or More Acceptability Results

Rate the Following Features	User Acceptance Rating ≥ 4	n
Initial Fit	100.0%	24
Retention	100.0%	24
Donning/Doffing	100.0%	24
Ease of Adjustment	100.0%	24
Snagging in the Vehicle	87.5%	24
Snagging while Dismounted	100.0%	24
Front of Throat Coverage	91.7%	24
Side of Throat Coverage	91.7%	24
Neck Range of Motion	91.7%	24
Overall Ease of Movements	100.0%	24
Ease of Use as a System	100.0%	22
Features Acceptance (snaps, etc.)	100.0%	22
Compatibility with Rest of PPE (fragmentation vest, etc.)	100.0%	22
Compatibility with Weapons	100.0%	24
Entering/Exiting Hatches	100.0%	22
Entering/Exiting Vehicle	100.0%	22
Compatibility with Clothing	95.5%	22
Compatibility with Helmet	100.0%	22
Thermal Comfort	100.0%	22
Physical Comfort	100.0%	22
Pressure Points	100.0%	22
Skin Irritation/ Abrasion/ Rubbing	95.5%	22
Hot Spots	100.0%	22
Weight	100.0%	22
Throat Discomfort	100.0%	22
Ability to Manoeuvre Through Buildings	100.0%	21
Ability to Engage Targets While Stationary	100.0%	22
Ability to Engage Targets While Moving	100.0%	21
Ability to Perform Mounted Infantry Tasks	100.0%	21
Ability to Perform Dismounted Infantry Tasks	95.2%	21
Suitability for FIBUA House Clearing Tasks	100.0%	20
Ability to Perform Fire and Movement Tasks	100.0%	23
Ability to Perform Vehicle Patrol Tasks	95.5%	22
Ability to Move in Tight Quarters (such as a breach hole)	91.3%	23
Suitability for Crawling	91.3%	23
Suitability for Throwing	100.0%	23
Overall Stability of Throat Protector	100.0%	23
Overall System Rating	100.0%	23

The above table shows, that greater than 85 percent of the participants considered the throat protector as acceptable for all issues on the daily exit questionnaire.

4.9 Thermal Discomfort Questionnaires Results

At the end of each day all participants completed a thermal discomfort questionnaire regarding hot spots, ventilation and overall thermal comfort.

Using the standard five point scale of thermal discomfort, participants rated the thermal discomfort. Only a small percentage of participants (3 participants, 12.5 percent) rated the items greater than three ("noticeably warm").

The majority (87.5%) of twenty four participants rated thermal discomfort as acceptable (rating <= noticeably warm) for both front and side of throat regions.

In addition, using the standard seven point scale of acceptance, participants rated the acceptability thermal comfort of the throat protector. The percentage of participants rating the items greater than or equal to four ("borderline") are shown below in Table 12.

The results indicate that for thermal discomfort, greater than 90 percent of the participants found the throat protector to be acceptable.

Table 12: Thermal Discomfort Percentage 'Borderline' or More Acceptability Results

Thermal Discomfort Aspects	**User Acceptance Rating ≥ 4** (n=24)
Hot Spots	91.7%
Ventilation	91.7%
Overall Thermal Comfort	91.3%

As shown above, greater than 90 percent of the participants considered the throat protector as acceptable for thermal discomfort, all acceptability issues and no discomfort as indicated on the questionnaire. Please note the trial winter weather condition does not reflect hot environments such as Afghanistan.

4.10 Physical Discomfort Questionnaires Results

At the end of each day all participants completed a physical discomfort questionnaire regarding pressure points, chaffing and overall physical comfort.

Using the standard five point scale of physical discomfort, participants rated the acceptability of physical discomfort. A small percentage of participants (<5%) rated the items greater than three ("noticeable discomfort").

The majority (95.8%) of twenty four participants rated physical discomfort as acceptable for the front of the throat region. In terms of the side throat region, all participants rated the physical discomfort acceptable

In addition, using the standard seven point scale of acceptance, participants rated the physical discomfort of the throat protector. The percentage of participants rating the items greater than or equal to four ("borderline") are shown below in Table 13.

Table 13: Physical Discomfort Percentage 'Borderline' or More Acceptability Results

Physical Discomfort Aspects:	User Acceptance Rating ≥ 4 (n=24)
Pressure Points	95.8%
Chaffing	87.5%
Overall Physical Comfort	95.8%

As shown above, greater than 85 percent of the participants considered the throat protector as acceptable for physical discomfort for all acceptability issues and no discomfort indicated on the questionnaire.

4.11 Throat Protector Features Results

At the end of the trial all participants completed a feature questionnaire to evaluate acceptability of the throat protector attachments and coverage features.

Using the standard seven point scale of acceptance, participants rated the acceptance of the throat protector. The results in Table 14 below indicate the percentage of participants rating the item greater than or equal to four ("borderline").

Greater than 90 percent of the participants found the throat protector to be acceptable for all feature functionality and durability evaluation criteria.

Table 14: Throat Protector Feature Durability and Functionality Percentage 'Borderline' or More Acceptability Results

Features	Functionality User Acceptance Rating ≥ 4 (n=24)	Durability User Acceptance Rating ≥ 4 (n=24)
Side Snap Attachment	100.0%	96.0%
Side Loop Attachment	96.0%	92.0%
Front Fragmentation Vest Snap Attachment	96.0%	100.0%
Front Fragmentation Vest Velcro Attachment	100.0%	100.0%
Side Area Coverage	96.0%	100.0%
Front Area Coverage	96.0%	100.0%

4.12 Final Exit Questionnaire Results

At the end of the trial each participant completed a final exit questionnaire assessing the throat protector for adjustments, comfort, equipment compatibility, task compatibility, range of motion and overall acceptance.

Using the standard seven point scale of acceptance, participants rated the acceptance of the throat protector. The results shown below in Table 15 indicate the percentage of participants rating the item greater than or equal to four ("borderline").

Greater than 80 percent of the participants found the throat protector to be acceptable for all the evaluation criteria.

Table 15: Final Exit Percentage 'Borderline' or More Acceptability Results

Features	User Acceptance Rating ≥ 4 (n=24)
Adjustments	
Putting On	95.8%
Fit Adjustment(s)	100.0%
Taking Off	95.8%
Adjustment Retention	100.0%
Ease of Use (attaching and removing)	95.8%
Comfort	
Snagging	95.8%
Stiffness	100.0%
Weight	100.0%
Physical Comfort	95.8%
Thermal Comfort	91.7%
Equipment Compatibility	
Fragmentation Vest	100.0%
Weapons (C7, C9, C6, etc)	95.8%
Equipment (helmet, gloves, clothing, etc.)	95.8%
Vehicles (LAV III, G-wagon, etc.)	87.5%
Overall Equipment Compatibility	100.0%
Task Compatibility	
Dismounted Combat Tasks	95.8%
Mounted Combat Tasks	87.5%
General Support Tasks	100.0%
Overall Suitability for Operations	95.8%
Range of Motion	
Throat Forward (Flexion)	87.5%
Throat Backward (Extension)	100.0%
Throat Side to Side (lateral bending)	87.5%
Throat Rotation Left to Right	83.3%
Overall Throat Motion	91.7%
Other	
Durability	100.0%
Stability	95.8%
Overall	
System Rating	91.7%

4.13 Focus Group Discussion

At the end of the trial, participants participated in a guided discussion focus group regarding the throat protector. The discussion took place after all participants had exposure to the throat protector over a wide range of activities.

A summary of major comments made by the participants and percent of participants in agreement with a particular topic during the focus group discussion are presented below – See Table 16.

Table 16: Focus Group Topics

Topic	Percentage (n=24)
• Problems with retention of the straps	0%
• Problems with initial high coverage position and fit of throat protector	8.3%
• Problem with Compatibility with Tac Vest • They were forced to lower the tac-vest lower than the edge of the Frag Vest.	16.7%
• Problem with irritation on the side of the throat when on the high position	25.0%
• Add another adjustment button on the sides	70.8%
• Material stiffness of the throat protector is acceptable	100%
• Throat protector overall is acceptable with no changes	33.3%
• Small modifications such as the material that touches the throat and an extra button would make it acceptable if forced to use.	66.7%
• Participants require proof that it provides increased protection	100%
• Participants concerned that this item will significantly affect thermal heat load	100%

While all participants felt that the throat protector was acceptable, they believed that minor modifications would improve the acceptance, such as the material that touches the throat and an extra button would make it acceptable if forced to use. The participants' biggest concern was proof that the throat protector provides increased protection and it would then be recognized as necessary.

4.14 Summary of Results

The overall performance of the throat protector was good. A summary of the different tasks is provided in Table 17 below.

Table 17: Summary of Results

✓ = generally acceptable (greater than 80%)

Questionnaires	Overall
Fit	✓
Obstacle Tasks	✓
Vehicle Patrol	✓
FIBUA	✓
Live fire	✓
Daily Exit	✓
Thermal Discomfort	✓
Physical Discomfort	✓
Feature Functionality	✓
Feature Durability	✓
Final exit	✓
Compatibility Ratings	
Weapon	✓
Vehicle	✓
Vehicle Inspection	✓

Based on the throat protector questionnaires and compatibility ratings, greater than 80 percent of the participants consider the throat protector as acceptable for all the tasks carried out in this trial.

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5 Discussion

A field trial was undertaken to evaluate user acceptance and performance of a new throat protector design. The 4-day trial was completed at CFB Valcartier with twenty-six regular force soldiers. Participants undertook a battery of operational and human factors tests while wearing the throat protector design.

A progressive testing protocol was used that included a static anthropometry assessment of fit, static range of motion stand, static compatibility with weapons and vehicles stand, dynamic military tasks, thermal load, and physical discomfort. Data collection included acceptability ratings following the tasks, thermal and physical discomfort ratings, range of motion assessments, fit assessments, daily and exit questionnaire acceptability ratings, and guided focus groups.

In terms of throat range of motion, there were no significant differences between the throat protector and no throat protector conditions.

The participants in this trial represented a large portion of the Canadian Forces population. The male participants almost represented the entire Canadian Forces population with respect to the anthropometric measurements taken. Since the goal of the throat protector is to add protection to the throat area, the current size throat protector is able to accommodate the vast majority of Canadian Forces males. It is safe to say that very few male soldiers would require a different throat protector size.

The trial had several limitations, one being the absence of females. Since, it was concluded that the vast majority of males can wear the current size it would have been beneficial to have an array of females (typically smaller in proportion to males) to see what percentage would wear this throat protector size. Furthermore, the trial was completed in late fall conditions, which are not the norm in hot theatre, such as Afghanistan. Therefore, the comfort could not be assessed in hot conditions.

The throat protector supported by the results of this study is compatible with a wide range of tasks, weapons compatibility, and vehicle compatibility. Furthermore, the vast majority of Canadian Forces males can wear the current throat protector size.

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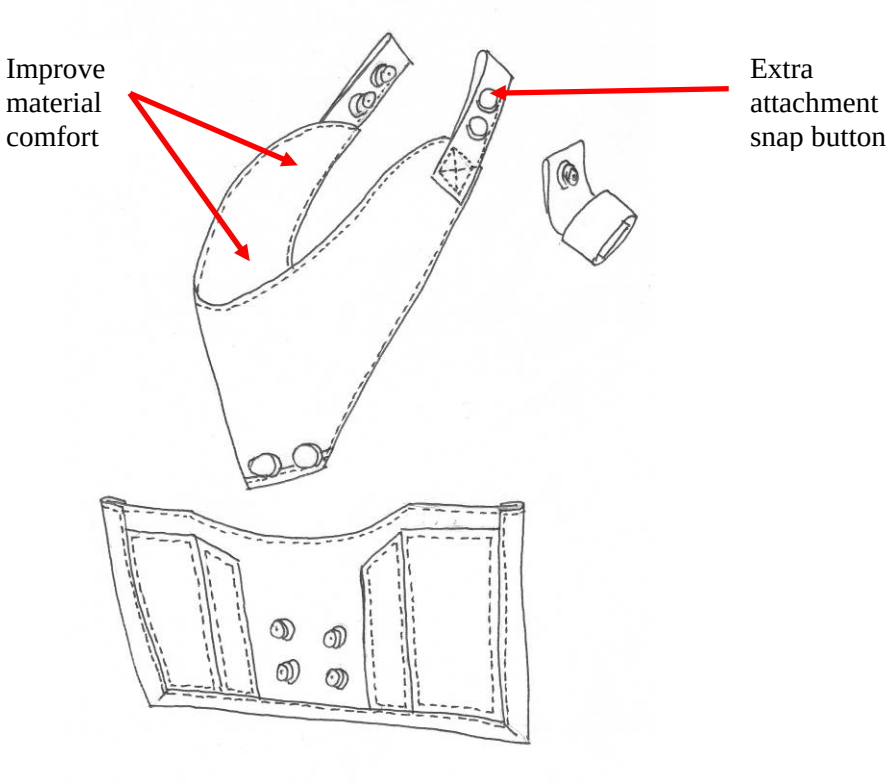
6 Recommendations

The results of this trial indicated that the throat protector will meet Canadian Forces needs. The trial participants supported the notion of throat protection and it appears that a single size throat protector will be sufficient for the majority (5^{th} to 95^{th}) of Canadian Forces males. Furthermore, the throat protector did not cause or amplify existing problems in performing their day-to-day tasks. Therefore, the Canadian Forces should continue to pursue the throat protector design, as it appears to meet the needs of the Canadian Army.

Participants suggest two small modifications with the current throat protector design to improve acceptance of design. Priorities for design changes:

- Improve the material of the throat protector where it touches the throat to improve comfort, and
- Improve the adjustability of the throat protector with extra snap buttons.



Future validation should investigate the impact of the throat protector on soldiers' thermal comfort because all participants had concerns that the throat protector will have significant impact on thermal heat load. Since, this trial was conducted in cold weather conditions it could not provide that information.

As this trial did not have any female participants future validation should also investigate the suitability of this throat protector size for female soldiers because typically females have smaller proportions than males which could have significant impact on fit.

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7 References

a. (1997) Anthropometric Survey of the Land Forces, DCIEM Report No. 98-CR-15.

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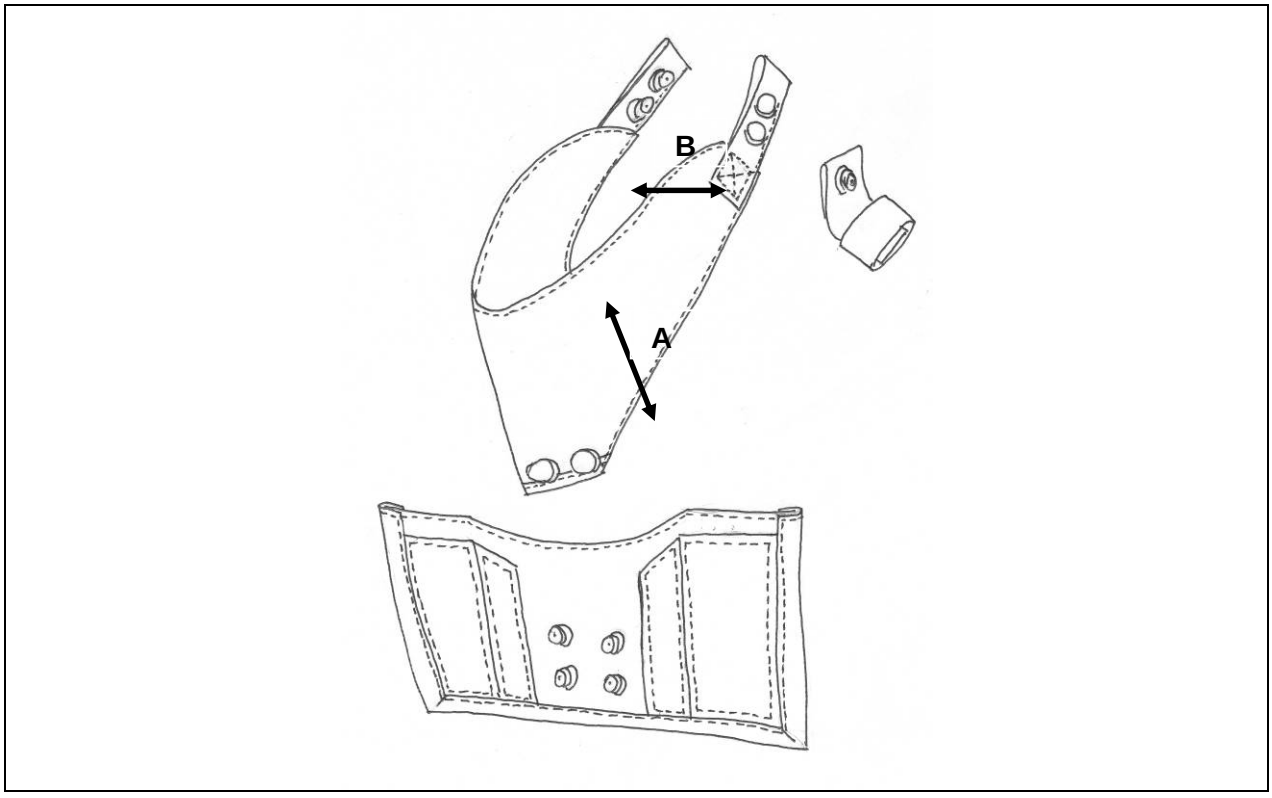
Annex A: Trial Fit Questionnaires

Annex A:

Trial Fit Questionnaires

Évaluez le protecteur de cou selon les critères suivants:	**Acceptabilité de l'ajustement**									**Taille du protecteur**			
	☹			😐			☺	☹ court petit serré	😐	☺	😐	☹ long large lâche
	1	**2**	**3**	**4**	**5**	**6**	**7**					
Hauteur (A)	O	O	O	O	O	O	O	O	O	O	O	O
Sangle (B)	O	O	O	O	O	O	O	O	O	O	O	O
AJUSTEMENT FINAL	**O**	**O**	**O**	**O**	**O**	**O**	**O**	**O**	**O**	**O**	**O**	**O**
Facilité pour attacher	O	O	O	O	O	O	O					
Facilité de mise en place	O	O	O	O	O	O	O					
Facilité d'enlèvement	O	O	O	O	O	O	O					
Évaluez la protection balistique selon les critères suivants:	**Acceptabilité de la protection**											
	☹			😐			☺					
	1	**2**	**3**	**4**	**5**	**6**	**7**					
Devant du cou (debout)	O	O	O	O	O	O	O					
Côté du cou (debout)	O	O	O	O	O	O	O					
Devant du cou (assis)	O	O	O	O	O	O	O					
Côté du cou (assis)	O	O	O	O	O	O	O					



Annex B: Trial Task Questionnaires

Annex B:

Trial Task Questionnaires

OBSTACLE, VEHICLE PATROL AND FIBUA TASK QUESTIONNAIRE

DONNÉES PERSONNELLES Indiquez clairement votre nom, votre numéro de sujet, la date et les informations requises dans les cases indiquées

Nom aaaaaaaaaa **Tâche:**

Protection du cou: Gorge 0 Gorge/ Nuque A 0 Gorge/ Nuque B 0

Taux les elements suivants	Utilisateur Acceptation cote ☹ 1	2	3	😐 4	5	6	☺ 7	Commentaires
Confort Physique	0	0	0	0	0	0	0	
Stabilité	0	0	0	0	0	0	0	
Confort Thermique	0	0	0	0	0	0	0	
Poids	0	0	0	0	0	0	0	
Matériel Compatibilité	0	0	0	0	0	0	0	
Arme Compatibilité	0	0	0	0	0	0	0	
Vêtements Compatibilité	0	0	0	0	0	0	0	
Facilité de Circulation	0	0	0	0	0	0	0	
La note globale pour cette tâche	0	0	0	0	0	0	0	

Annex B:

Trial Task Questionnaires

Live Fire Task Questionnaire

Évaluez l'acceptabilité de l'uniforme selon les critères suivants:

Évaluez le niveau d'acceptabilité pendant le tir réel:	☹ 1	2	3	😐 4	5	6	☺ 7	N/A
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	0
En courant	O	O	O	O	O	O	O	0
En regardant à travers le télescope (Sighting)	O	O	O	O	O	O	O	0
Stabilité de l'arme	O	O	O	O	O	O	O	0
Tir	O	O	O	O	O	O	O	0
Manipulation pour charger / décharger	O	O	O	O	O	O	O	0
Accès aux chargeurs / Boitiers de la C9	O	O	O	O	O	O	O	0
Mesures correctives d'enrayages (clearing Stoppages) si applicable	O	O	O	O	O	O	O	0
Compatibilité avec la bandouilière (sling) si nécessaire	O	O	O	O	O	O	O	0
Facilité des mouvements du coup et de la tête	O	O	O	O	O	O	O	0
Vitesse des mouvements du coup et de la tête	O	O	O	O	O	O	O	0
Performance générale des tâches	O	O	O	O	O	O	O	0

Compatibilité avec l'équipement	☹ 1	2	3	😐 4	5	6	☺ 7	N/A	**Confort**	☹ 1	2	3	😐 4	5	6	☺ 7	N/A
Arme	0	0	0	0	0	0	0	0	Ajustement	0	0	0	0	0	0	0	0
Veste anti-fragmentation	0	0	0	0	0	0	0	0	Poids	0	0	0	0	0	0	0	0
Casque	0	0	0	0	0	0	0	0	Volume	0	0	0	0	0	0	0	0
Visière	0	0	0	0	0	0	0	0	Irritation	0	0	0	0	0	0	0	0
Vêtements	0	0	0	0	0	0	0	0	Raideur	0	0	0	0	0	0	0	0
Gants	0	0	0	0	0	0	0	0	**Confort physique général**	0	0	0	0	0	0	0	0
Compatibilité générale avec l'équipement	0	0	0	0	0	0	0	0	**Confort thermique général**	0	0	0	0	0	0	0	0

Annex B:

Trial Task Questionnaires

Stabilité	☹ 1	2	3	😐 4	5	6	☺ 7	**N/A**
Stabilité des attaches de côté lors du tir réel	0	0	0	0	0	0	0	0
Stabilité de l'attache de face lors du tir	0	0	0	0	0	0	0	0
Stabilité générale	0	0	0	0	0	0	0	0
COMPATIBILITÉ GÉNÉRALE LORS DU TIR	0	0	0	0	0	0	0	0

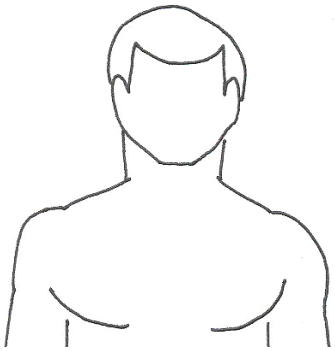
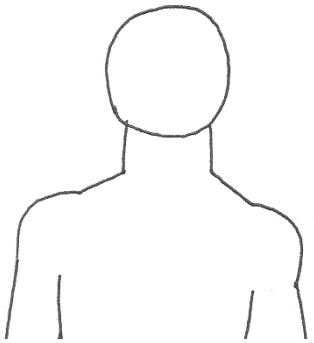
Annex C: Trial Discomfort Questionnaires

Annex C:

Trial Discomfort Questionnaires

THERMAL DISCOMFORT QUESTIONNAIRE

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

FACE	**CÔTÉ**	**DOS**
		

Évaluez les aspects suivants du confort thermique:	☹ 1	2	3	😐 4	5	6	☺ 7
Points chauds	O	O	O	O	O	O	O
Ventilation	O	O	O	O	O	O	O
Confort thermique général	O	O	O	O	O	O	O

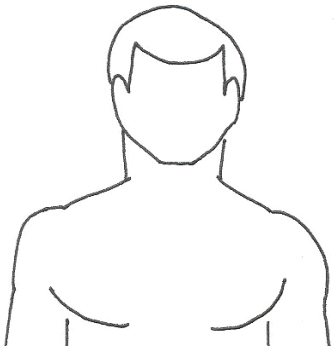
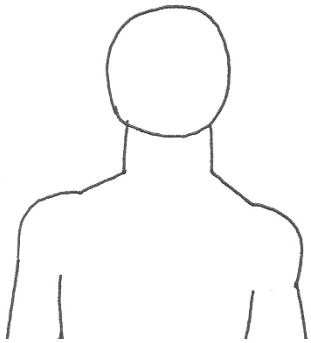
Commentaires:

Annex C:

Trial Discomfort Questionnaires

PHYSICAL DISCOMFORT QUESTIONNAIRE

En utilisant les différentes positions du torse 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**	**DOS**
		

Évaluez les aspects suivants du confort physique:	☹ **1**	**2**	**3**	😐 **4**	**5**	**6**	☺ **7**
Points de pression	O	O	O	O	O	O	O
Irritation	O	O	O	O	O	O	O
Confort physique général	O	O	O	O	O	O	O

Commentaires:

Annex D: Trial Daily Exit Questionnaires

Annex D:

Trial Daily Exit Questionnaires

Évaluez les différents critères	Niveau d'acceptabilité							N/D
	☹ 1	2	3	😐 4	5	6	☺ 7	
Ajustement initial	0	0	0	0	0	0	0	0
Rétention	0	0	0	0	0	0	0	0
Mise en place/enlèvement	0	0	0	0	0	0	0	0
Facilité d'ajustement	0	0	0	0	0	0	0	0
Mise en place dans le véhicule	0	0	0	0	0	0	0	0
Mise en place quand démonté	0	0	0	0	0	0	0	0
Protection du devant du cou	0	0	0	0	0	0	0	0
Protection du côté du cou	0	0	0	0	0	0	0	0
Étendue de mouvement	0	0	0	0	0	0	0	0
Facilité de mouvement (général)	0	0	0	0	0	0	0	0
Facilité d'utilisation	0	0	0	0	0	0	0	0
Acceptabilité des caractéristiques (fermoir, etc…)	0	0	0	0	0	0	0	0
Compatibilité avec le reste de l'équipement de protection (veste anti-fragmentation, etc...)	0	0	0	0	0	0	0	0
Compatibilité avec les armes	0	0	0	0	0	0	0	0
Compatibilité avec la conduite	0	0	0	0	0	0	0	0
Entrée/Sorties par les sas	0	0	0	0	0	0	0	0
Entrée/Sortie des véhicules	0	0	0	0	0	0	0	0
Compatibilité avec les vêtements	0	0	0	0	0	0	0	0
Compatibilité avec le casque	0	0	0	0	0	0	0	0
Compatibilité avec la visière	0	0	0	0	0	0	0	0
Confort thermique	0	0	0	0	0	0	0	0
Confort physique	0	0	0	0	0	0	0	0
Points de pression	0	0	0	0	0	0	0	0
Irritation de la peau/ Abrasion/ Frottement	0	0	0	0	0	0	0	0
Points chauds	0	0	0	0	0	0	0	0
Poids	0	0	0	0	0	0	0	0

Annex D:

Trial Daily Exit Questionnaires

Évaluez les différents critères	Niveau d'acceptabilité							N/D
	☹ 1	2	3	😐 4	5	6	☺ 7	
Inconfort du cou	0	0	0	0	0	0	0	0
Facilité pour manoeuvrer dans les bâtiments	0	0	0	0	0	0	0	0
Facilité d'attaque des cibles quand vous êtes à l'arrêt	0	0	0	0	0	0	0	0
Facilité d'attaque des cibles quand vous êtes en mouvement	0	0	0	0	0	0	0	0
Facilité d'effectuer les tâches de commandant d'équipe	0	0	0	0	0	0	0	0
Facilité d'effectuer les tâches d'artilleurs	0	0	0	0	0	0	0	0
Facilité d'effectuer les tâches de chauffeur	0	0	0	0	0	0	0	0
Facilité d'effectuer les tâches de sentinelles aériennes	0	0	0	0	0	0	0	0
Facilité d'effectuer les tâches d'observation (autres que sentinelle aérienne)	0	0	0	0	0	0	0	0
Facilité d'effectuer les tâches de l'infanterie motorisée	0	0	0	0	0	0	0	0
Facilité d'effectuer les tâches de l'infanterie à pied	0	0	0	0	0	0	0	0
Adéquat pour les tâches de déblayage de maisons lors d'opérations militaires en terrain urbain	0	0	0	0	0	0	0	0
Facilité pour tirer et facilité de mouvement	0	0	0	0	0	0	0	0
Facilité d'effectuer les tâches de patrouilleur en véhicule	0	0	0	0	0	0	0	0
Facilité de mouvement dans les endroits étroits (comme les brèches)	0	0	0	0	0	0	0	0
Adéquat pour l'escalade	0	0	0	0	0	0	0	0
Adéquat pour ramper	0	0	0	0	0	0	0	0
Adéquat pour lancer	0	0	0	0	0	0	0	0
Stabilité générale de la protection du cou	0	0	0	0	0	0	0	0
Évaluation générale du système	0	0	0	0	0	0	0	0

Commentaires :

Annex E: Trial Final Exit Questionnaires

Annex E:

Trial Final Exit Questionnaires

Évaluez les critères suivants:	Protecteur de la gorge							Aucune protection présentement en service						
	☹ 1	2	3	😐 4	5	6	☺ 7	☹ 1	2	3	😐 4	5	6	☺ 7
Ajustements														
Mettre	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ajustement	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Enlever	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maintient de l'ajustement	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Facilité d'utilisation – attacher et enlever	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Confort														
S'accroche dans l'équipement	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Raideur	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poids	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Confort physique	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Confort thermique	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Compatibilité avec l'équipement														
Veste anti-fragmentation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Armes (C7, C9, C6, etc)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Équipment (casque, gants, habillement, etc)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Véhicules (LAV III, G-wagon, etc)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Compatibilité générales avec l'équipement	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Conpatibilité pendant les tâches														
Täches de combat démontée	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Täches de combat montée	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Täches de support general	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pertinence générale pour les opérations	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Étendue des mouvements														
Tête en avant (flexion)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tête en arrière (extention)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tête de côté (flexion latérale)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rotation de la tête	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Annex E:

Trial Final Exit Questionnaires

Évaluez les critères suivants:	Protecteur de la gorge							Aucune protection présentement en service						
	☹ 1	2	3	😐 4	5	6	☺ 7	☹ 1	2	3	😐 4	5	6	☺ 7
Mouvement général de la tête	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Otre														
Durabilité	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stabilité	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ÉVALUATION GÉNÉRALE DU SYSTEME	0	0	0	0	0	0	0	0	0	0	0	0	0	0

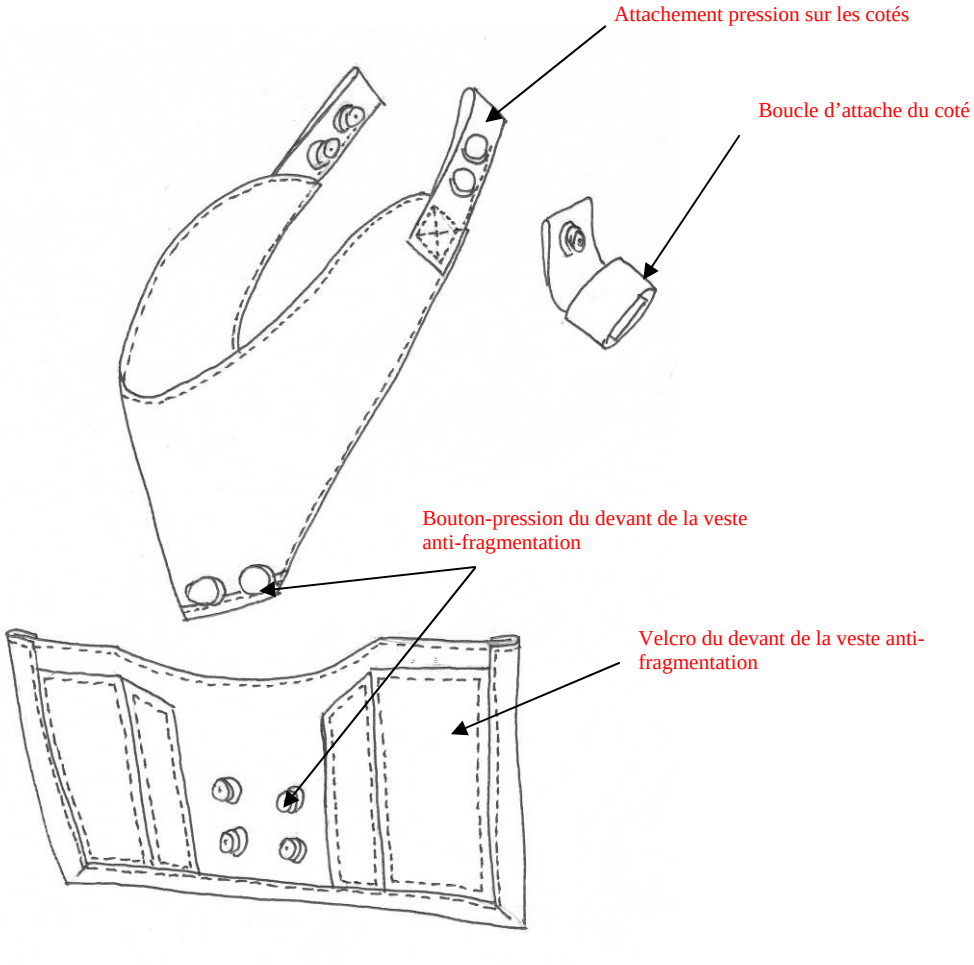
Commentaires:

Annex F: Trial Feature Questionnaires

Annex F:

Trial Feature Questionnaires

Vue frontale



CRITÈRES	FONCTIONNALITÉ							DURABILITÉ						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
1. Attachement pression sur les cotés	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Boucle d'attache du coté	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Bouton-pression du devant de la veste anti-fragmentation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4. Velcro du devant de la veste anti-fragmentation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5. Couverture sur les cotés	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6. Couverture de la région buccale	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Annex F:

Trial Feature Questionnaires

DOCUMENT CONTROL DATA
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3. TITLE (The complete document title as indicated on the title page. Its classification is indicated by the appropriate abbreviation (S, C, R, or U) in parenthesis at the end of the title)

Exposed Crew Throat Protector Human Factor Usability Trial (U)
Test d'utilisation ergonomique d'un protège−gorge pour les membres d'équipage exposés (U)

4. AUTHORS (First name, middle initial and last name. If military, show rank, e.g. Maj. John E. Doe.)

Paul G. Santos Vilhena; Chris Ste−Croix

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6b. NO. OF REFS (Total cited in document.)

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(U) A four day field trial was conducted at Canadian Forces Base (CFB) Valcartier from November 19 to November 23 2007 to evaluate the usability of a new throat protector design. The aims of the trial were to confirm that one size effectively covered off the 5th to 95th percentile of the Canadian forces (CF) male population and to assess the functional impact of the proposed throat protector design on the ability of Land Forces personnel to perform their day−to−day tasks. Twenty−six soldiers completed a battery of human factors tests while wearing either no throat protector (baseline condition) or the new throat protector. A progressive testing protocol was used that included static stands; anthropometry assessment of fit, range of motion, compatibility with weapons and vehicles, and dynamic military tasks; firing range, obstacle course, mounted vehicle ambush and combat dismount, dismounted section attack, and FIBUA. Data collection included fit assessments, range of motion assessments, acceptability ratings following the tasks, thermal and physical discomfort ratings, daily and exit questionnaires, and guided focus groups. The results of this trial indicated that the throat protector design fit the male population and was acceptable for the majority of participants. The trial participants also suggested minor design modifications. Design changes to improve the throat protector design are discussed in the report.

(U) Un essai sur le terrain d’une durée de quatre jours s’est déroulé à la Base des Forces canadiennes (BFC) Valcartier du 19 au 23 novembre 2007 en vue d’évaluer facilité d'utilisation de la conception du nouveau protège−gorge. Le test avait pour objectifs de confirmer que la taille unique couvre effectivement le 5e au 95e percentile de la population des hommes des Forces canadiennes (FC) et d’évaluer l’impact fonctionnel de la conception du protège−gorge proposé sur la capacité du personnel de la force terrestre à effectuer ses tâches quotidiennes. Vingt−six soldats ont complété une batterie de tests d’ergonomie en ne portant aucun protège−gorge (condition de départ) ou en portant le nouveau protège−gorge. Un protocole d’essai progressif a été utilisé en position statique, à savoir des évaluations anthropométriques de l’ajustement, de l’amplitude des mouvements, de la compatibilité avec les armes et les véhicules, ainsi que des tâches militaires dynamiques, à savoir sur les champs de tir, les parcours du combattant, les embuscades antivéhicules montées et la descente du combat, les attaques de section légère et le combat dans les zones bâties. La collecte des données comprenait les évaluations des ajustements, les évaluations des amplitudes des mouvements, les cotes d'acceptabilité à la suite des tâches, les cotes d’inconfort thermique et physique, des questionnaires quotidiens et de sortie ainsi que des groupes cibles dirigés. Les résultats de cet essai ont indiqué que la conception du protège−gorge s’ajustait bien à la population des hommes et était acceptable pour la majorité des participants. Les participants à l'essai ont également suggéré des modifications de conception mineures. Les changements de conception pour améliorer la conception du protège−gorge sont élaborés dans le présent rapport.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (Technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

(U) throat protection; blast protection; fragmentation protection; PPE; Personal protective equipment; C−IED; counter−IED; protective equipment