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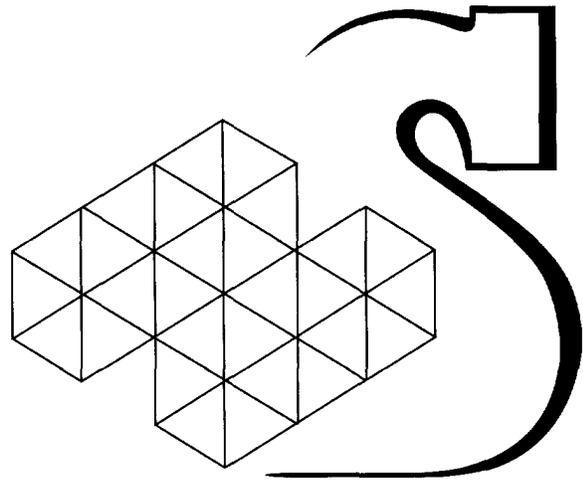
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**LIGHT UTILITY VEHICLE  
WHEELED (LUVW) PROJECT  
HUMAN FACTORS ANALYSIS**

**PWGSC Contract No. W7711-9-7582/002/TOR**

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**July 2001**

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HUMAN FACTORS ANALYSIS**

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DEPARTMENT OF NATIONAL DEFENCE

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July 2001

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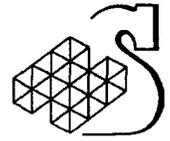
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(U) Within the Canadian Land Force, light, highly mobile vehicles are required to facilitate the tactical command of combat, combat support and combat service support units of the field formations. The aim of this project was to establish the key human factors (HF) vehicle criteria necessary to ensure that the Request For Proposal (RFP) released to industry incorporated human-centered design criteria for maximum benefit to the vehicle user groups (i.e. the soldiers). The scope of work included a literature review of vehicle related HF performance requirements, a review and comment on the draft LUVW SOR, identification of user needs and performance requirements via focus group sessions with intended LUVW user classes, and development of draft HF performance requirements and test protocols. Areas of general concern with the vehicle requirements, as well as concerns relevant to specific variants, are detailed in the report. Soldiers reinforced the desire to test prospective vehicles under real conditions or with real tasks. As well, participants identified the need for adequate training on the vehicles prior to assessment. A number of general trial principles were identified, as well as the need for a progressive testing protocol. Human Factors performance criteria were determined based on a review of the LUVW tasking requirements, a review of relevant vehicle and military literature, and focus group discussions with relevant users. Future HF efforts will be required to conduct a HF user acceptance trial of potential LUVW bid contenders. Options for performance assessment approaches are discussed, including trial principles, scientific testing controls, and progressive testing protocol. The incorporation of the human-centered design criteria developed in these HF efforts will help to ensure that the RFP will provide maximum benefit to the Canadian Forces vehicle user groups.

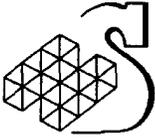
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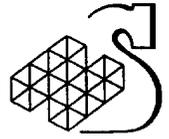
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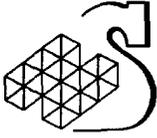
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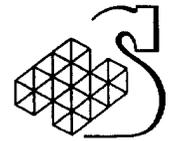
## Abstract

Within the Canadian Land Force, light, highly mobile vehicles are required to facilitate the tactical command of combat, combat support and combat service support units of field formations, to assist in the gathering and passing of information and to effect liaison within and between field formations. The aim of this project was to establish the key human factors (HF) vehicle criteria necessary to ensure that the Request For Proposal (RFP) released to industry incorporated human-centered design criteria for maximum benefit to the vehicle user groups (i.e. the soldiers). The scope of work included a literature review of vehicle related HF performance requirements, a review and comment on the draft LUVW SOR, identification of user needs and performance requirements via focus group sessions with intended LUVW user classes, and development of draft HF performance requirements and test protocols. Areas of general concern with the vehicle requirements, as well as concerns relevant to specific variants, are detailed in the report. Soldiers reinforced the desire to test prospective vehicles under real conditions or with real tasks. As well, participants identified the need for adequate training on the vehicles prior to assessment. A number of general trial principles were identified, as well as the need for a progressive testing protocol. Human Factors performance criteria were determined based on a review of the LUVW tasking requirements, a review of relevant vehicle and military literature, and focus group discussions with relevant users. Future HF efforts will be required to conduct a HF user acceptance trial of potential LUVW bid contenders. Options for performance assessment approaches are discussed, including trial principles, scientific testing controls, and progressive testing protocol. The incorporation of the human-centered design criteria developed in these HF efforts will help to ensure that the RFP will provide maximum benefit to the Canadian Forces vehicle user groups.



## Sommaire

Dans la Force terrestre canadienne, les véhicules légers à grande mobilité doivent faciliter le commandement tactique des unités de combat, d'appui au combat et de soutien logistique des formations; ils doivent aussi contribuer au recueil et à la transmission des renseignements et assurer les liaisons entre les formations et au sein de celles-ci. Le but de ce projet était de déterminer les facteurs humains (FH)critères pour les véhicules, afin de s'assurer que la demande de propositions (DP) communiquée à l'industrie incorpore ce type de critères pour le bénéfice maximal des groupes d'utilisateurs des véhicules (les soldats). L'étendue des travaux comprenait une analyse documentaire des exigences en matière de FH, un examen et des commentaires sur l'ébauche d'EB du VULR, l'identification des besoins et des exigences de rendement des utilisateurs, grâce à des discussions en groupes avec les catégories d'utilisateurs prévus, ainsi qu'une définition provisoire des besoins en matière de FH et des protocoles d'essai. Les principaux sujets de préoccupation sur les exigences relatives au véhicule et les questions propres à des versions particulières sont expliqués en détail dans le rapport. Les soldats ont souligné le désir d'essayer les futurs véhicules en conditions réelles ou dans le cadre de fonctions réelles. De plus, les participants ont identifié le besoin d'une instruction adéquate sur les véhicules avant leur affectation. Un certain nombre de principes d'essai généraux ont été identifiés, de même que la nécessité d'un protocole d'essai par étapes. Les critères de FH ont été déterminés sur la base d'un examen des fonctions du VULR, d'une revue de la documentation militaire et mécanique pertinente et de discussions en groupes avec les utilisateurs prévus. Il faudra faire d'autres travaux sur les FH pour effectuer des essais d'acceptation par l'utilisateur des modèles concurrents du véhicule VULR. Les options sur les méthodes d'évaluation du rendement sont en discussion, y compris les principes des essais, les contrôles scientifiques et le protocole d'essais par étapes. L'incorporation des critères de FH élaborés à partir de ces travaux contribuera à s'assurer que la DP sera aussi bénéfique que possible aux groupes d'utilisateurs de ces véhicules au sein des Forces canadiennes.



## Executive Summary

Within the Canadian Land Force, light, highly mobile vehicles are required to facilitate the tactical command of combat, combat support and combat service support units of field formations, to assist in the gathering and passing of information and to effect liaison within and between field formations. The Defence and Civil Institute of Environmental Medicine (DCIEM) was tasked to provide human factors input to help support the LUVW Project team with its goal of finding the most suitable replacement for the in-service Iltis vehicle to satisfy the end-user requirement for a multi-purpose, user-friendly vehicle.

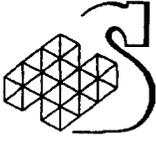
The aim of this project was to establish the key human factors (HF) vehicle criteria necessary to ensure that the Request For Proposal (RFP) released to industry incorporated human-centered design criteria for maximum benefit to the vehicle user groups (i.e. the soldiers). The scope of work included:

1. a literature review of vehicle related HF performance requirements,
2. a review and comment on the draft LUVW SOR,
3. identification of user needs and performance requirements via focus group sessions with intended LUVW user classes, and
4. development of draft HF performance requirements and test protocols.

A set of keywords for the literature search was developed and a series of searches conducted. Due to time and resource constraints, the search was limited to easily accessible documents and those readily available on the web. The articles acquired were reviewed for relevance and applicability according to the LUVW Project's HF effort. The data from the relevant articles were incorporated into a draft Technical and HF Design Checklist. This was subsequently used as a basis for identifying HF design issues and performance requirements.

The draft LUVW SOR was reviewed and relevant HF requirements were identified. The HF requirements and ballistic protection requirements were then reviewed and commented upon. Comments on the SOR were presented to the LUVW Project Team on 25 February 2000 and forwarded to the Scientific Authority. The LUVW Project Team was briefed on the general approach taken by the Clothe the Soldier (CTS) Project in evaluating HF requirements for compliance or bid testing. An initial framework for evaluating the LUVW contenders was also presented to the LUVW Project Team.

A user needs assessment for the LUVW was conducted with potential LUVW variant users and vehicle mechanics. A series of three focus group discussions were held with representative users. Participants were then requested to review and comment on the draft LUVW SOR for the relative variant. Discussions were also held on potential performance assessment approaches, including suitable tasks and acceptable performance requirements. Next, the soldiers participated in a hands-on inspection of the Iltis jeep, the Light Support Vehicle Wheeled (LSVW), and a representative commercial-off-the-self LUVW. The purpose of the inspection was to help identify HF issues and design concerns with the in-service vehicles, and to ensure that these concerns were addressed in any future HF performance requirements.



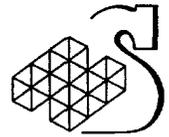
While some minor comments and concerns were raised with the general vehicle requirements, considerable concerns were raised with the variant kit and equipment lists. Areas of general concern with the vehicle requirements, as well as concerns relevant to specific variants, are detailed in the report.

The Command and Signals personnel commented on the need for the design of the LUVW to permit easy access to the TCCCS radio systems for code and frequency uploads by the units signal personnel. Recce soldiers had some concerns that the LUVW Recce variant's equipment and ammunition stowage requirements were underestimated. Recce personnel also commented on the need for a crew commander's hatch in addition to the gunner's station. Military Police (MP) personnel were concerned that the introduction of the LUVW MP variant, designed for three personnel and machine guns, may significantly affect the manning, organization and equipment distribution of Field MP Platoons. MP's also indicated concern for inadequate equipment and ammunition stowage, and inadequate acceleration requirements. Vehicle maintenance personnel raised concerns with the potential maintainability of the new vehicle. Introduction of electrical systems or options such as air conditioning will require training and access to appropriate equipment. Some mechanical problems from other vehicle acquisitions were identified to ensure they provided lessons learned for the LUVW.

Soldiers reinforced the desire to test prospective vehicles under real conditions or with real tasks. As well, participants identified the need for adequate training on the vehicles prior to assessment. A number of general trial principles were identified, as well as the need for a progressive testing protocol.

Human Factors performance criteria were determined based on a review of the LUVW tasking requirements, a review of relevant vehicle and military literature, and focus group discussions with relevant users. These are detailed in the report.

Future HF efforts will be required to conduct a HF user acceptance trial of potential LUVW bid contenders. Options for performance assessment approaches are detailed in the report. These include trial principles, scientific testing controls, and progressive testing protocol. Trial principles include establishing representative independent measures, users, conditions, and tasks. Appropriate experimental design may incorporate repeated measures with trial participants. Scientific testing controls include standardized testing, statistical analyses, balanced order, participant training, and control of bias. A progressive testing protocol begins with static compatibility tests, then progresses to stationary vehicle task tests, dynamic task tests and finally culminates with representative combat tasks. The progressive testing protocols promotes systematic user training and evaluation on the contender vehicles, and culminates with the overall system evaluation. The incorporation of the human-centered design criteria developed in these HF efforts will help to ensure that the RFP will provide maximum benefit to the Canadian Forces vehicle user groups.



## Résumé

Dans la Force terrestre canadienne, les véhicules légers à grande mobilité doivent faciliter le commandement tactique des unités de combat, d'appui au combat et de soutien logistique des formations; ils doivent aussi contribuer au recueil et à la transmission des renseignements et assurer les liaisons entre les formations et au sein de celles-ci. L'institut militaire et civil de médecine environnementale (IMCME) a été chargé de faire des commentaires sur les facteurs humains (FH) pour aider l'équipe chargée du projet VULR à atteindre son objectif, qui est de déterminer le meilleur remplaçant du véhicule Iltis présentement en service pour répondre au besoin d'un véhicule polyvalent facile à utiliser.

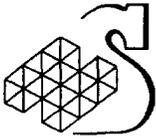
Le but de ce projet était d'établir les facteurs humains clés du véhicule pour s'assurer que la demande de propositions (DP) communiquée à l'industrie incorpore ce types de critères pour que les utilisateurs concernés (les soldats) en bénéficient le plus possible. L'étendue des travaux incluait :

1. une analyse documentaire des exigences en matière de FH;
2. un examen de l'ébauche d'EB du VULR et des commentaires;
3. l'identification des besoins et des exigences de rendement des utilisateurs grâce à des discussions en groupes avec les utilisateurs prévus;
4. une définition provisoire des besoins en matière de FH, ainsi que des protocoles d'essai.

Une liste de mots-clés a été établie pour la recherche documentaire, et une série de recherches a été effectuée. En raison de contraintes de temps et de ressources, ces recherches se sont limitées à des documents facilement accessibles et à ceux directement accessibles sur le Web. Les articles obtenus ont été examinés pour leur pertinence et leur validité pour ce projet. Les renseignements provenant des articles pertinents ont été incorporés dans une ébauche technique et une liste de contrôles FH, qui ont par la suite servi de base pour identifier les besoins en matière de conception et de rendement ayant trait aux FH.

L'ébauche d'EB du VULR a été révisée et les exigences en FH ont été identifiées. Ces exigences et celles de protection balistique ont été ensuite examinées et commentées. Les commentaires sur l'EB ont été présentés à l'équipe du projet VULR le 25 février 2000 et ont été transmis aux autorités scientifiques. L'équipe du projet VULR a été mise au courant de la méthode générale adoptée par le projet «Habillez le soldat» lors de l'évaluation des exigences en FH pour les essais de conformité ou les soumissions. Un programme initial d'évaluation des concurrents pour le VULR a été aussi présenté à l'équipe du projet.

Une évaluation des besoins a été effectuée auprès des utilisateurs éventuels des versions du VULR et auprès des mécaniciens. Il y a eu trois séries de discussions en groupe avec des utilisateurs représentatifs. On a demandé aux participants d'examiner l'ébauche de l'EB de la version pertinente du VULR et de faire des commentaires. On a également discuté des méthodes d'évaluation possibles du rendement du véhicule, y compris des fonctions pertinentes et des exigences de rendement acceptables. Ensuite, les soldats ont participé à l'inspection pratique d'un véhicule Iltis, d'un véhicule de soutien léger à roues (VSLR) et d'un véhicule utilitaire léger à roues (VULR) commercial représentatif. Le but de cette inspection était de faciliter l'identification des questions



relatives aux FH et des difficultés de conception rencontrées sur les véhicules en service, et de s'assurer que toutes ces questions seront prises en compte dans les exigences futures.

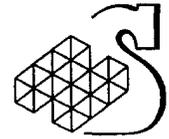
Bien que des commentaires mineurs et quelques questions aient été soulevés sur les exigences générales du véhicule, on s'est beaucoup préoccupé des listes et des nécessaires d'équipements des versions. Les sujets des discussions générales sur les exigences relatives au véhicule, de même que les questions concernant des versions particulières, figurent en détail dans le rapport.

Le personnel de commandement et de transmission a mentionné la nécessité pour la conception du VULR de permettre un accès facile aux systèmes de radio STCCC pour les téléchargements des codes et des fréquences par le personnel de transmission des unités. Les soldats spécialisés en reco craignaient qu'on sous-estime les besoins de stockage de munitions et d'équipements de la version reco du VULR. Le même personnel a aussi fait des commentaires sur la nécessité d'une écoute pour le chef d'équipage, en plus du poste de tireur. Le personnel de la police militaire (PM) croyait que la mise en service de la version PM du VULR, prévue pour trois personnes et des mitrailleuses, pourrait influencer de façon notable la dotation en personnel, l'organisation et la distribution d'équipement des pelotons de PM en campagne. Il a aussi émis des réserves sur l'espace insuffisant réservé aux munitions et à l'équipement, ainsi que sur l'accélération inadéquate. Le personnel de maintenance des véhicules s'est préoccupé de la facilité d'entretien du nouveau véhicule. L'introduction de systèmes électriques ou d'options comme la climatisation exigera une formation et l'accès à l'équipement approprié. Des problèmes mécaniques sur d'autres véhicules acquis ont été identifiés pour éviter qu'ils se reproduisent sur le VULR.

Les soldats ont réaffirmé leur désir d'essayer les futurs véhicules en conditions réelles ou dans le cadre de fonctions réelles. De plus, les participants ont indiqué le besoin d'une instruction adéquate sur le véhicule avant leur affectation. On a indiqué un certain nombre de principes généraux pour les essais, de même que le besoin d'un protocole d'essais par étapes.

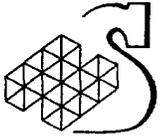
Les critères de facteurs humains ont été déterminés sur la base d'un examen des besoins particuliers ux fonctions du VULR, d'une revue de la documentation militaire et de celle sur les véhicules et des discussions en groupes avec les utilisateurs. Ces critères sont expliqués en détail dans le rapport.

D'autres travaux sur les FH seront requis pour effectuer un essai d'acceptation des véhicules proposés. Les méthodes d'évaluation de rendement possibles sont détaillées dans le rapport. Ces méthodes comprennent les principes d'essai, les contrôles scientifiques et un protocole d'essais par étapes. Les principes d'essais comprennent la mise en place de mesures indépendantes, et le recours à des utilisateurs, des conditions et des fonctions représentatives. Un véhicule expérimental approprié peut prévoir des mesures répétitives avec la présence des participants aux essais. Les contrôles scientifiques comprennent les épreuves, les analyses statistiques, la commande équilibrée, la formation des participants et le contrôle des écarts. Un protocole d'essais par étapes débute par des essais de compatibilité statiques, puis passe aux essais stationnaires relativement aux fonctions du véhicule, aux essais dynamiques de ces fonctions et se termine par des fonctions de combat représentatives. Ce protocole encourage l'instruction systématique des utilisateurs et l'évaluation des véhicules concurrents; il se termine par une évaluation générale des systèmes. L'incorporation des critères de FH résultant des discussions à ce sujet contribuera à s'assurer que la DP bénéficiera le plus possible aux groupes des Forces canadiennes qui utilisent des véhicules.

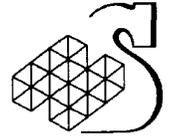


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# 1. Background

Within the Canadian Land Force, light, highly mobile vehicles are required to facilitate the tactical command of combat, combat support and combat service support units of field formations, to assist in the gathering and passing of information and to effect liaison within and between field formations. While the requirements are currently being met with the Iltis light vehicle fleet, the Iltis (see Figure 1) is nearing the end of its service life. As a result the Canadian Land Force has developed requirements for a new Light Utility Vehicle Wheeled (LUVW) to replace the Iltis. The LUVW Project team has developed a set of draft technical and human factor requirements (Reference A)



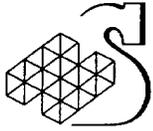
**Figure 1: Iltis**

The new LUVW vehicle shall be used by field force units in support of the following operations:

- territorial and continental defence;
- domestic operations;
- collective defence;
- peacekeeping;
- contingency operations; and
- regional command and training.

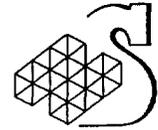
The vehicle shall be fielded in the following specific variant configurations:

- Basic;
- Command and Reconnaissance (C&R).; and
- Military Police (MP).



The new LUVW vehicle shall be capable of sustained, effective combat and support operations, and meet peacetime training requirements. It shall do so, fully loaded, with minimal breakdown, damage, or maintenance. These conditions include operation on highways and cross-country, including hilly, unpaved and severe washboard surfaces, rocky ground, plowed fields, sand, mud, snow, ice and water obstacles. All components shall be capable of operating without malfunction under the conditions stated herein while withstanding rugged military usage. The vehicle shall be operated by many users throughout the in-service period and shall be capable of withstanding such usage. The vehicle shall support the maximum gross loads, including all attachments and equipment (listed in the SOR) while maintaining the necessary stability, structural integrity, and operational capability. The new LUVW vehicle shall be capable of operating in all parts of the world. Likely areas of operations shall include, but not be limited to, all of continental North America and Europe, the Middle East, Africa and Central America.

DCIEM was tasked to provide human factors input to help support the LUVW Project team with its goal of finding the most suitable replacement for the in-service Iltis vehicle. One of key objectives of the LUVW Project is to satisfy the end-user requirement for a multi-purpose, user-friendly vehicle. The Defence and Civil Institute of Environmental Medicine (DCIEM) requested Humansystems Incorporated® (HSI®) help to support the human factors effort.



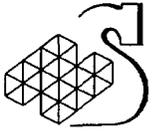
## 2. Aim

The aim of this project was to establish the key human factors (HF) vehicle criteria necessary to ensure that the Request For Proposal released to industry incorporates human-centered design criteria for maximum benefit to the vehicle user groups (i.e. the soldiers).

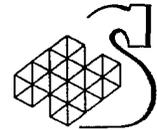
### 2.1 Scope of Work

The Statement of Work (Reference B) included the following work items

- Based on a literature review, identify possible HF performance requirements;
- Review and comment on the draft LUVW SOR;
- Identify user needs and performance requirements via focus group sessions with intended LUVW user classes; and
- Develop and validate the draft HF performance requirements and test protocols with one user group.



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### 3. Method

The following methodology was employed to address each of the work items detailed in the scope of work.

#### 3.1 Identify Possible HF Requirements – Literature Review

Humansystems® was tasked to conduct a literature review to help develop possible HF requirements for the LUVW. A set of keywords for the literature search was developed and a series of in-house databases developed for previous and ongoing efforts were searched (References C and D). As well, DCIEM conducted a specific literature search for HF in vehicle evaluations. Thus the searches by HSI® and the Scientific Authority were conducted on the following databases and sources:

- HF of Armoured Fighting Vehicles (HSI®)
- DCIEM Systems Integration and Operational Engineering Database (DCIEM)
- ALFCS Database (HSI®)
- Canadian Defence Research Reports Database (HSI®)
- National Technical Information Service (DCIEM)
- World Wide Web (DCIEM)

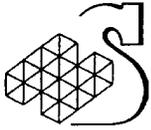
The HF of Armoured Fighting Vehicles (AFV) database contained over 500 articles. The database was temporarily developed to support the Research and Development effort to support how the Human System Integration requirements in the new Statement of Operational Requirements (SOR) templates can be met using AFV Human System Integration as a worked example (Reference C).

Traditionally, the Systems Integration and Operational Engineering Section at DCIEM has been involved in providing HF support to vehicle projects. As a result, the Section holds a quantity of reports and microfiche on HF in AFV. The collection contains over 500 records of published and unpublished research and letters, consisting of citations to journal articles, reports, reviews, SOR comments, etc.

A detailed database was developed on the HF aspects of tank gunnery and related systems for the Advanced Land Fire Control System (ALFCS) Project. The database contains over 100 records of published and unpublished research, consisting of citations to journal articles, reports, books, book chapters, and symposia.

The Defence Research Reports Database is a database of scientific and technical research produced by and for Defence Research and Development Branch (DRDB) over the past 50 years.

NTIS is an agency of the U.S. Department of Commerce's Technology Administration. It is the official source for government sponsored U.S. and worldwide scientific, technical, engineering, and business related information. The database contains almost three million titles, including 450,000 technical reports from U.S. government research. The information in the database is gathered from U.S. government agencies and government agencies of countries around the world.

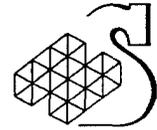


### 3.1.1 The Search

Due to time and resource constraints, a detailed literature search was not conducted by HSI®, and the search was limited to HSI® or DCIEM held documents and those readily available on the web. The Scientific Authority at DCIEM conducted the detailed literature search. As the project timetable and budget were limited, we were not able to apply all possible word combinations to a rigorous search on each and every database we located. Some word combinations elicited no hits on various databases and others elicited far too many to review, with the exception of the “top 10” or so.

Various ‘search engines’ such as Lycos, Altavista, HotBot, Excite, and MSN were used to conduct searches of the World Wide Web. “Surfing” the World Wide Web can produce very mixed results, depending on the subject matter being researched and the words used in defining the search. Some search engines indicate the number of “hits” and others don’t. A search engine will locate useful web sites and databases such as NTIS, as well as useless ones such as the personal page of someone who happens to use the phrase or words “human factors” and “vehicles” somewhere on their site. In just about all cases, we used advanced search methods that allowed us to specify a combination of words appearing together on a page and to eliminate words.

Some of the sites found provide a database or list of their publications that are generally sold at a cost to the public. Most of the sites are outside of Canada, and many outside of North America; time and budget restraints prevented us from obtaining papers where available.

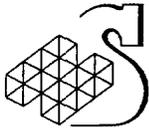


### 3.1.2 List of Keywords

Table 1 details the keywords or topic areas used in the LUVW literature search.

**Table 1: Keyword Search List**

SEARCH	KEYWORD(S)/TOPICS
1.	Vehicle Deficiencies
2.	User/crew Characteristics + Anthropometry + Target Audience Description (TAD)
3.	Military vehicles, trucks, jeeps
4.	Vehicle performance
5.	Crew task performance + Driving + Maintenance
6	Crew stations + Clothed anthropometry + Interior Design/habitability + Stowage + Design Checklists
7.	Test and Evaluation
8.	User Acceptance
9.	Maintainability
10.	Reliability
11	Safety + Acoustical energy • Steady state noise • Impulse noise • Blast overpressure + Biological substances • Exposure to microorganisms, their toxins and enzymes + Chemical substances + Weapon combustion products • Engine combustion products • Other toxic materials + Oxygen deficiency • Displacement from an enclosed space + Radiation energy • Ionizing radiation • Nonionizing + Shock • Mechanical impulse or impact from acceleration or deceleration i.e. weapon recoil + Temperature and Humidity • High temperatures, i.e. heatstroke • Low temperatures, i.e. hypothermia • Surface Contact, i.e. contact burns or cold induced dexterity loss + Trauma • Physical, i.e. Blunt impact damage to the eyes or body • Musculoskeletal, i.e. Strain due to lifting + Vibration • Whole body • Segmental
12.	Personnel
13.	Training and Simulation



### 3.1.3 Article Review

The articles acquired were reviewed for relevance and applicability according to the LUVW Project's HF effort. The articles were then grouped according to the keyword categories. A limited number of articles (as time and budget permitted) were then reviewed. The articles were rated according to the following scheme:

1. Directly Relevant
2. Somewhat Relevant
3. Not Relevant

The data from the relevant articles were incorporated into a draft Technical and HF Design Checklist (Annex A).

## 3.2 Review Draft LUVW SOR and Development Process

Humansystems was tasked to review and comment on the draft LUVW SOR dated 01 December 1999, (Reference A). The draft LUVW SOR was reviewed and relevant HF requirements were identified. The HF requirements and ballistic protection requirements were then reviewed and commented upon. Comments on the SOR were presented to the LUVW Project Team on 25 February 2000 and forwarded to the Scientific Authority. The Scientific Authority then consolidated these comments with internal DCIEM reviews. These comments will not be presented in this report.

Discussions also centered on how to incorporate HF testing into the bid evaluation process and how the specific HF requirements could be evaluated. The LUVW Project Team was briefed on the general approach taken by the Clothe the Soldier (CTS) Project in evaluating HF requirements for compliance or bid testing. The CTS approach involves the following stages:

Stage 1- Initial evaluation of proposals for compliance to mandatory requirements;

- Terms and conditions, price proposal, cost data and financial information
- Technical/managerial/quality assurance capability
- Technical proposal and support for technical compliance

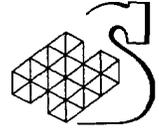
Stage II – Detailed evaluation of proposals for compliance to mandatory requirements and evaluation of rated requirements

- Terms and conditions, price proposal, cost data and financial information (point ratings)
- Technical/managerial/quality assurance capability (point ratings)
- Technical proposal and support for technical compliance (point ratings)

Stage III – DND assessment of technical requirements

- Engineering tests

Stage IV – Short listing of complaint bidders



Stage V – HF user acceptance trial

- Minimum acceptance ratings for defined criteria
- Minimum overall acceptance ratings

Stage VI – Bid award based on best value/performance

An initial framework for evaluating the LUVW contenders was also presented to the LUVW Project Team.

### 3.3 Identify User Needs

A user needs assessment for the LUVW was conducted with potential LUVW variant users and vehicle mechanics. A series of three focus group discussions were held with the following series of users at CFB Petawawa (5 –6, and 17-18 April 2001) and at Fort York Armoury (15 April). The participants included:

- 2 Service Battalion vehicle maintenance personnel (4)
- the Royal Canadian Dragoons (3)
- 2 CMBG Headquarters and Signals personnel (4)
- 2 Field Military Police Platoon personnel (4)
- Queens York Rangers personnel (4)

During the first series of focus group discussions (5-6 April) Service Battalion vehicle maintenance personnel, Headquarters and Signals personnel and members of the Royal Canadian Dragoons were introduced to the LUVW project and the aims of this HF effort. Participants were then requested to review and comment on the draft LUVW SOR Command and Signal variant requirements and the vehicle maintenance requirements. Discussions were also held on potential performance assessment approaches, including suitable tasks and acceptable performance requirements. Next, the soldiers were split into two groups and they participated in a hands-on inspection of the Iltis jeep and the Light Support Vehicle Wheeled (LSVW). The purpose of the inspection was to help identify HF issues and design concerns with the in-service vehicles. The ultimate aim was to insure that these concerns were addressed in any future HF performance requirements. The vehicle inspections used the following criteria (Table 2) as a framework for discussion:

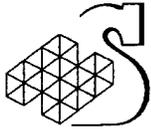
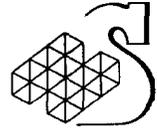


Table 2: User Needs Criteria

CRITERIA
<b>Drivers Compartment/Front and Rear Passengers/Cargo</b>
<b>General boarding, movement</b>
<ul style="list-style-type: none"> <li>• Entering (door access)</li> </ul>
<b>Seating</b>
<b>Driver's workspace</b>
<ul style="list-style-type: none"> <li>• Displays <ul style="list-style-type: none"> <li>– Instruments</li> </ul> </li> <li>• Interior Lighting</li> <li>• Controls <ul style="list-style-type: none"> <li>– Position</li> <li>– Operation</li> </ul> </li> </ul>
<b>External visibility</b>
<b>Communications</b>
<ul style="list-style-type: none"> <li>• Positioning</li> <li>• Installation</li> <li>• Operations</li> </ul>
<b>Heating/Air conditioning/Ventilation</b>
<b>Vibration</b>
<b>Crew Integration, Health and safety</b>
<ul style="list-style-type: none"> <li>• Compatibility</li> <li>• Ease of training</li> <li>• Workload</li> </ul>
<b>Stowage</b>
<b>Toxicity/Ventilation/Fumes</b>
<ul style="list-style-type: none"> <li>• From weapons</li> <li>• From exhaust</li> </ul>
<b>Noise</b>
<ul style="list-style-type: none"> <li>• Steady state</li> <li>• Hard surfaces, X-country</li> <li>• Impulse noise</li> </ul>
<b>Maintenance</b>
<ul style="list-style-type: none"> <li>• Ease of access</li> <li>• Ease of maintenance/repair</li> <li>• Ease of self-recovery</li> </ul>
<b>Protection</b>
<ul style="list-style-type: none"> <li>• Directed weapons</li> <li>• Blast</li> <li>• Ease of camouflaging</li> </ul>
<b>Vehicle Handling Characteristics</b>
<ul style="list-style-type: none"> <li>• Cornering</li> <li>• Road feel</li> <li>• Braking</li> <li>• Vehicle control</li> <li>• Engine – horse power, responsiveness</li> </ul>
<b>Ride Quality</b>
<b>Task Performance</b>

During the second series of focus group discussions (15 April) Militia Reconnaissance (Recce)

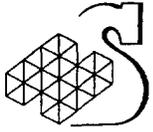


soldiers from the Queens York Rangers were introduced to the LUVW project and the aims of this HF effort. Participants were then requested to review and comment on the draft LUVW SOR Reconnaissance (Recce) variant requirements. Discussions were then held on Recce tasks, acceptable performance requirements and bid assessment approaches. The soldiers then participated in a hands-on review of their Iltis jeeps configured for reconnaissance. The vehicle inspections used the previously described criteria as a framework for discussion.

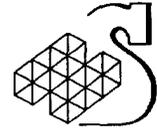
During the last series of focus group discussions (17-18 April) military police (MP) participants were introduced to the LUVW project and the aims of this HF effort. Participants were then requested to review and comment on the draft LUVW SOR MP variant's requirements. Discussions were then held on representative field MP tasks, acceptable performance requirements and bid assessment approaches. The MPs then participated in a hands-on an abbreviated review of the Iltis jeep and LSVW vehicle to identify their HF concerns. The participants then participated in the inspection of one representative commercial off the shelf vehicle to identify HF concerns. The vehicle inspections used the previously described criteria as a framework for discussion.

### **3.4 Develop Human Factors Performance Criteria**

Human Factors performance criteria were determined based on a review of the LUVW tasking requirements, a review of relevant vehicle and military literature, and focus group discussions with relevant users.



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## 4. Results

The following section describes the results and deliverables for each of the work items detailed in the scope of work.

### 4.1 General

A literature search and a series of focus group discussions were conducted to support the LUVW HF effort. A detailed draft technical and HF Design Checklist was developed and HF performance specifications were created.

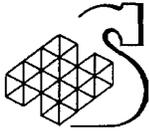
### 4.2 Literature Review Results

A literature search was conducted by Humansystems Incorporated® and the Scientific Authority to identify potential HF issues in a performance requirement specification and to identify previous approaches undertaken to evaluate vehicles from a user's perspective. The HF requirements were consolidated into a list of draft technical and HF Design Checklist (Annex A). Key design articles included:

- Human Factors Engineering Design for Army Materiel, US Army. MIL-HDBK-759.
- Human Engineering Design Criteria for Military System, Equipment and Facilities, US Army. MIL-HDBK-1472.
- Human Factors Engineering Data Guide for Evaluation (HEDGE), Part II of Test Operating Procedure (TOP) 1-2-610
- O'BRIEN, T., ET AL (1986). Human Factors Engineering DataBase Development for Armoured Combat Vehicles and Analyses of Three NATO Tank Systems, Volume 1: Data Base Development and Methodology. Albuquerque, NM, The BDM Corporation
- Human Factors Engineering Design Standard for Vehicle Fighting Compartments. Aberdeen Proving Ground, Maryland, Human Engineering Laboratories, Aberdeen R&D Centre, Maryland, 1968.

The draft technical and HF Design Checklist (Annex A) was used as a basis for identifying HF design issues and performance requirements.

Traditionally, human performance requirements for Land Force vehicles were identified and evaluated by the Systems Integration and Operational Engineering Section at DCIEM. Areas of investigation typically included: health and safety, toxicity, anthropometry, workstation design and workload. While the support process was not as formalized as the US MANPRINT Program, the Systems Integration and Operational Engineering Section evaluated a number of AFV for the land Forces (Leopard C1, Armoured Vehicle General Purpose (AVGP), Light Armoured Vehicle (LAV III), etc.) Since the US MANPRINT Program's inception, all new vehicles and equipment items have undergone HF engineering acceptance trials. Key articles on approaches to evaluating vehicles from a human performance perspective included:



- Human Factors Engineering Data Guide for Evaluation (HEDGE), Part II of Test Operating Procedure (TOP) 1-2-610
- GREENE, J. T. (1987). Initial Operational Test and Evaluation of Bradley Fighting Vehicle System (BFVS) High Survivability Modifications. Fort Benning, GA, Army Infantry Board.
- HILL, M. V. C. (1983). Human Engineering Evaluation of the Leopard C1 Main Battle Tank. Downsview, Ontario., Department of National Defense: 34.
- YOWELL, R. D., AVALLONE, S.M. (1988). First Article - Initial Production Test (FA-IPT) of Bradley Fighting Vehicle Systems A1 Program (BFVS-A1). Maryland, Army Combat Systems Test Activity, Aberdeen Proving Ground.
- MALONE, T. B., MICOCCL, A.J., BRADLEY, J.G. (1974). Man-Machine Evaluation of the M60A2 Tank System, Army Research Institute for the Behavioral and Social Sciences.

These articles on approaches to evaluating vehicles from a human performance perspective were utilized in developing a draft HF Evaluation Plan (Annex B).

### 4.3 Review Draft LUVW SOR and Development Process –Results

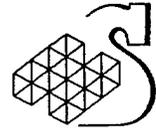
Humansystems® reviewed and commented on the draft LUVW SOR dated 01 December 1999, (Reference B). Although the LUVW SOR has a specific section on Human Factors and Environmental Characteristics (C3.10) and Ergonomics (C3.10.1), a significant number of other requirements were identified as having a HF component. These requirements are detailed in Annex C with HF components shaded. Comments on the SOR were presented to the LUVW Project Team on 25 February 2000 and forwarded to the Scientific Authority for consolidation of these comments with internal DCIEM reviews.

### 4.4 Identify User Needs -Focus Group Results

A user needs assessment for the LUVW was conducted with potential LUVW variant users and vehicle mechanics using the in-service Iltis jeep and LSVW as representative vehicles for discussion purposes.

#### 4.4.1 User Needs-LUVW SOR Review

A series of three focus group discussions were held with potential users for all the LUVW variant types (C&R, Basic, MP) and potential users (operators and maintenance personnel). The three focus group discussions and needs analyses were conducted over three -six hour sessions. Participants reviewed and commented on the draft LUVW variant requirements and the vehicle maintenance requirements. While some minor comments and concerns were raised with the general vehicle requirements, considerable concerns were raised with the variant kit and equipment lists. Areas of general concern with the vehicle requirements included:

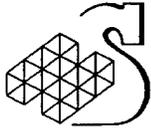


- Robustness of the proposed electrically adjustable and heated mirrors
- Robustness of the proposed map light
- Robustness of electric door locks
- Desirability for a removable winch
- Concerns with engine power – acceleration to highway speeds
- Concerns with engine power –gradeability
- Concerns with crew equipment stowage volume
- Concerns with weapon and ammunition stowage
- Concerns that the basic kit and equipment weights were incorrect
- Ease of access to radio

The Command and Signals personnel commented on the need for the design of the LUVW to permit easy access to the TCCCS radio systems for code and frequency uploads by the units signal personnel. The codes have to be uploaded at the radio, thus necessitating the requirement for ease of access.

Overall, the recce soldiers were enthused that a dedicated Recce vehicle was being acquired. They did however have concerns with the LUVW Recce variant's equipment and ammunition stowage requirements. Recce vehicles presently have requirements to carry medium anti-armour weapons (ERYX or Carl Gustav) not just the M72 LAW. As well, the Recce personnel commented that they would routinely carry more ammunition than allocated. Recce personnel commented on the need for a crew commander's hatch in addition to the gunner's station. In a Recce vehicle the crew commander is responsible for target detection and navigation. Having an ability to stand-up and survey the ground ahead from a hull-down vehicle position is significantly advantageous. Having the ability to have two sets of raised eyes was viewed as being more important than the associated safety risk from the ring mounted machine gun. Placing the commander in the gunner's seat was not recommended, as the commander has to also give directions to the driver.

Specific concerns were raised by the Military Police personnel with the LUVW MP variant's equipment and ammunition stowage requirements. Currently, MP vehicles are crewed by just two personnel, not the three envisioned with the LUVW MP variant. MPs are also not equipped with the machine guns identified with the LUVW MP variant. Thus the introduction of the LUVW MP variant may significantly affect the manning, organization and equipment distribution of Field MP Platoons. When deployed MP vehicles typically have to be self-sufficient for a number of days. This results in the need for additional vehicle fuel reserves (Jerry Cans), water and cooking fuel. Concerns were also raised with the identified stowage location of assigned kit and equipment. MPs typically tow ¼ ton trailers loaded with stakes, POL, camouflage nets, etc. The focus group attendees were particularly concerned with the feasibility of stowing all their personnel kit, weapons, etc. with traffic control stakes. The MP attendees were particularly concerned with requirement C 3.11.2.3 Acceleration. The MPs believed they needed to accelerate to highway speeds much faster than those specified in the requirement. Presently the requirement is to accelerate to 80 km/h in 27 seconds, while they desire acceleration to 80 km/h in 15 seconds.



Vehicle maintenance personnel raised concerns with the potential maintainability of the new vehicle. Exterior mirrors are frequently damaged on exercise and while the existing systems can be easily and quickly replaced, electric mirrors will be much more difficult to replace and will require specialized training. The incorporation of air conditioning is also problematic. Very few bases have mechanics trained on the maintenance of air conditioning systems. Thus the introduction of the LUVW variant may significantly affect the manning, organization and training of field maintenance platoons. Due to problems with the LSVW and MLVW, maintenance personnel were concerned with the wording of paragraph C 3.12.5.3 – Corrosion Protection. They believed that explicit procedures should be detailed on metal preparation (i.e. acid wash), priming and painting. Due to problems with the LSVW and the Iltis when pulling a fully laden trailer, maintenance personnel were concerned with the engine power requirements for gradeability. While the requirements specify 3 % gradeability at 90 km/h, problems are particularly evident when climbing grades from the stopped position. Anecdotal evidence suggests that fully laden LSVW's sometimes have problems climbing curbs from the stopped position.

#### **4.4.2 User Needs -Performance Assessment Approaches and Tasks**

For each of the LUVW variant types (C&R, Basic, MP), discussions were held to identify assessment approaches and potential HF assessment. One of the focus group participants had participated in the LSVW acceptance evaluation and was concerned that the LUVW Project was taking the same approach. He was concerned that the vehicles would not be tested under real conditions or with real tasks. As well, participants identified the need for adequate training on the vehicles prior to assessment. A number of general trial principles were identified, as well as the need for a progressive testing protocol.

#### **4.4.3 In-service Vehicle Assessment Results**

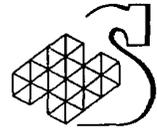
Inspections of the Iltis, LSVW and a commercial off the shelf jeep were used to identify human performance issues and to validate the drafted Technical and HF Design Checklist. Nineteen soldiers participated in a hands-on inspection of the Iltis jeep and the Light Support Vehicle Wheeled (LSVW). Using the design checklist as a framework, the investigation team received positive and negative feedback on the two in-service systems. Focus group notes are detailed at Annex D. Focus group comments were utilized in the development of the human performance criteria.

### **4.5 Human Performance Criteria**

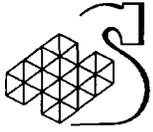
HF performance requirements for the LUVW were derived from insights gathered during each of the following:

- A review of the scientific literature, military studies, and the draft statement of requirements for the LUVW.
- The results of the user focus groups.
- Feedback received from the LUVW Project Engineer

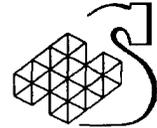
HF performance requirements for LUVW are detailed in Annex E– LUVW HF Performance Requirements. Test Protocols were not included as per the instructions of the LUVW Project Team. Human performance requirements are detailed in the following areas:



1. Overall User Acceptance
2. User / Maintenance Manual Acceptance
3. Ease of External Boarding and Movement
4. Ease of Cab Ingress and Egress - Driver's Station
5. Ease of Cab Ingress and Egress – Passengers' Stations
6. Ease of Cab Ingress and Egress - Gunner's Station
7. Cab Workstation - Driver and Passenger Seat Design
8. Cab Workstation - Weapon Station Hatch Seat Design
9. Cab Workstation - Driver's Station Design
10. Cab Workstation - Passenger Compartment Design
11. Cab Workstation - Gunner's Compartment Design
12. Display, Instrument and Gauge Design
13. Control Design and Operation
14. External Visibility – Driver
15. External Visibility - Gunner
16. Internal Visibility
17. Cab Environment – Heating and Cooling
18. Cab Environment – Ventilation
19. Cab Environment – Noise
20. Cab Environment – Vibration
21. Cab Environment – General Safety
22. Vehicle Stowage
23. Vehicle Handling Characteristics
24. Vehicle Ride Quality
25. Vehicle Maintainability
26. Task Compatibility



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## 5. Conclusions and Recommendations

A literature search and a series of focus group discussions were conducted in support of the LUVW HF effort. These were used to develop a detailed draft Technical and HF Design Checklist. These were subsequently used in the development of LUVW HF performance requirements. Future HF efforts will be required to conduct a HF user acceptance trial of potential LUVW bid contenders. Options for performance assessment approaches are outlined below. These include trial principles, scientific testing controls, and progressive testing protocol. The incorporation of the human-centered design criteria developed in these HF efforts will help to ensure that the RFP will provide maximum benefit to the CF vehicle user groups.

### 5.1 Trial Principles

The following general scientific principles should be applied to the LUVW field evaluations:

#### 5.1.1 Representative Independent Measures

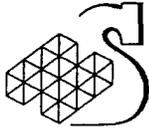
To ensure that the results of the field trial testing are valid and applicable, the trial participants, testing conditions, and tasks need to accurately represent the actual operating environment in which the LUVW would be employed. These independent measures (i.e. Users, conditions, and tasks) typically represent a range of possible characteristics. To be representative in any field trial, these ranges of characteristics need to be reflected in the trial design.

#### 5.1.2 Representative Users

The characteristics of the LUVW user population are represented by a statistical distribution (e.g. stature, reach, strength, dexterity, visual acuity, etc.). Any LUVW user testing needs to include participants who are sampled across this range of statistical distribution for the characteristics relevant to each particular test. For example, stature and shoulder breadths are particularly relevant when examining workstation dimensions. Therefore, any field testing of the performance of LUVW prototypes should be performed with participants who reflect the range of sizes of the prospective users. As well, any equipment/clothing worn should be evaluated for LUVW compatibility.

Ideally, categorical User distinctions also need to be represented (e.g. gender, ethnicity, trade). The LUVW user population also includes a range of trade-specific characteristics, which must also be represented within the participant sample. Proposed representative users include:

- Militia Recce personnel
- Command and signals personnel
- Military policemen
- Maintenance personnel



### 5.1.3 Representative Conditions

The LUVW is required to be operationally usable in a wide range of possible conditions: daylight through to night ops, arctic to desert, wet and dry climates, etc. Field testing of the LUVW needs to be representative of these conditions. However, the scope of HF testing needs to be limited to only those technologies or LUVW capabilities which are practically applicable to the condition in question. For example, compatibility of clothing and equipment in night operations will not be different to day light conditions. Representative conditions could include:

- Highway driving
- Cross country driving
- Black track driving
- City driving
- Tactical driving.

### 5.1.4 Representative Tasks

Identified LUVW variant tasks will have to be selected for this trial because variant tasks are both typical and atypical. The LUVW field evaluations and trials should reflect the mix of tasks and conditions performed by potential variant users in the field. These tasks include basic operation, target engagement, communications, etc. Representative tasks could include:

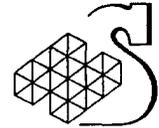
- Dispatch task( C&S variant)
- Route recce task(Recce variant)
- Evasion and target engagement task (recce variant)
- Route signing task (MP variant)
- Airfield security task(MP variant)
- Harbour and hide tasks
- Recovery tasks
- First line and second line maintenance tasks

### 5.1.5 Repeated Measures Design

Wherever possible, a repeated measures experimental design should be employed for User assessments of the LUVW contender capabilities. A repeated measures design requires the User to repeat each field trial test using the LUVW contenders and the in-service Iltis system. Testing will be against the minimum requirements detailed in the Statement of Requirements. With each User acting as his own statistical control condition in the repeated measures comparison, the statistical power of field testing, for a given sample of trial participants, can be greatly improved.

### 5.1.6 Trial Participants

Given the variability of User characteristics, each field test must be performed with a minimum number of trial participants (i.e. sample size) to ensure sufficient statistical power for a meaningful analysis.



## **5.2 Scientific Testing Controls**

Ideally, during scientific testing, all sources of error are controlled to ensure that statistical differences identified during testing are due solely to the test effect being investigated. Rigorous error control in field trial testing is difficult. Scientific testing controls are employed during field trial testing to limit or to discriminate sources of systemic and measurement error through the use of standardized testing, balanced testing order, statistical analysis methods, and bias controls.

### **5.2.1 Standardized Testing**

To be statistically reliable, field trial testing must be repeatable. To achieve the necessary level of repeatability, all field tests will be closely standardized for all test protocols, conditions, and procedures. Where appropriate, start state and procedural instructions will be detailed in the test plan procedures to ensure that field-testing is carried out in the same manner and under the same conditions from test to test.

### **5.2.2 Statistical Analyses**

Due to the bid acceptance nature of this trial, analyses will be restricted to descriptive measures only for the dependant variables. The in-service system will be used as a baseline measure to assess the relative performance of the contender vehicles.

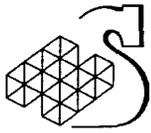
### **5.2.3 Balanced Testing Order**

The conditions within which the trial will be run (i.e. independent variables) typically vary from trial run to trial run. This variability among independent variables is very difficult to control in a field environment. For example, to test weapon sight targeting performance between the LUVW contenders and the in-service Ittis in the field, independent variables such as lighting conditions, wind speed, temperature, User fatigue, User motivation, etc., can all vary from test to test, despite rigorous standardization of testing procedures. This variability contributes error to the interpretation of fighting performance between the LUVW contenders and in-service technologies. Since we cannot always control these sources of error in the field from test to test, we must control the order of testing conditions to mitigate this error effect. To achieve this equalization of error, the order of testing will be balanced between the LUVW Contender and in-service conditions (i.e. during each test, all conditions will be represented in equal proportions).

### **5.2.4 Participant Training**

A major source of performance variability during User testing will be associated with the User's level of skill and knowledge of their trade tasks and their individual and group ability to effectively employ the LUVW contender's capabilities in the field. LUVW effectiveness in the field will depend heavily on the soldier participant's understanding of the task and mission advantages afforded by the LUVW system technologies, knowing when to employ these technologies individually.

To provide a fair test of the LUVW contenders, Users will be screened to ensure that they have passed the requisite infantry individual and specialized battle task standard. Prior to data collection in the field, participants will be trained on the LUVW contender vehicles (operators and maintenance personnel). Prior to the actual bid evaluation participants will be required to demonstrate that they are capable of achieving the training performance objectives detailed in the



LUVW HF Trial Plan. Additional practice sessions, for the subjects will also be included as part of each field trial test.

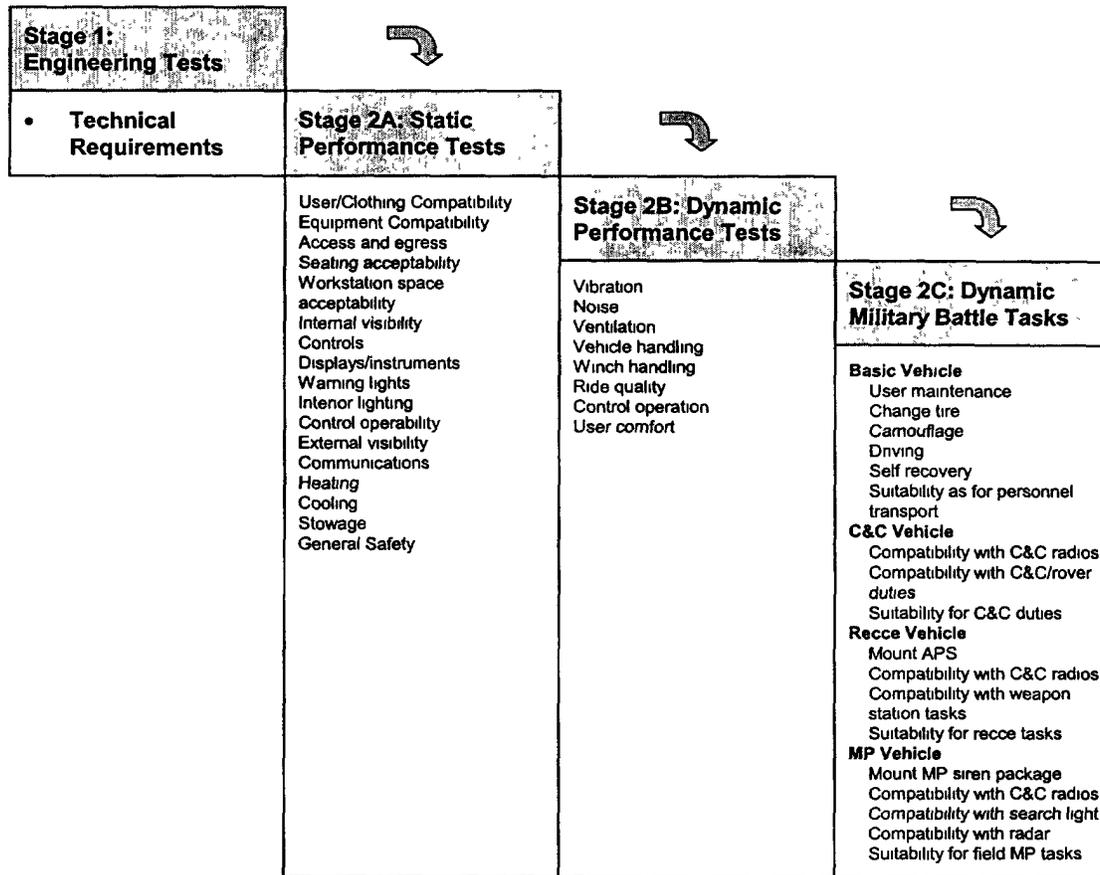
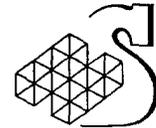
### **5.2.5 Control of Bias**

Several LUVW criteria will be evaluated using subjective reporting and insight from soldier participants. To ensure that participant opinions and insights are uniquely their own, sources of potential bias and unintentional influence must be controlled. The responsibility for enforcing these bias guidelines will vest with the Trial Director. While most sources of bias and influence are benign and unintentional, their impact on participant opinions and state of mind during the trial can be significant.

For these reasons, general guidelines will be provided to control these sources of potential bias. While these guidelines may appear overly restrictive, past experience with User trials have repeatedly demonstrated the necessity.

## **5.3 Progressive Testing Protocol**

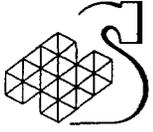
A progressive testing protocol will be employed in the LUVW trial. All contender systems will first be evaluated according to engineering performance standards in an earlier assessment phase. LUVW contender systems that meet the minimum technical standards will be forwarded for the HF field evaluation. During the HF evaluation, testing begins with static compatibility tests, then progresses to stationary vehicle task tests, dynamic task tests and finally culminates with representative combat tasks. The progressive testing protocols promotes systematic user training and evaluation on the contender vehicles, and culminates with the overall system evaluation. The framework for progressive testing in the LUVW trial is outlined in Figure 2.



**Figure 2: Progressive Testing Approach**

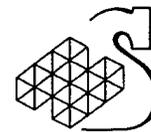
Stage 1 begins with engineering tests to determine the acceptance of contender systems on the LUVW technical requirements (horsepower, gradeability, etc.) Stage 2 includes the HF performance test stands. This stage builds on Stage 1 by introducing the HF user acceptance performance tests. The tests progress from static test stands in Phase 2A, to dynamic test stands in 2B and finally task test stands in Phase 2C.

The static compatibility tests include the assessments of individual items of clothing and equipment and associated LUVW items of kit. These assessments can be accomplished while the vehicle is stationary. The static performance tests include the assessments of individual tasks associated with the LUVW. The dynamic tasks include generic tasks applicable to any LUVW variant and would be assessed while operating the vehicle in a controlled environment. Finally, Stage 2C will build on all previous stages by performing associated LUVW-equipped unit battle tasks, which combine many vehicle activities and skills into high fidelity simulations of combat missions.



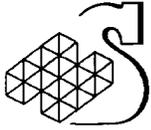
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**ANNEX A:**  
**Draft Technical and Human Factors**  
**Design Checklist**



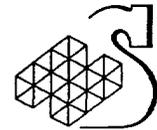
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✓	<b>Drivers Compartment</b>		
	<b>1000</b>	<b>General Boarding/Movement</b>	
		1001	Handholds/footholds, adequacy of boarding
		1002	Boarding, handholds, grasp space (mm)
		1003	Boarding, footholds, dimensions, 1 x w, (mm)
		1004	Non-skid surfaces, adequacy of
		1005	Obstructions to boarding vehicle?
	<b>2000</b>	<b>Entering and exiting drivers station</b>	
		2001	Driver station, adequacy of door entry padding
		2002	Driver station, ease of opening/closing door
		2003	Driver station, ease of access
		2004	Driver station, door operating force. Requires less than 220 N of force to open/close under any condition of vehicle tilt
		2005	Driver station, door dimensions, 1 x w x d (mm)
		2006	Driver station, time to egress, from closed door position to outside of vehicle, non-NBC clad
		2007	Driver station, time to egress, from closed door position to outside of vehicle, NBC TOP-High clad
		2008	Driver station, adequacy of door size for 95th percentile arctic garbed male
		2009	Driver station, closed door mode, positive safety lock description
	<b>2100</b>	<b>Entering and exiting front passenger station</b>	
		2101	Front passenger station, adequacy of door entry padding
		2102	Front passenger station, ease of opening/closing door
		2103	Front passenger station, ease of access
		2104	Front passenger station, door operating force. Requires less than 220 N of force to open/close under any condition of vehicle tilt
		2105	Front passenger station, door dimensions, 1 x w x d (mm)
		2106	Front passenger station, time to egress, from closed door position to outside of vehicle, non-NBC clad
		2107	Front passenger station, time to egress, from closed door position to outside of vehicle, NBC TOP-High clad
		2108	Front passenger station, adequacy of door size for 95th percentile arctic garbed male
		2109	Front passenger station, closed door mode, positive safety lock description
	<b>2200</b>	<b>Entering and exiting rear passenger/quarter station</b>	
		2201	Rear passenger station, adequacy of door entry padding
		2202	Rear passenger station, ease of opening/closing door
		2203	Rear passenger station, ease of access
		2204	Rear passenger station, door operating force. Requires less than 220 N of force to open/close under any condition of vehicle tilt
		2205	Rear passenger station, door dimensions, 1 x w x d (mm)
		2206	Rear passenger station, time to egress, from closed door position to outside of vehicle, non-NBC clad
		2207	Rear passenger station, time to egress, from closed door position to outside of vehicle, NBC TOP-High clad



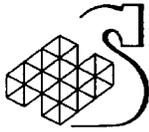
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	2208	Rear passenger station, adequacy of door size for 95th percentile arctic garbed male
	2209	Rear passenger station, closed door mode, positive safety lock description
<b>3000</b>	<b>Driver's Passengers/Gunner's Seat</b>	
	3001	Driver/Passenger/Gunner station, seat back dimensions, L x W (mm)
	3002	Driver/Passenger/Gunner station, seat pan dimensions, L x W (mm) IAW MIL-STD-1472C
	3003	Driver/Passenger/Gunner station, seat padding, thickness, IAW MIL-STD-1472C (mm)
	3004	Driver/Passenger/Gunner station, seat back rest-to-seat angle, IAW MIL-STD-1472C (mm)
	3005	Driver/Passenger/Gunner station, seat slope, IAW MIL-STD-1472C (degrees)
	3006	Driver/Passenger/Gunner station, distance from seat front, top of padding, to floor, IAW MIL-STD-1472C (mm)
	3007	Driver/Passenger/Gunner station, seat vertical adjustability, IAW MIL-STD-1472C (range in -mm)
	3008	Driver/Passenger/Gunner station, seat forward-rearward adjustability, IAW MIL-STD-1472C (mm)
	3009	Driver/Passenger/Gunner station, seat, adequacy of lumbar support
	3010	Driver/Passenger/Gunner station, seat provided with restraint, seat belts?
	3011	Driver/Passenger/Gunner station, adequacy of seat restraint/seat belt system
	3012	Driver/Passenger/Gunner station, seat designed to prevent blood flow to popliteal area
	3013	Driver/Passenger/Gunner station, seat provided with adjustable headrest
	3014	Driver/Passenger/Gunner station, seat material, promote excessive perspiration during extended operations?
	3015	Driver/Passenger/Gunner station, seat material, become excessively hot during operations in hot conditions?
	3016	Driver/Passenger/Gunner station, seat back material (acceptability)
	3017	Driver/Passenger/Gunner station, head rest material (acceptability)
	3018	Driver/Passenger/Gunner station, overall seat acceptability (comfort)
<b>4000</b>	<b>Driver's compartment workspace</b>	
	4001	Driver station, MIL-STD-1472C, Table 28 dimension A, Elbow, dynamic (mm)
	4002	Driver station, MIL-STD-1472C, Table 28 dimension A, Elbow, static (mm)
	4003	Driver station, MIL-STD-1472C, Table 28 dimension C, Shoulder (mm)
	4004	Driver station, MIL-STD-1472C, Table 28 dimension D, Knee width, minimum (mm)
	4005	Driver station, MIL-STD-1472C, Table 28 dimension E, Knee width, maximum (mm)
	4006	Driver station, MIL-STD-1472C, Table 28 dimension F, Boot clearance from pedal (mm)
	4007	Driver station, MIL-STD-1472C, Table 28 dimension G, Distance between pedals (mm)
	4008	Driver station, MIL-STD-1472C, Table 28 dimension H, Boot clearance from brake pedal (mm)
	4009	Driver station, MIL-STD-1472C, Table 28 measurement 1, Head clearance, closed hatch, SRP to underside of hatch (mm)
	4010	Driver station, MIL-STD-1472C, Table 28 measurement 2, abdominal, seat back to steering device (mm)
	4011	Driver station, MIL-STD-1472C, Table 28 measurement 3, front of knee, seat back to closest forward object (mm)
	4012	Driver station, MIL-STD-1472C, Table 28 measurement 4, seat depth, SRP to front edge of seat pan (mm)
	4013	Driver station, MIL-STD-1472C, Table 28 measurement 7, boot, front of seat pan to heel



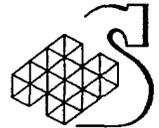
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		point of accelerator (mm)
	4014	Driver station, adequacy of viewing and operating hand and foot controls, viewing displays in all vertically adjusted seat positions
	4015	Driver station, distance closest hand control from SRP (mm)
<b>5000</b>	<b>Displays</b>	
	5001	Driver station, visibility, quality of visibility of controls/displays, day and night operations
	5002	Driver station, visibility, viewing distance to most distant display (mm)
	5003	Driver station, visibility, viewing angle from design eye position to worse condition primary display (degrees)
	5004	Driver station, adequacy of displays for critical driving tasks
	5005	Driver station, display-functions grouped together?
	5006	Driver station, master caution light provided?
	5007	Driver station, master caution light, distance, angle from design eye position (mm)
	5008	Driver station, master caution light, range of luminance, (range in lx; ft-C)
	5009	Driver station, master caution light, colour
	5010	Driver station, visibility of PLGR display
		<b>Instruments</b>
	<b>5012</b>	<b>Speedometer</b>
	5012.01	Design
	5012.02	Location
	5012.03	Readability during vehicle operation (vision unobst., scale markings, labelling, size)
	<b>5013</b>	<b>Odometer</b>
	5013.01	Design
	5013.02	Location
	5013.03	Readability during vehicle operation (vision unobst., scale markings, labelling, size)
	<b>5014</b>	<b>Trip Odometer</b>
	5014.01	Design
	5014.02	Location
	5014.03	Readability during vehicle operation (vision unobst., scale markings, labelling, size)
	<b>5015</b>	<b>Water temperature gauge/warning light</b>
	5015.01	Design
	5015.02	Location
	5015.03	Readability during vehicle operation (vision unobst., scale markings, labelling, size)
	<b>5016</b>	<b>Oil pressure gauge</b>
	5016.01	Design
	5016.02	Location
	5016.03	Readability during vehicle operation (vision unobst., scale markings, labelling, size)
	<b>5017</b>	<b>Fuel gauge</b>
	5017.01	Design
	5017.02	Location
	5017.03	Readability during vehicle operation (vision unobst., scale markings, labelling, size)
	<b>5018</b>	<b>Battery charge/discharge gauge</b>
	5018.01	Design
	5018.02	Location
	5018.03	Readability during vehicle operation (vision unobst., scale markings, labelling, size)
	<b>5019</b>	<b>Transmission fluid temperature gauge</b>
	5019.01	Design



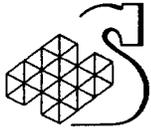
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	5019.02	Location
	5019.03	Readability during vehicle operation (vision unobst., scale markings, labelling, size)
	5020	Coolant Heater display
	5020.01	Design
	5020.02	Location
	5020.03	Readability during vehicle operation (vision unobst., scale markings, labelling, size)
	5021	PLGR display
	5021.01	Design
	5021.02	Location
	5021.03	Readability during vehicle operation (vision unobst., scale markings, labelling, size)
	5022	Park brake display
	5022.01	Design
	5022.02	Location
	5022.03	Readability during vehicle operation (vision unobst., scale markings, labelling, size)
	5023	4-Wheel drive display
	5023.01	Design
	5023.02	Location
	5023.03	Readability during vehicle operation (vision unobst., scale markings, labelling, size)
	5024	Differential lock display
	5024.01	Design
	5024.02	Location
	5024.03	Readability during vehicle operation (vision unobst., scale markings, labelling, size)
	5025	Signal light display
	5025.01	Design
	5025.02	Location
	5025.03	Readability during vehicle operation (vision unobst., scale markings, labelling, size)
	5026	4-Way flasher display
	5026.01	Design
	5026.02	Location
	5026.03	Readability during vehicle operation (vision unobst., scale markings, labelling, size)
	5027	Overall display acceptability
	5027.01	Overall evaluation of the Instrumentation
	5028	Driver station, displays illuminated?
	5029	Driver station, primary display colour (red, blue green, white, other)
	5030	Driver station, display luminance range (lx; ft-C)
	5031	Driver station, display luminance variable control? Ease of access, ease of operation
	5032	Driver station, spot brightness values, primary displays (display, type, location, ft-L)
	5033	Driver station, primary displays, colour-coded efficiently?
	5034	Driver station, luminance controls provided with full OFF? Ease of access, ease of operation
	5035	Driver station, indicator lights, grouped together, close to driver's line of sight?
	5036	Driver station, indicator lights, coloured correctly, IAW MIL-STD-1472C?
	5037	Driver station, indicator lights testable?
	5038	Driver station, indicator lights dimmable? Ease of access, ease of operation
	5039	Driver station, indicator lights, luminance range (lx; ft-C)
	6000	Interior lighting (night-time)
	6001	Adequacy for operation of control
	6001.01	brightness
	6001.02	adjustability



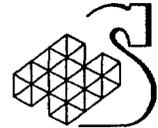
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	6002	Adequacy of map light during night operations (map light)
	6002.01	brightness
	6002.02	adjustability
	6003	Overall evaluation of interior lighting in the cab - adequacy
	6004	Driver station, methods provided to reduce glare?
	6005	Driver station, instrument panel nomenclature used of appropriate size, contrast with panel, and readable?
	6006	Driver station, decals/placards readable, properly placed?
	<b>7000</b>	<b>Controls</b>
	7001	Driver station, controls provided best choice for critical driving tasks?
	7002	Driver station, shape, spacing between controls appropriate for effective intended usage?
	7003	Driver station, controls located and arranged to facilitate sequential usage?
	7004	Driver station, adequacy of access to driver's controls
	7005	Driver station, direction of control movement correct?
	7006	Driver station, controls located adequately near associated displays?
	7007	Driver station, adequacy of driver control/display arrangement
		<b>Controls and Control Operation</b>
	<b>7008</b>	<b>Accelerator</b>
	7008.01	Design, location and effort required to operate the accelerator, accessibility and operation
	7008.01.01	Pedal size
	7008.01.02	Shape
	7008.01.03	Reach distance
	<b>7009</b>	<b>Brake</b>
	7009.01	Design, location and effort required to operate the brake pedal, accessibility and operation
	7009.01.01	Pedal size
	7009.01.02	Shape
	7009.01.03	Reach distance
	<b>7010</b>	<b>Clutch/transmission</b>
	7010.01	Design, location and effort required to operate the clutch pedal, accessibility and operation
	7010.01.01	Size
	7010.01.02	Shape
	7010.01.03	Reach distance
	7010.02	Design, location and effort required to operate the gear shift lever, accessibility and operation
	7010.02.01	Size
	7010.02.02	Shape
	7010.02.03	Reach distance
	<b>7011</b>	<b>All wheel drive</b>
	7011.01	Design, location and effort required to operate the all wheel drive control, accessibility and operation
	7011.01.01	Size
	7011.01.02	Shape
	7011.01.03	Reach distance
	<b>7012</b>	<b>Steering wheel</b>
	7012.01	Design and location of the steering wheel, accessibility and operation
	7012.01.01	Angle
	7012.01.02	Size
	7012.01.03	Shape
	7012.01.04	Reach distance
	<b>7013</b>	<b>Emergency park brake</b>



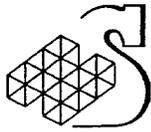
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	7013.01	Design, location and effort required to operate the emergency/parking brake control, accessibility and operation
	7013.01.01	Size, acceptability
	7013.01.02	Shape, acceptability
	7013.01.03	Reach distance
	7014	<b>Lights</b>
	7014.01	Design, location and effort required to operate the headlights/parking lights control/blackout lights, accessibility and operation
	7014.01.01	Size
	7014.01.02	Shape
	7014.01.03	Reach distance
	7014.01.04	Guard to prevent accidental activation
	7014.02	<b>Design, location and effort required to operate the interior lights control, accessibility and operation</b>
	7014.02.01	Size, acceptability
	7014.02.02	Shape, acceptability
	7014.02.03	Reach distance
	7014.02.04	Guard to prevent accidental activation
	7014.03	<b>Design, location and effort required to operate the headlights dimmer control, accessibility and operation</b>
	7014.03.01	Size
	7014.03.02	Shape
	7014.03.03	Reach distance
	7014.04	<b>Design, location and effort required to operate the turn signals, accessibility and operation</b>
	7014.04.01	Size
	7014.04.02	Shape
	7014.04.03	Reach distance
	7015	<b>Windshield wipers</b>
	7015.01	Design, location and effort required to operate the windshield wiper control, accessibility and operation
	7015.01.01	Size
	7015.01.02	Shape
	7015.01.03	Reach distance
	7016	<b>Heater/ventilation</b>
	7016.01	Design, location and effort required to operate the heater/ventilation controls, accessibility and operation
	7016.01.01	Size
	7016.01.02	Shape
	7016.01.03	Reach distance
	7017	<b>Starter</b>
	7017.01	Design, location and effort required to operate the starter control, accessibility and operation
	7017.01.01	Size
	7017.01.02	Shape
	7017.01.03	Reach distance
	7018	<b>Cold start</b>
	7018.01	Design, location and effort required to operate the cold start control, accessibility and operation
	7018.01.01	Size
	7018.01.02	Shape
	7018.01.03	Reach distance
	7019	<b>Electric door locks</b>
	7019.01	Design, location and effort required to operate the electric door locks, accessibility and operation
	7019.01.01	Size



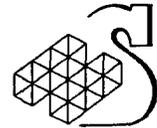
Annex A:  
Draft Technical and Human Factors Design Checklist

	7019.01.02	Shape
	7019.01.03	Reach distance
	7020	Electric mirror control
	7020.01	Design, location and effort required to operate the electric mirrors, accessibility and operation
	7020.01.01	Size
	7020.01.02	Shape
	7020.01.03	Reach distance
	7021	Hand throttle
	7021.01	Design, location and effort required to operate the choke control, accessibility and operation
	7021.01.01	Size
	7021.01.02	Shape
	7021.01.03	Reach distance
	7022	Horn
	7022.01	Design, location and effort required to operate the horn, accessibility and operation
	7022.01.01	Size
	7022.01.02	Shape
	7023	Master disconnect switch
	7023.01	Design, location and effort required to operate the master disconnect switch, accessibility and operation
	7023.01.01	Size
	7023.01.02	Shape
	7023.01.03	Reach distance
	7023.01.04	Guard to prevent accidental activation
	7024	Driver station, emergency brake, location
	7025	Driver station, emergency brake, type of actuation
	7026	Driver station, emergency brake, force required, operation (lbs)
	7027	Driver station, excessive force required to operate hand controls? Acceptability
	7028	Driver station, force measurements of primary hand control (N; lbs.)
	7029	Driver station, force measurements of secondary hand control (N; lbs.)
	7030	Driver station, force measurements of tertiary hand control (N; lbs.)
	7031	Driver station, excessive force required to operate foot controls?
	7032	Driver station, force measurement of accelerator (N; lbs.)
	7033	Driver station, force measurement of foot brake (N; lbs.)
	7034	Driver station, control switch guards, protective covers or guards provided?
	7035	Driver station, protective covers/guards, adequately positioned to permit observation of displays, nomenclature, indicators, etc.
	7036	Driver station, steering device, adequacy of size to permit complete control of vehicle
8000		NBC Protection System
	8001	Driver station, NBC collective protection provided?
	8002	Driver station, NBC collective protection, hose located to provide ready access by driver, closed door operations
	8003	Driver station, NBC collective protection, air temp/humidity at mask
	8004	Driver station, NBC collective protection, access to collective protection filter canister
	8005	Driver station, NBC collective protection, location of collective protection filter
	8006	Driver station, NBC mask type
	8007	Driver station, NBC, access to heater with collective protection
	8008	Driver station, NBC collective protection, air flow rate/volume at mask (ft <sup>3</sup> /min; cu ft/min)



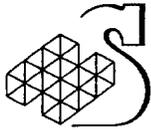
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		8009	Driver station, NBC collective protection, effectiveness of over pressure on driver tasks
		8010	Driver station, NBC collective protection, bulk air dump provided
		8011	Driver station, NBC collective protection, bulk air dump rate/volume (ft/min; cu ft/min)
		8012	Driver station, NBC collective protection, effectiveness of NBC filter to strain dust, other non-NBC particulates
	<b>9000</b>	<b>Visibility</b>	
		9002	Driver's front vision - normal and armoured glass
		9002.01	Freedom from distortion
		9002.02	Freedom from glare
		9002.03	Field of view
		9003	Driver's rear vision - normal and armoured glass
		9003.01	Freedom from distortion
		9003.02	Freedom from glare
		9003.03	Field of view
		9004	Driver's vision to the left - normal and armoured glass
		9004.01	Freedom from distortion
		9004.02	Freedom from glare
		9004.03	Field of view
		9005	Driver's vision to the right - normal and armoured glass
		9005.01	Freedom from distortion
		9005.02	Freedom from glare
		9005.03	Field of view
		9006	Sunvisor
		9006.01	Number
		9006.02	Size
		9006.03	Location
		9006.04	Adjustability
		9007	Mirrors (normal)
		9007.01	Overall adequacy
		9007.02	Number
		9007.03	Size
		9007.04	Location
		9007.05	Adjustability
		9007.06	Blind spots
		9007.07	Freedom from vibration
		9008	Electric mirrors
		9008.01	Overall adequacy
		9008.02	Number
		9008.03	Size
		9008.04	Location
		9008.05	Adjustability
		9008.06	Blind spots
		9008.07	Freedom from vibration
		9008.08	Heater
		9008.09	Electric operation
		9009	Headlights (night time)
		9009.01	High beam effectiveness
		9009.02	Low beam effectiveness
		9010	Driver station, closed door viewing, viewing distance to closest point in front of vehicle



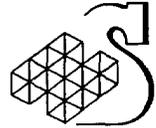
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		9011	Driver station, general adequacy of closed hatch viewing to outside of vehicle, visibility
		9012	Driver station, forward viewing angle, left to right (degrees)
		9013	Driver station, upward viewing angle (degrees)
		9014	Driver station, adequacy of defroster system, operation in cold weather
		9015	Driver station, time to defrost, cold weather operations, from cold start (min,sec)
		9016	Driver station, cold weather operations, frosting or misting of windshield?
		9017	Driver station, adequacy of wipers to remove rain, snow, dust, etc. from window
		9018	Driver station, night vision device provided?
		9019	Driver station, adequacy of night vision device
		9020	Driver station, time to remove night vision device from stowed position (seconds)
		9021	Driver station, adequacy of viewing ground, open hatch, seat adjusted fully up, 5th percentile male
		9022	Driver's exterior lights, illumination level, 25m, full ON; front of vehicle (lx; ft-C)
		9023	Driver's exterior lights, replace bulbs, etc., ease of replacement
	<b>10000</b>	<b>Communications</b>	
		10001	Front passenger station, location of communication (comms) hook-up
		10002	Front passenger station, ease of access to comms hook-up from normal seated position
		10003	Front passenger station, comms equip, ease of operation of comms box w/arctic handwear
		10004	Front passenger station, comms equip, space between connector and bulkhead, or connector and closest object (mm)
		10005	Front passenger station, comms equip, probability of intercom cord interfering with driver mobility
		10006	Front passenger station, effectiveness of communicating with gunner using hand signals or other methods
	<b>1000</b>	<b>Heating/Cooling</b>	
		11001	Driver, front passenger station, temperature at driver's feet, full (degrees C) - cooling for A2 environments and heating for arctic environments - adequacy
		11002	Driver, front passenger station, heater, variable heat control provided?
		11003	Driver, front passenger station, heater, station designed for equal distribution of heat?
		11004	Driver, front passenger station, ease of operation considering practicality of heater, reliability, accessibility, etc.
		11005	Driver, front passenger station, heater, accessibility of heater control
		11006	Driver, front passenger station, heater, adequacy of safeguards to prevent heater injury to personnel
	<b>12000</b>	<b>Vibration</b>	
		12001	Driver, passenger, gunner station, seat vibration, probability of degrading task performance
		12002	Driver, passenger, gunner station, whole body vibration, at SRP IAW TECOM TOP 1-2-610, X-axis (RMS, 30 HZ; 50 HZ; 80 HZ)
		12003	Driver, passenger, gunner station, whole body vibration, at SRP IAW TECOM TOP 1-2-610, Y-axis (RMS, 30 HZ; 50 HZ; 80 HZ)
		12004	Driver, passenger, gunner station, whole body vibration, at SRP IAW TECOM TOP 1-2-610, Z-axis (RMS, 30 HZ; 50 HZ; 80 HZ)
		12005	Driver, passenger, gunner station, probability of ride vibrations causing visual difficulties
		12006	Driver, passenger, gunner station, vibration amplitude, driver's instrument panel (RMS)
		12007	Driver, passenger, gunner station, vehicle lurch, start-stop?
	<b>13000</b>	<b>Crew Integration Safety/Health Hazards</b>	
		13001	Crew, feasible to cross-train crewmembers in all functions of the vehicle?



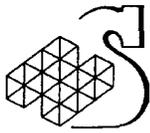
**Annex A:  
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	13002	Training, system design accommodating to training aids, instructional devices, New Equipment Training?
	13003	Driver station, chance of handedness or eye glasses interfering with driving operations
	13004	Driver station, ease of training new operator quickly
	13005	NBC/Arctic gear, considering design of vehicle, probability of NBC/arctic gear degrading crew performance of critical tasks
	13006	NBC/Arctic gear, probability of NBC/arctic gear interfering with emergency egress from vehicle
	13007	NBC/Arctic gear, probability of NBC/arctic gear interfering with emergency egress
	13008	NBC/Arctic gear, adequacy of workspace to permit efficient donning/doffing of NBC/Arctic garb
	13009	NBC decontamination, type of decontamination agent in use
	13010	NBC decontamination, probability of damaging exposed, sensitive instruments/equipment w/decon agent
	13011	General, adequacy of interior space for extended ops; crew work/rest cycles
	13012	General, probability of driver injury from elevation/depression of main weapon
	13013	General adequacy of padding of protruding objects to protect driver, passengers from injury
	13014	Fire suppression, portable fire extinguisher provided?
	13015	Fire suppression, quick accessibility to fire extinguishers
	13016	First aid kit, quick accessibility to first aid kit
<b>14000</b>	<b>Stowage</b>	
	14001	Door compartment
	14001.01	adequate size
	14002	Glove compartment
	14002.01	adequate size
	14003	Tool compartment
	14003.01	adequate size
	14004	Water storage, capacity (litres)
	14005	Water storage, effectiveness of stowage to avoid interference with driver activities
	14006	Personal Wpn stowage, accessibility, to driver, passengers
	14006.01	Personal Wpn stowage, effectiveness of stowage to avoid interference with driver activities
	14007	Stowage, adequacy of design for stowage of driver's Night Viewing Aid for transport into combat
	14008	Stowage, adequacy of design for stowage of vehicle items (i.e., tools, chains, etc.) for transport into combat
	14009	Stowage, adequacy of space for personnel equipment, NBC garments, individual weapons/ammunition, inside vehicle
	14010	Stowage, personnel gear/weapons stowed outside vehicle?
	14011	Stowage, adequacy of stowage of combat rations
	14012	Stowage, amount of personnel combat rations stowed on-board (days)
	14013	Stowage, quick access of personnel weapons/ammunition/grenades
	14014	Acceptability of external tie down points
	14014.01	Number
	14014.02	Location
	14014.03	Design
<b>15000</b>	<b>Ventilation</b>	



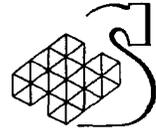
**Annex A:  
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	15001	Ventilation, location of fresh air intake, distance from engine/other exhausts
	15002	Driver, passenger, gunner station, ventilation, non-NBC; air flow rate/volume at station (ft <sup>3</sup> /min; cu ft/min)
	15003	Driver, passenger, gunner station, ventilation, non-NBC; proportion fresh outside air provided to station (percent)
	15004	Driver, passenger, gunner station, ventilation, non-NBC; variable control provided for ventilation system?
	15005	Driver, passenger, gunner station, ventilation, non-NBC; accessibility to ventilation control
	15006	Driver, passenger, gunner station, ventilation, non-NBC; effectiveness of ventilation system at gunner station
	15007	Toxic fumes, probability of task degradation because of CO, NH <sub>3</sub> , NO <sub>2</sub> , or SO <sub>2</sub> concentrations
	15008	Toxic fumes, health hazards imposed on crew
	15009	Toxic fumes, level of CO, driver, passenger, gunner station, automotive, closed hatch (PPM; COHb)
	15010	Toxic fumes, level of CO, driver, passenger, gunner station, main weapon firing, closed door, battlefield day (PPM, COHb)
	15011	Toxic fumes, level of SO <sub>2</sub> , driver, passenger, gunner station, main weapon firing, closed door, battlefield day (PPM, COHb)
	15012	Toxic fumes, level of NO <sub>2</sub> , driver, passenger, gunner station, main weapon firing, closed door, battlefield day (PPM, COHb)
	15013	Toxic fumes, level of NH <sub>3</sub> , driver, passenger, gunner station, main gun firing, closed door, battlefield day (PPM, COHb)
	15014	Ventilation, ventilator fan in ceiling provided?
<b>16000</b>	<b>Noise</b>	
	16001	Driver, passenger, gunner station, steady-state noise hazards, any frequency/condition
	16002	Driver, passenger, gunner station, steady-state noise, closed hatch, veh moving, 30 MPH, hard surfaced road, 125 HZ, (dBA)
	16003	Driver, passenger, gunner station, steady-state noise, closed hatch, veh moving, @10 MPH, hard surfaced road, 500 HZ, (dBA)
	16004	Driver, passenger, gunner station, steady-state noise, closed hatch, veh moving, 10 MPH, hard surfaced road, 2000 HZ, (dBA)
	16005	Driver, passenger, gunner station, impulse noise hazards, main weapons/coax
	16006	Driver, passenger, gunner station, impulse noise, weapon, closed door, gun position forward (A duration; B duration: peak pressure-dBA)
<b>17000</b>	<b>Maintenance</b>	
	17001	Maintenance, automotive, accessibility to light bulbs, lamps, ease of replacement
	17002	Maintenance, automotive, accessibility to drain valves, ease of replacement
	17003	Maintenance, automotive, accessibility to oil filters, ease of replacement
	17004	Maintenance, automotive, accessibility to air filters, ease of replacement
	17005	Maintenance, automotive, accessibility to engine adjustment
	17006	Maintenance, automotive, accessibility to batteries/terminals, ease of replacement
	17007	Maintenance, interior, accessibility to weapons
	17008	Maintenance, automotive, accessibility to hydraulics
	17009	Maintenance, interior/exterior+C514, accessibility to electrical systems, ease of replacement
	17010	Maintenance, ease of identifying maintenance checkpoints
	17011	Maintenance general adequacy of workspace for performing checks, maintenance services
	17012	Maintenance, ease of reading dipsticks, gauge, levels, etc.
	17013	Maintenance, automotive, average time to perform routine maintenance checks (no. trials;



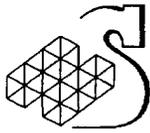
**Annex A:  
Draft Technical and Human Factors Design Checklist**

			min/sec)
		17014	Maintenance, automotive, average time to replace oil filter
		17015	Maintenance, automotive, average time to replace air filter
		17016	Maintenance, effectiveness of caution/warning labels/placards for PMCS considering size, location colour-coding, etc.
		17017	Maintenance, special tools required?
		17018	Maintenance, special tools stowed on-board?
		17019	Maintenance, adequacy of maintenance procedures in terms of complexity, training requirements, etc.
		17020	Maintenance, specialized diagnostics required?
		17021	Maintenance, built-in test/diagnostic equipment provided?
		17022	Maintenance, average time to diagnose faults (no. trials; seconds)
		17023	Ease of cleaning, interior
		17024	Repairs, interior, accessibility to electrical cables/hydraulic lines, ease of replacement
		17025	Repairs, quality of protection afforded to cables, indicators, etc. against inadvertent damage during repairs
		17026	Repairs, cables/indicators, etc., adequacy of labels, colour-coding, etc. for easy identification
		17027	Battle damage assessment/repair, capability/probability of crew being able to assess/repair damage during combat
		17028	Maintenance, ease of removing/replacing power pack
		17029	Maintenance, ease of replacing wheels (consider workspace)
		17030	Maintenance, average time to remove wheels and, replace with new (no. trials; min/sec)
		17031	Refueling, ease of accessing fuel inlet, manipulating with arctic handwear
		17032	Refueling, prevention of splash back
		17033	Combat operations, pre-combat systems checks required?
		17034	Combat operations, average time to conduct pre-combat systems checks (no. trials; min/sec)
		17035	Combat operations, probability of vibrations/acceleration causing adverse effects on vehicle
	<b>18000</b>	<b>Handling characteristics</b>	
		18001	Cornering
		18001.01	Ability to corner at low speeds (less than 15 mph)
		18001.02	Ability to corner at high speeds (greater than 15 mph)
		18001.03	Turning radius of vehicle
		18001.04	Overall evaluation of cornering ability
		18002	Road feel
		18002.01	Ability to feel the road surface through the steering wheel
		18003	Braking
		18003.01	Ability to make quick stops
		18003.02	Control of vehicle (directional stability) when braking (weaving, rear end breaking loose)
		18003.03	Effort required to stop the vehicle
		18003.04	Overall evaluation of braking ability of vehicle
		18004	Vehicle control (maneuverability)
		18004.01	Controllability of the vehicle at low speeds (less than 15 mph) on a hard surface road
		18004.02	Controllability of the vehicle at high speeds (greater than 15 mph) on a hard surface road
		18004.03	Controllability of the vehicle at low speeds (less than 15 mph) off road
		18004.04	Controllability of the vehicle at high speeds (greater than 15 mph) off road



Annex A:  
Draft Technical and Human Factors Design Checklist

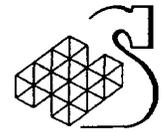
	18004.05	Safety hazards related to vehicle handling characteristics (instability)
	18004.06	Controllability of the vehicle while backing up to a hide
	18004.07	Controllability of the vehicle while parallel parking
	18004.08	Controllability of the vehicle during fording operations
	18004.09	Controllability of the vehicle while traversing mud or very soft ground
	18004.1	Controllability of the vehicle while operating on a steep slope
	18004.11	Overall evaluation of vehicle controllability
	18005	Engine
	18005.01	Amount of engine power
	18005.02	Responsiveness of vehicle to accelerator inputs
	18005.03	Overall evaluation of engine performance
	18006	Overall
	18006.01	Overall evaluation of the vehicle handling characteristics
<b>19000</b>	<b>Ride quality</b>	
	19001	Ride quality (freedom from up-down side-to-side, and front-to-back vibrations; smoothness; stability)
	19001.01	Quality of ride at low speeds (less than 15 mph) on a hard surface road
	19001.02	Quality of ride at high speeds (greater than 15 mph) on a hard surface road
	19001.03	Quality of ride at low speeds (less than 15 mph) off road
	19001.04	Quality of ride at high speeds (greater than 15 mph) off road
	19002	Overall
	19002.01	Overall evaluation of the vehicle ride characteristics
<b>20000</b>	<b>Towing compatibility</b>	
	20001	Pintle hook
	20001.01	Access
	20001.02	Size
	20001.03	Operation
	20002	Towing loops
	20002.01	Access
	20002.02	Size
	20003	Electric receptacle
	20003.01	Access
	20003.02	Cover
<b>21000</b>	<b>Recovery compatibility</b>	
	21001	Tow hooks/points
	21001.01	Number
	21001.02	Access
	21001.03	Size
	21001.04	Compatibility with A
	21002	Lifting and tie down points
	21002.01	Number
	21002.02	Access
	21002.03	Suitability
	21003	Winch controls
	21003.01	Accessibility by driver in vehicle
	21003.02	Ease of operation by driver in vehicle
	21003.03	Ease of operation by driver remotely
	21003.04	Ease of connecting remote controller
<b>22000</b>	<b>Fording</b>	



**Annex A:  
Draft Technical and Human Factors Design Checklist**

	22001	Ease of preparation
<b>23000</b>	<b>Compatibility with APS</b>	
	23001	Ease of mounting
	23002	Requires use of mechanical assist?
	23003	Maximum weight per panel
	23004	Maximum size?
	23005	Installation/removal time
	23006	Mounting points covered when not in use?
<b>24000</b>	<b>Compatibility with IRIS Radio</b>	
	24001	Radio/radio trays
	24001.01	Ease of installation
	24001.02	Ease of removal
	24001.03	Ease of operation
	24002	Outlet power bar
	24002.01	Access to power bar
	24002.02	Access to circuit breaker
	24003	Radio, antennae mounting points
	24003.01	Suitability of location
	24004	GPS, antennae mounting points
	24004.01	Suitability of location
	24005	Antennae
	24005.01	Ease of mounting
	24005.02	Ease of dismounting
<b>25000</b>	<b>Compatibility with IRIS UCD</b>	
	25001	Access to external mount for IRIS UCD
	25002	Suitability of location
	25003	Adequacy of seal
<b>26000</b>	<b>User manual</b>	
	26001	Suitability
	26002	Detail
<b>27000</b>	<b>Camouflage Net</b>	
	27001	Suitability of stowage location
	27002	Acceptability of net snagging during erection and teardown

**ANNEX B:  
Human Factors  
Evaluation Plan**



## 1.0 User acceptance trial

- Minimum overall soldier acceptance rating of 80%
- Minimum acceptance rating of 75% for defined criteria

### 1.1. Static Compatibility Tests

#### User/Clothing

- IECS
- Cold wet weather gloves
- Temperate combat gloves
- Combat clothing
- IPE?
- Load carriage
- Generation III fragmentation vests
- Soldier's helmet
- Temperate combat boot
- Cold wet weather combat boot
- Mukluks?
- Rucksacks?

#### Equipment

- Towing
- Recovery
- APS
- IRIS radio
- IRIS UCD
- PLGR
- Camouflage net
- NODLR

### 1.2. Static Performance Tests

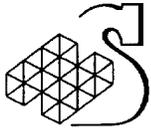
#### Access and egress

#### Seating acceptability

#### Workstation space acceptability

#### Internal visibility

- Controls
- Displays/instruments
- Warning lights



**Annex B:  
Human Factors Evaluation Plan**

**Interior Lighting**  
**Control Operability**  
**External visibility**  
**Communications**  
**Heating**  
**Cooling**  
**General safety**  
**Stowage**

**1.3. Dynamic Performance Tests**

**Vibration**  
**Noise**  
**Ventilation**  
**Vehicle handling**  
**Winch handling**  
**Ride quality**  
**Control Operation**  
**User comfort**

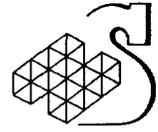
**1.4. Maintainability**

**Access**  
**Ease of replacement**

**1.5. Task Performance**

**Basic vehicle**

- User maintenance
  - Change tire
- Camouflage
- Driving
- Self recovery
- Suitability as for personnel transport
- Personnel transport
- City driving



- Highway driving

**C&C vehicle**

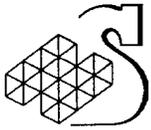
- Compatibility with C&C radios
- Compatibility with C&C / rover duties
- Suitability for C&C duties
- Dispatch runs
- Negotiates black tracks
- Upload TCCCs radio CEOs
- Harbour and hide drills

**Recce Vehicle**

- Mount APS
- Compatibility with C&C radios
- Compatibility with weapon station tasks
- Suitability for recce tasks
- Route recce
- Cross country driving
- Tactical driving, evasion
- Crash harbour

**MP vehicle**

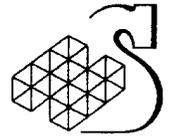
- Mount MP siren package
- Compatibility with C&C radios
- Compatibility with search light
- Compatibility with radar
- Suitability for field MP tasks-rte signing
- Airfield security tasks
- TCP tasks



**Annex B:  
Human Factors Evaluation Plan**

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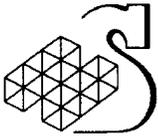
**ANNEX C:  
LUVW HF Requirements**



**Annex C:  
LUVW HF Requirements**

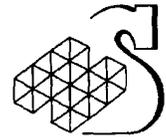
*Note: Shaded areas relate specifically to Human Factors evaluation.*

<b>LUVW Requirement #</b>	<b>Description</b>
C 3.4.1	<b>Physical.</b> The vehicle shall be capable of sustained, effective combat and support operations, and meet peacetime training requirements. It shall do so, fully loaded, with minimal breakdown, damage, or maintenance. These conditions include operation on highways and cross-country, including hilly, unpaved and severe washboard surfaces, rocky ground, plowed fields, sand, mud, snow, ice, and water obstacles. All components shall be capable of operating without malfunction under the conditions stated herein while withstanding rugged military usage. The vehicle shall be operated by many users throughout the in-service period and shall be capable of withstanding such usage. The vehicle shall support the maximum gross loads, including all attachments and equipment (listed elsewhere in this document) while maintaining the necessary stability, structural integrity, and operational capability. Except where stated otherwise, all performance requirements shall be met with the vehicle loaded as described in section. less the requirement of towing a trailer.
C 3.5.7	<b>RAMD.</b> The vehicle shall be reliable, available, maintainable and durable. These characteristics are described in section.; and
C 3.7.1	<b>Crew.</b> The vehicle shall be able to carry the number of personnel as stated in Appendices CB through CD for the individual variants. Personnel ranging in all body size characteristics from the 95 <sup>th</sup> percentile male crew members to 5 <sup>th</sup> percentile female crew members, dressed in full Improved Environmental Clothing System (IECS), winter clothing, fighting order shall be accommodated and shall be able to operate the vehicle safely in the manner intended;
C 3.7.2.2.1	<b>Personal Weapons.</b> Mounting space shall be provided inside the cab for C7A1 personal weapons complete with mounting brackets. In vehicles with APS installed, the weapons shall be mounted in the armored portion of the cab. The upper rifle bracket shall be NSN 5340-21-901-8461 (DND Dwg 8790001) and the lower bracket shall be NSN 2540-21-116-6897 (DND Dwg 313209). The placement of the brackets and weapons shall not hinder access into/out of the vehicle, shall not interfere with any of the vehicle controls and shall afford ease of access by each individual to their personal weapon. The number of personal weapons to be stored in each variant is indicated in the individual variant kit lists, Appendices CB to CD.
C 3.7.4.2	<b>Navigation Equipment.</b> The vehicle shall accommodate the Precision Lightweight Global Positioning System Receiver (PLGR, NSN 5825-01-395-3513) inside the cab, plus the externally mounted, remote antenna (Part Number 013-1925-030) and related cabling. The PLGR receiver shall be easily accessible and operable by the vehicle operator and co-driver. The details of the PLGR are described in CFTO C-65-174-000/MB-001. For details on the PLGR installation requirements see sections.



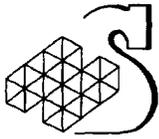
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C 3.8.4.2	To facilitate ease of installation/removal and to reduce the installation/removal time, the use of large panels in combination with assembly replacement should be employed. To illustrate, the roof protection should be accomplished by maximum size panels and the doors should be replaced with armoured door assemblies which are already fitted with armoured glass, power mirrors and power door locks;
C 3.8.6.1	The construction of the ballistic glass shall be such as to minimize reduction in visibility and image distortion when looking through the glass. All ballistic glass used in the Armour Protection System shall allow the proper and effective use of night vision equipment by the crew with minimum degradation;
C 3.8.6.2	There shall be a minimum reduction in the fields of view through the ballistic glass as compared to the standard glass in the windshield and side windows. The size of the field of view of the ballistic glass shall not be reduced by any more than a nominal twenty-five millimeters (25mm) around the perimeter as compared to the dimensions of the standard vehicle glass;
C 3.9.3.3	<u>Oil Filter System.</u> A full flow oil filter shall be provided. The filter shall be readily accessible for changing. The fill and drain locations shall be suitably sized and be readily accessible. The filter should be a 'spin-on' type.
C 3.9.4.4	The control system for the heater shall incorporate 'On-Board' diagnostics that indicate heater operational faults, should they occur. The fault codes shall be easily read without the use of special tools; and
C 3.9.4.5	The heater shall have an easily accessible operator control mounted in a location that is easily operable by the driver. The control shall allow the heater to be turned 'On' or 'Off', shall indicate when the heater is 'On' and shall indicate when faults are detected in the heater.
C 3.9.5.1	A fuel filter/water separator shall be provided in the fuel system. An easily accessible, manual water drain mechanism shall be provided on the filter/water separator assembly;
C 3.9.5.2	A method for quick, easy and complete draining of contaminated fuel from the fuel tank shall be provided;
C 3.9.5.6	The lines and fittings in the fuel system shall be selected to maximize the size of the fuel flow path and to eliminate sharp corners or restrictions which could potentially inhibit fuel flow due to "waxing" in extreme cold operations; and
C 3.9.6.7	A readily accessible transmission fluid filter, as recommended by the transmission manufacturer for the intended application, shall be provided.



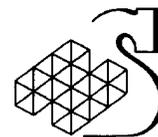
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C 3.9.9.3.2	The vehicle ride quality, as defined in section 0. shall be provided in order to minimize the detrimental effects to vehicle components, personnel and payload.
C 3.9.10.6	One full size spare tire and wheel assembly shall be provided. A spare wheel carrier shall be provided. The spare tire shall be capable of being removed or replaced when the tire is inflated or flat. The spare tire stowage location shall be accessible from the curbside or rear of the vehicle. Spare wheel location shall be easily accessible under all cross-country terrain conditions. All functions associated with the replacement of a flat tire in the field shall be able to be performed by a 5 <sup>th</sup> percentile female.
C 3.9.11.1	<u>Toxic Fumes.</u> The cab and crew compartment shall be sealed such that the driver and passengers will not be subject to toxic levels of exhaust gases while the vehicle is at rest, in still air, with the engine idling. The exhaust may be generated by the engine or by the coolant heater, operating separately or concurrently.
C 3.9.11.3	<u>Seats.</u> Seating for the number of crew, as specified in variant sections shall be provided. The driver's seat shall be adjustable forwards and backwards. The driver's seat should also be adjustable up and down. All adjustments of the driver's seat shall be capable of being done while the driver is occupying the seat. All seating positions shall be fitted with an adjustable headrest. The rear seats should embody a folding type backrest and be capable of being tilted forward. If so equipped, folding seats shall have a locking device to keep them in either the upright or folded position;
C 3.9.11.6	<u>Glove Compartment.</u> A glove compartment or suitable enclosure for storage of maps and papers shall be provided. It shall be easily accessible and shall protect the contents from water and debris;
C 3.9.11.8.2	The windshield shall be constructed of a laminated safety glass and shall be the largest size practical consistent with the vehicle design. It shall be mounted in such a manner as to reduce or eliminate glare from reflected sunlight. A vertically mounted windshield is preferred;
C 3.9.11.11	<u>Construction.</u> The cab system shall be strong enough to allow a male soldier of 95 <sup>th</sup> percentile weight to climb on/over the vehicle as necessary during camouflaging or like operations without damaging any part of the cab/body. The areas where a soldier will step during these operations shall have non-slip surfaces. All components and surfaces of the cab system shall be capable of being cleaned with high-pressure water or steam without deterioration. Hand holds and step points to be provided as necessary to access the hood and roof of the vehicle.



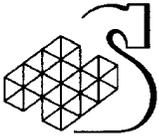
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C 3.9.11.12.2	<p><u>Switches.</u> (starter, lighting, etc. ...) shall not interfere with the occupants' movements and shall be readily accessible to and easily operable by the 95<sup>th</sup> percentile male soldier or 5<sup>th</sup> percentile female soldier when seated and wearing his/her seat belt. Switches shall be easily operable by personnel wearing full IECS, winter clothing, fighting order, shall be visible to the operator, shall be capable of being dimmed and shall be subject to blackout lighting override if lighting is integral to the switch;</p>
C 3.9.15	<p><u>Towhooks and Tie-Down Points.</u> All towhooks and tiedown points shall be accessible and operable with minimal preparation by the Operator in all variants with or without APS.</p>
C 3.19.9.2	<p>Warning or precautionary data plates shall be provided where necessary to protect personnel or equipment. Data plates shall contain both English and French;</p>
C 3.9.20.5.1	<p>Slave receptacle, 24 volt, NATO single pin, Type 1 in accordance with STANAG 4074, with waterproof cover and chain (NSN 5935-01-097-9974). The receptacle should be located either inside the cab enclosure or under the engine bonnet. The receptacle shall be mounted in a location which is easily accessible for attachment of the slaving cable. The receptacle shall be capable of accepting all the various single pin, Type 1 slave cable end connectors;</p>
C 3.9.20.5.3	<p>A three-pin, 24 volt receptacle (NSN 5935-00-850-5593) for a plug-in trouble light, mounted in the cab interior in a location which is easily accessible from the external of the cab.</p>
C 3.9.20.6	<p><u>Master Disconnect Switch.</u> A switch shall be provided to completely isolate the batteries from the vehicle electrical system. The switch should be in accordance with NSN 5930-00-930-5016. The switch shall be located inside the cab enclosure. The switch shall be mounted in an easily accessible location for operation by the vehicle operator;</p>
C 3.9.20.7.3	<p><u>Map Reading Light.</u> A map reading light shall be provided. It shall have a selectable blue/clear lens. It shall be capable of being used by either the driver or front passenger. The light shall be securely installed, typically to the dash between the driver and passenger, and shall be a flexible gooseneck design. The gooseneck shall be a minimum of 250 mm long;</p>
C3.9.20.7.4	<p><u>Interior Dome Light(s).</u> An interior dome light(s) shall be provided to allow the driver and passengers to read maps or carry out similar type tasks in the vehicle at night while in their seated positions; and</p>



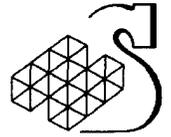
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C 3.10.1	<u>Ergonomics</u> . The vehicle design shall be such that the range of all dimensional characteristics, as collected in DCIEM Report 98-CR-15 for CF personnel, be accommodated while wearing the full Improved Environmental Clothing System (IECS), winter clothing, fighting order. The ranges would be from the minimum value to the maximum value, typically from the 5 <sup>th</sup> percentile female to the 95 <sup>th</sup> percentile male respectively. The vehicle design shall allow the full range of personnel to easily do the following:
C 3.10.1.1	Carry out all the actions required to drive the vehicle safely;
C 3.10.1.2	Ride comfortably as passengers;
C 3.10.1.3	Enter or exit the vehicle safely and easily without catching kit or clothing on vehicle fittings;
C 3.10.1.4	Operate the communication equipment while the vehicle is on the move; and
C3.10.1.5	Carry out all other crew functions and duties related to operating and maintaining or servicing the vehicle
C 3.10.2.1	<u>Heating</u> . The crew compartment heating system shall be of a sufficient capacity to maintain temperatures above 20°C IAW the requirements of paragraph 5.12.6.1 of MIL-STD-1472 during the extreme cold "C2" winter temperature conditions specified at .; and
C 3.10.2.2	<u>Ventilation</u> . The crew compartment ventilation system shall satisfy the requirements described in paragraph 5.12.6.2. of MIL-STD-1472. The ventilation fan shall have a minimum of 3 speed settings (low, medium, high) in addition to the 'OFF' position. Consistent with MIL-STD-1472, outside fresh air shall be supplied above a minimum rate of 80 CFM to accommodate up to four (4) persons which could occupy the compartment at any one time. The ventilation system shall be configured to ensure maximum dispersal of the fresh air throughout the compartment. The fresh air intake shall be configured to prevent water, sand, dust and debris from entering into the ventilation / heating system; and
C 3.10.2.3	<u>Air Conditioning</u> . The A/C system shall be capable of maintaining an effective temperature of 29.5°C in accordance with MIL-STD-1472 when the vehicle with APS installed is subjected to the extreme ambient temperatures as described in STANAG 2895, condition A2 (+ 44°C). The effective temperature shall be attained within one hour of air conditioner startup with four vehicle occupants in the cab and all vehicle equipments and systems operating in the manner intended. The 29.5°C effective temperature should be achievable concurrently with the solar radiation as described in MIL-STD-810.
C 3.10.3	<u>Outward Vision</u> . The basic vehicle configuration shall provide the driver with an unobstructed view both to the front and the sides of the vehicle;



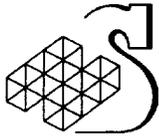
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C 3.10.4.1	The eight hour equivalent noise levels measured at the driver's ears shall not exceed 85 dB(A) in accordance with Category D of MIL-STD-1474. The eight hour equivalent noise levels measured at the driver's ears should be less than 75 dB(A); and
C 3.10.4.2	Vibration levels resulting from traveling cross-country or on dirt roads shall not result in excessive fatigue or motion sickness or in any physical injury to crewmembers. The vibration exposure limits should be within the limits given in Para. 5.8.4.1. of MIL-STD-1472. The levels of vibration shall also be such as to minimize damage to stowed tools, MSE equipment, cargo or electronic system assemblies or components.
C 3.11.2.12	<u>Ride Quality.</u> The vehicle shall expose the driver and passengers to no more than an average of six (6) watts absorbed power, as measured at both the driver's and passenger's seats, at speeds up to and including 50 km/h while continuously traversing a random roughness course of 25 mm rms. In addition, shock accelerations resulting from traversing a single 150 mm bump at 15 km/h shall not exceed 2.5 g (measured on the floor at the driver's feet). This requirement shall be satisfied by the vehicle through out its weight range ie. from the curb weight (CW) carrying only the driver without APS installed to the vehicle at the maximum GVWR with the APS installed;
C 3.12.2	<u>Mission Essential Functions.</u> The vehicle shall be capable of effectively manoeuvring such that it can start, continue and complete assigned missions in all weather conditions and terrain types. In order to carry out its mission, the vehicle shall be able to:
C 3.12.2.5	Operate ring mount with weapon mounted, while vehicle is on the move.
C 3.12.5.2.2	<u>Operator and Preventive Maintenance.</u> Daily operator maintenance shall not exceed 1/4 hour. Routine preventive maintenance shall not exceed once every 5000 operating kilometres or twice a year (biannually), whichever occurs first. The 5000 km / biannual preventive maintenance should not require more than 3.0 man-hours;
C 3.5.12.5.5	<u>Maintenance and Repair.</u> The vehicle should incorporate design characteristics such that all maintenance and repair tasks can be completed in as short a time as possible. Examples are:
C 3.5.12.5.5.5	Transparency in vehicle fluid reservoirs (brake fluid, engine coolant, windshield washer fluid, etc.) shall be provided for ease of inspection and to minimize the possibility of introducing contaminants to the respective systems;



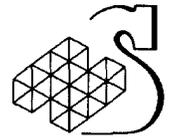
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C 3.14.1	The communications equipment and the navigation system must be located to <b>ensure ease of operation and to be easily accessible for removal/replacement by all personnel</b> in all variants. Some components of the system may be located in the cargo area of the cab subject to the approval of the DND Project Manager. For radio equipment located in the cargo area, or in an un-armoured area of a vehicle with APS installed, access from inside the crew compartment to allow for running adjustments (ie. Frequency/crypto fill) to the components without exiting the vehicle shall be provided.
C 3.14.2.1	The vehicle shall have space and electrical power supply to allow adaptation of the IRIS radio installations. The space claims for the maximum sized, three radio installation (two 'A+' radios, one 'C' radio and the 'GPS' - Allocation Code 94) is shown in Appendix CE. Power draw shall be from a four (4) outlet distribution box (similar to NSN 5820-21-897-4700) which is to be provided by the contractor, the part number for the connectors is NSN 5995-21-898-2413. This box shall be equipped with adequate short circuit protection. This box shall be located adjacent to and be <b>easily accessible</b> for attaching the power cables from the radios. This box shall be capable of supplying 50 amps, 28 VDC;
C 4.1.4	The cab shall accommodate a crew of three (3) or four (4) persons. This consists of the driver (operator), the front seat passenger (navigator) and one (1) or two (2) rear seat passengers. It is not necessary to carry rucksacks when carrying four (4) crew members. Crew members may range in size from the 5 <sup>th</sup> percentile female characteristics to the 95 <sup>th</sup> percentile male characteristics in full IECS winter clothing, fighting order as referred to in section 0.. All crewmembers shall be accommodated for in such a way as to be able to <b>safely operate all vehicle and weapon systems in the manner intended</b> . The following are typical operations / tasks to be carried out by crew members:
C 4.1.4.1	Driver. The driver shall be able to <b>easily enter and exit the vehicle, fit comfortably in the seated position, easily operate the seat belts, operate all vehicle controls ie. brakes, steering, shifting, signal switches, lighting controls, etc..., see clearly to the front and rear of the vehicle, access personal weapon and be able to read and observe all instruments, gauges and warning lights while the vehicle is operational for periods up to four (4) hours and over distances of up to 200 kilometers in a safe and comfortable manner;</b>



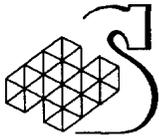
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C 4.1.4.2	Front Seat Passenger. The front seat passenger shall be able to easily enter and exit the vehicle, fit comfortably in the seated position, easily operate seat belts, effectively communicate with the driver, read a map or route card, use communication(s) devices ie. handset, cellular phone, etc.. and access personal weapon while the vehicle is operational for periods up to four (4) hours and over distances of up to 200 kilometers in a safe and comfortable manner;
C 4.1.4.3	Rear Seat Passenger(s). The rear seat passenger(s) shall be able to easily enter and exit the vehicle, fit comfortably in the rear passenger seated positions, easily operate seat belts and access personal weapons. Provisions shall be such to allow the rear seat passenger(s) to be accommodated for in transit for periods up to four (4) hours and / or over distances of up to 200 kilometers in a safe and comfortable manner.
C 5.1.4	The C&R variant shall carry and securely store the kit and equipment as detailed in section 0.; and
C 5.1.5	The cab shall accommodate a crew of three (3) which consists of the driver (operator), the front seat passenger (navigator) and a rear seat passenger (gunner). Crew members may range in size from the 5 <sup>th</sup> percentile female characteristics to the 95 <sup>th</sup> percentile male characteristics in full IECS winter clothing, fighting order as referred to in section 0.. All crewmembers shall be accommodated for in such a way as to be able to safely operate all vehicle and weapon systems in the manner intended. The following are typical operations / tasks to be carried out by crew members:
C 5.1.5.1	Driver: The driver shall be able to easily enter and exit the vehicle, fit comfortably in the driver's seated position, easily operate the seat belts, operate all vehicle controls ie. brakes, steering, shifting, signal switches, lighting controls, etc..., see clearly to the front and rear of the vehicle, access personal weapon and be able to read and observe all instruments, gauges and warning lights while the vehicle is operational for periods up to four (4) hours and / or over distances of up to 200 kilometers in a safe and comfortable manner;
C 5.1.5.2	Front Seat Passenger: The front seat passenger shall be able to easily enter and exit the vehicle, fit comfortably in the front passenger's seated position, easily operate seat belts, effectively communicate with the driver, read a map or route card, use communication(s) devices ie. Handset, cellular phone, etc.. and access personal weapon while the vehicle is operational for periods up to four (4) hours and / or over distances of up to 200 kilometers in a safe and comfortable manner; and



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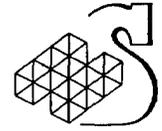
C 5.1.5.3	Rear Seat Passenger: The rear seat passenger shall be able to easily enter and exit the vehicle. As a passenger, the individual shall fit comfortably in the rear passenger's seated position, easily operate seat belts and access personal weapons. As the gunner, the individual shall be able to comfortably execute all weapon system functions while a weapon is mounted on the ring mount through the ranges of motion specified at 0.. The gunner shall be comfortably supported when operating the weapon as specified at 0.. Provisions shall be such to allow the rear seat passenger to be accommodated for in transit for periods up to four (4) hours and / or over distances of up to 200 kilometers in a safe and comfortable manner.
C 5.2.2.1	The capability to stow and operate either the 50 Cal MG or the MK 19 Grenade Launcher in place of either the C6 or C9 MG shall be provided. The bidder should identify brackets for attaching and operating each of these weapons on the ring. The vehicle shall be capable of carrying and securely stowing two boxes of ammunition for either weapon.
C 5.2.3	<u>Weapon Accuracy.</u> The weapon station shall not degrade the inherent accuracy of the C6 or C9 as compared to that achieved when the weapons are fired from a ground location;
C 5.2.4	<u>Elevation and Azimuth.</u> The movement of the weapon station shall allow the gunner the freedom of movement to engage aerial and ground targets as described as follows:
C 5.2.4.2	a total arc in depression of 35 mils throughout the 6400 mils of horizontal arc with either the C6 or C9 MG mounted. The arc of depression shall however, be limited with safety stops, so as to prevent endangering the driver or co-driver;
C 5.2.4.3	the gunner shall be able to traverse a horizontal arc of 3200 mils in either direction in under 3 seconds with either the C6 or C9 mounted; and
C 5.2.4.4	the movement shall not interfere with the normal functions of the driver or the co-driver.
C 5.2.5	<u>Weapon Stowage Items.</u> a secure storage space for the following shall be provided for in the vehicle:
C 5.2.7.1	the ring shall have an easy to use locking mechanism to prevent the ring from inadvertently rotating (in the horizontal plane). The locking mechanism shall be capable of locking the ring at any location in the horizontal plane. The gunner shall be able to lock and unlock this ring mount locking mechanism with one hand while holding the MG; and



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C 5.2.8	<b>Ring Seat.</b> The weapon station shall have a method for the gunner to safely and securely position him/herself to carry out all operations other than firing the weapon necessary to operate the weapon system. The gunner shall be able to acquire targets and fire the MG from a standing position. The ring seat shall not restrict the rotation of the ring while acquiring a target or interfere with the preparation to fire or firing. The device should have minimal restriction on the mounting of the weapon system on the ring, loading or reloading of the weapon or removing the weapon from the ring. The device shall be adjustable to accommodate various sized individuals. This device should take the form of a suspended webbing assembly securely attached to the rotating portion of the ring, allowing the gunner to easily alternate between a seated and standing position as required;
C 5.2.9.3	The hatch shall be well secured when opened and shall not interfere with any of the operations of the weapon system. The ring mount mechanism shall be sealed from the elements, whether the hatch is open or closed, such that its performance is not affected.
C 5.2.10	there shall be no sharp edges, protrusions, mechanisms or other parts of the ring mount which would hinder operations or restrict movements by the gunner.
C 5.2.11	<b>Wire' Protection.</b> The C&R and MP variants shall be configured to protect the gunner from strung wires while the vehicle is on the move with a gunner positioned in the ring, operating a weapon. The wire protection shall have minimal impact on the operability of the weapon while ring mounted.
C 5.3	<b>Kit and Equipment Stowage.</b> Stowage space shall be provided to carry and securely store the following:
C 5.6.2	The connector shall have a waterproof cover secured with a chain. The connector should be located on the exterior curbside of the vehicle, accessible from ground level; and
C 6.1.6.7	<b>Front Seat Passenger:</b> The front seat passenger shall be able to easily enter and exit the vehicle, fit comfortably in the front passenger's seated position, easily operate seat belts, effectively communicate with the driver, read a map or route card, use communication(s) devices ie. handset, cellular phone, etc.. and access personal weapon while the vehicle is operational for periods up to four (4) hours and / or over distances of up to 200 kilometers in a safe and comfortable manner; and
C 6.3	<b>Kit and Equipment Stowage.</b> Stowage space shall be provided to carry and securely store the following:

**ANNEX D:  
LUVW Focus Group Notes**



*Note: These notes detail some of the comments and points raised by soldiers during focus group discussions. Comments are provided in point-form below and interpreted for the report and the development of the LUVW Human Factors Performance Requirements.*

### **1000 General, Boarding, Movement**

- Iltis rated “reasonably acceptable”
- step hold desirable
- toehold on HLVW, 2 pieces of cable, susceptible to rotting
- panic bars inside desirable
- ability to get on hood desirable with non-skid surfaces
- access from front desirable
- performance tests require access with mukluks, cbt gloves, and cwubs
- durable, white paint desirable
- hand holds desirable
- self recovery on all vehicles desirable
- access with personal body armour

### **2000 Entering and Exiting Drivers Station**

- park brake away from foot pedals
- handle to adjust pitch on steering wheel desirable
- HL – sprung loaded door, stays open
- Must provide easy emergency egress
- Performance test ease of access w/o webbing, IECS w/ frag vest, w/ TAV
- knees are a problem in the field, egress
- door dimensions on Iltis

### **2100 Entering and Exiting Front Passenger Station**

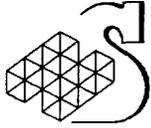
- less than 2 seconds desirable
- test w/ IECS & vests
- universal keys (like 5/4 ton) desirable
- no airbags
- fire exit from front seat desirable

### **2200 Entering and Exiting Rear Passenger/Gunner Station**

- provide latch for door opening
- rated “reasonably unacceptable” on ILTIS

### **3000 Driver’s/Passenger’s/Gunner’s Seat**

- seat like HL desirable (rated “completely acceptable”)
- high seat back desirable for neck support
- no vinyl seats
- performance tests should include full days driving to assess comfort
- seat belt should be easy to adjust (like Iltis)
- seat material, not cloth or vinyl, hot/cold durability and rugged all purpose,
- 3 pt harness, inertial lock, adjustable shoulder height
- seat should be adjustable to accommodate drivers tasks



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- seat adjustable forward/back desirable

**4000 Driver's Compartment Workspace**

- rated "reasonably acceptable" for Iltis
- arm rest desirable
- sliding window desirable
- 95%ile accomodation
- performance test - distance between pedals test w/ gumbies (good on HL)
- head clearance should consider helmet
- must accommodate mukluks on pedals (ILTIS pedals too small)

**5000 Displays**

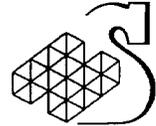
- fuel & speed most important
- more wing lights desirable
- follow cultural stereotype
- ILTIS or LS switches were acceptable
- visibility of PLGR, up top on ceiling, or on dash
- performance tests should include day and night conditions
- desirable to change batteries in 5 min (battery rack is good in LSVW)
- check levels quickly & easily
- consider fuel economy
- accommodate a 48 hour recce
- current map light unreliable
- coffee cup holder X2 desirable, provide both red and white light
- gun mount desirable
- cargo area, bigger, see Grizzly
- cover windshield, canvas snaps
- always have cell phones, hand held radar, provide space for cell phones
- provide plug ins – 3 in middle
- remove ashtrays
- recovery to rear desirable
- provide tow points for recovery out on axle and up high
- provide durable bumpers
- desire dim adjust, better for NVG use
- may forget to turn off vehicle in hurry, audible warnings?
- easy to see odometer
- provide trip meter
- warnings should turn off in blackout

**5012 Speedometer**

- test in day/night

**5013 Odometer**

- odometer should be visible to co-driver



**5014 Trip Odometer**

- both consoles

**5017 Fuel Gauge**

- fuel bar on control panel, visible to dvr/co dvr

**5021 PLGR Display**

- visible to pass/dvr
- swivel first

**5023 4-Wheel Drive Display**

- in/out for on/off
- manual shift/direct
- no locking
- 4 x 4 prefer button on the fly

**5025 Signal Light Display**

- indicate direction by sight

**5027 Overall Display Acceptability**

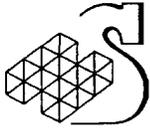
- follow industry standards
- blackout – dim it down
- check colour of light – easier for blackout
- blackout shutter
- velcro – dots
- dimmer control
- not to blackout
- dimness, difficult to read
- LTIS rated as “reasonably acceptable”

**6000 Interior Lighting (Night-time)**

- AFV dome light, centre light, map lights
- visibility, provide min lux required w/ night adaptation
- provide lighting, esp map read, report writing
- LTIS rated as “reasonably unacceptable”

**7000 Controls**

- industry standard
- master switch & 3 siren slide
- spot light
- PA system & volume control
- Compatibility with radio control tasks desirable (erase codes, change frequency, etc
- tire underneath – not good, sides/rear, readily accessible
- tail gate desirable
- access kit on the move
- quickly load vehicle



**Annex D:  
LUVW Focus Group Notes**

- quickly access stores, slide items vertically, not stacked, 30 min
- full time 4 wheel drive – 2H, 4H, 4L, diff lock desirable
- standardize bolts – fine/coarse, std bolts, 6 M metric, std bolts
- standardize hinges – same metal, not brass/steel
- wiring – should be colour coded as #s get worn off.
- change oil – 30 minutes max, include new filter, drain plug, protected
- transmission – check, fill, drain plug
- starter/alt easy to access
- air cleaner – indicator to check
- provide closed bin for tool kit, spare barrels
- C6 & cover – provide stowage, secure with bungee cord tie downs
- cam net – folded on hood or on back, including cam net spreaders
- poles – provide racks on outside, mount point on top
- arctic tent bag storage accommodation

**7008 Accelerator**

- test feedback while wearing gumby boots

**7009 Brake**

- pedal size – bigger than Iltis w/ anti-skid

**7011 All Wheel Drive**

- provide manual shift
- less electronics are better

**7012 Steering Wheel**

- adjust steering wheel angle/tilt
- consider diameter of grip, thickness

**7013 Emergency Park Brake**

- foot pedal design
- follow cultural stereotype (i.e. LSVW backwards)
- should not obstruct use of controls

**7015 Windshield Wipers**

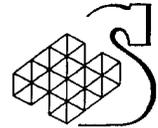
- match commercial setup - on steering column

**7016 Heater/Ventilation**

- blower/control
- hot/cold
- defrost
- better distribution than Iltis desired

**7017 Starter**

- switch, no key, locate on dash/column



- if key, make universal

**7018 Cold Start**

- on the dash
- glow plug – accessory switch
- heater required

**7019 Electric Door Locks**

- standard/not electric
- VOR- because of water
- need for central key
- not desired

**7020 Electric Mirrors Control**

- big waste of money
- take a beating
- won't keep up with repairs
- not desired
- breakable
- heated mirrors, maybe OK

**7021 Hand Throttle**

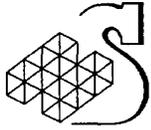
- need 1000 RPN
- recessed
- kick – shouldn't vibrate off
- like current design on Iltis

**7022 Horn**

- located on wheel
- avoid inadvertent activation

**7023 Master Disconnect Switch**

- control on wheel
- easily accessible
- not a key
- pull & turn
- not too flimsy
- use HL forces
- not on ILTIS, not required



**Annex D:  
LUVW Focus Group Notes**

**7032/33 Driver Station, Force Measurement of Accelerator and Foot Brake**

- test on convoys, highways, parking

**7035/36 Driver Station, Protective Covers/Guards**

- test – parking
- adequately positioned to permit observation of displays, nomenclature, indicators, etc.,

**8000 NBC Protective System**

- not trained for NBC ops

**9000 Visibility**

- read a drivers plate
- operational effectiveness

**9006 Sunvisor**

- pivot
- ILTIS – better adj, down, extend sides, currently do not go to sides

**9007 Mirrors (normal)**

- Itis rated “completely unacceptable”
- Test backing in, parking, light, unlighted
- spring mounted

**9008 Electric Mirrors**

- no required
- electrical hazard

**9009 Headlights (Night-time)**

- take down lights if desired

**9010 Driver Station, Closed Door Viewing, Viewing Distance to closest point in front of vehicle**

- headlights – high/low – to attract attention

**9014/15/16 Driver Station – Defrosting, Cold Weather Operations**

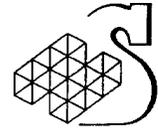
- commercially available standards

**9017 Driver Station, Adequacy of Wipers**

- Itis “completely acceptable”
- 4 L reservoir
- good spray

**9018 Driver Station, Night Vision Device Provided**

- rarely used



**9023 Driver's Exterior Lights, replace bulbs, etc., ease of replacement**

- ensure easy – cage over light

**10000 Communications**

- between driver & commander in the front
- Performance tests = change frequency, change mikes/headphones
- mount in firewall
- 2 racks in front
- requires place to secure mike, place to hang mike
- locate CI up front for ease of access
- easy change of frequency
- LUVW should provide acceptable access to comms from front (driver & passenger) stations
- no cord interference

**11000 Heating, Cooling**

- MPs like AC, AC desirable
- equal distribution of heat – better
- better air flow, blower on LS good, not good air flow
- test thermal comfort
- provide full range windows
- defrost windows

**12000 Vibration**

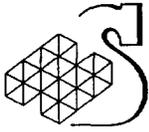
- as normal
- drive test
- test physical comfort
- should be acceptable after an extended haul
- driver fatigue not as important for short haul

**13000 Crew Integration, Safety, Health Hazards**

- not necessary
- DD/vehicle driver use
- off road
- living, repack, reload, comfort
- fire suppression – inside front or back, doesn't matter, not on floor between seats, firewall, under seats, easy to get at
- elevation/depression of main weapon – provide, access item

**14000 Stowage**

- maps, drinks, keep handy, gloves, crash kit, accident report forms
- convoy flag, glow sticks, flashlight, pers wpn stowage, trays
- accessible & secure
- coleman stoves/rats – not on outside
- 4' x 2' x 2' – put everything



**Annex D:  
LUVW Focus Group Notes**

- rucksacks strapped
- webbing straps, hooks, interior
- bungies are our friend, most efficient
- bungee net, recessed, holes
- fire extinguishers
- mounting points – on external, rucksacks on outside, mud flaps break, provide fully enclosed working space
- external stowage cage, no hard cage
- spectrum of conflict – wpn rack & allowance for BFA, test w/ mag in/out
- acceptability of external tie down points – trailer
- secure rucksacks on appropriate side, up against wall
- store fuel outside
- capable to load/store items (gear box) on front of vehicle
- desire door pockets, maps, reports
- snaps over light reflective surface for blackout

**15000 Ventilation**

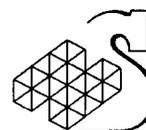
- thermal comfort
- stagnant, stall air, little fan
- prevent exhaust fumes into vehicle

**16000 Noise**

- highway speeds 50/60 mph
- test acceptability of noise
- brakes & engine-tire should not cause safety problem, protect gas tank
- brakes must not squeak

**17000 Maintenance**

- fresh air vent
- drivers should be able to lube, oil change, greasing, air filter, batteries, check levels
- ease of cleaning interior, not really important
- consider ease of parts procurement
- easy – brakes, hydraulics, access to inspection, ease of cylinders, ease of adjustment, ease of replacement
- time – 15/20 minutes
- tools – no special tools, no heavy lifting
- bigger nozzle (2” fuel nozzle from a pod)
- never trust gauge for gas
- maintenance of batteries difficult in ILTIS
- problem with accessibility to hydraulics in LUVW, leaking wheel cylinder causes brake lines to twist off, improve ease of removing wheel cylinder
- colour code wiring on electrical systems, numbers wear off
- poor access in LUVW – workspace for performing checks
- special tools stored on board – yes
- special tools required – none
- average time to diagnose faults – LUVW long, due to white wiring



- ILTIS – keep tool stowage
- ILTIS located filter after pump, should be before

#### **18000 Handling Characteristics**

- very important, w/ add on armour
- test on switch backs, 30 kmh curve, 3 point turn on a single track
- test handling w/ trailer
- check blind spot
- should have excellent off-road handling
- test responsiveness – stop on a hill & then power up, accel to speed, leap frog ahead,
- overall evaluation – 1 week/vehicle, 3 weeks
- pneumatic air tires
- ability to make quick stops – loaded & unloaded
- trailer adds problems
- overall evaluation of vehicle controllability – 80% acceptance

#### **20000 Towing Compatibility**

- cell phone charger
- use MP vehicle
- electrical receptacle – rubber sometimes difficult to manage in cold, try 3 prong

#### **21000 Recovery Compatibility**

- lifting
- eye hooks up high
- 4 front, 2 driving, 2 tow
- A frame
- done with trailer
- tow cable, capability
- electrical not hydraulic, hydraulic wear out from non-use

#### **23000 Compatibility with APS**

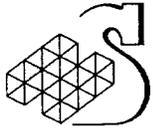
- bullet proof
- ballistic blanket
- blanking plugs
- hard to get com net up

#### **24000 Compatibility with IRIS Radio**

- compact & range of movement
- have a drop down tail gate

#### **27000 Camouflage Net**

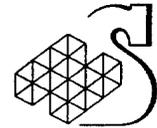
- 2 cam nets – w/ each vehicle
- covers for windows



**Annex D:  
LUVW Focus Group Notes**

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**ANNEX E:**  
**LUVW Human Factors**  
**Performance Requirements**



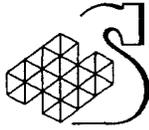
## LUVW Usability Requirements

### A. Introduction

Human Factors (HF) performance requirements and test protocols, for evaluating the human factors acceptability of LUVW proposals with respect the following criteria:

1. Overall User Acceptance
2. User / Maintenance Manual Acceptance
3. Ease of External Boarding and Movement
4. Ease of Cab Ingress and Egress - Driver's Station
5. Ease of Cab Ingress and Egress - Passengers' Stations
6. Ease of Cab Ingress and Egress - Gunner's Station
7. Cab Workstation - Driver and Passenger Seat Design
8. Cab Workstation - Weapon Station Hatch Seat Design
9. Cab Workstation - Driver's Station Design
10. Cab Workstation - Passenger Compartment Design
11. Cab Workstation - Gunner's Compartment Design
12. Display, Instrument and Gauge Design
13. Control Design and Operation
14. External Visibility - Driver
15. External Visibility - Gunner
16. Internal Visibility
17. Cab Environment - Heating and Cooling
18. Cab Environment - Ventilation
19. Cab Environment - Noise
20. Cab Environment - Vibration
21. Cab Environment - General Safety
22. Vehicle Stowage
23. Vehicle Handling Characteristics
24. Vehicle Ride Quality
25. Vehicle Maintainability
26. Task Compatibility

Ease of use requirements are stated in both absolute and relative terms. A typical absolute requirement might state that the LUVW proposal must be rated by at least 75% of user as acceptable (i.e.  $\geq 4$ ) using the scale below.



**Annex E:  
LUVW Human Factors Performance Requirements**

Physical Comfort Requirements are stated in the absence of discomfort terms. A typical physical discomfort requirement might state that the discomfort associated with a LUVW proposal must be rated by 75% of user as less than notable (i.e.  $\leq 3$ ) using the scale below.

**Definitions:**

**User:** For the sake of these LUVW proposal evaluations, a “user”, as referenced in these HF requirements, is considered to have the following characteristics;

- a representative of the Canadian Forces (CF), responsible for either operating or maintaining the LUVW,
- no physical or mental impairment,
- wearing appropriate environmental and operational equipment

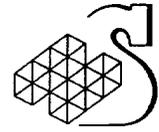
Test participants should consist of representative users with a range of anthropometry (i.e. 5<sup>th</sup> percentile female and 95<sup>th</sup> percentile male for height and girth).

**Operator:** For the sake of these LUVW proposal evaluations, an operator is defined as either the LUVW driver, passenger / crew commander or in some variants, gunner. While operators will perform user maintenance on the vehicles their primary role is to operate the LUVW or to be transported by the LUVW.

**Maintainer:** For the sake of these LUVW proposal evaluations, a maintainer is primarily responsible for the automotive service and maintenance of the LUVW vehicle systems. While maintainers can also be viewed as operators they are specially trained to service and maintain vehicles.

**LUVW :** For the sake of these LUVW proposal evaluations, a LUVW is defined as a light utility vehicle wheeled. These encompass light, highly mobile vehicles required to facilitate the tactical command of combat, combat support and combat service support units of field formations to assist in the gathering and passage of information and to effect liaison within and between field formations.

Test procedures should consist of armoured and unarmoured conditions (APS and non-APS)



**Annex E:  
LUVW Human Factors Performance Requirements**

**Trial Principles:** The following principles will be applied to the human factors acceptance test of the LUVW contender vehicles.

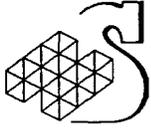
- Training of subjects to common baseline standard
- Rigorously Standardized Tests
- Standardized Measures
- Representative Tasks
- Progressive Testing
- Controlled Test Environment
- Repeated Measures Design
- Balanced Order of LUVW presentation
- Thorough documentation of any unacceptable rating (observer notes, user comments, diaries, video recordings, photographs, etc.)

**Operator Instructor Training:** Three vehicle instructors (wheeled ) will be trained and assessed on the LUVW contender systems by the contender systems' technical experts. These same vehicle instructors (operations) will in turn train the trial participants on the new vehicles. Conversion training should not exceed two days (per vehicle).

**Abbreviated Operator Conversion Training:** Due to time constraints on the trial, some subjects and spares must be trained on the handling and safety requirements of the LUVW contender systems. Conversion training should not exceed 1.5 days (per vehicle). Total conversion training on three contenders (4.5 days).

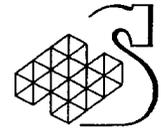
**Maintenance Instructor Training:** Three vehicle maintenance instructors will be trained and assessed on aspects of the LUVW maintenance systems by the contender systems' technical experts. These same vehicle instructors (maintenance) will in turn train the trial participants on the new vehicles. Conversion training should not exceed two days (per vehicle).

**Abbreviated Maintenance Conversion Training:** Due to time constraints on the trial, the maintenance subjects and spares will be trained on maintenance inspection, and repair of the LUVW contender systems. The focus of the conversion training will be around the identified maintainability aspects of the LUVW systems. Conversion training should not exceed 1.5 days (per vehicle). Total conversion training on three contenders (4.5 days).



**Annex E:  
LUVW Human Factors Performance Requirements**

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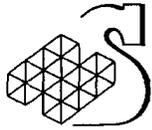
# 1. Overall Human Factors User Acceptance

## 1.1. Definition

The extent to which users find the LUVW bid vehicles acceptable for CF use from a human factors perspective.

## 1.2. Requirements

1. The LUVW bid vehicle shall be judged acceptable for operational use by at least 75% of the users in each of the following categories:
  - a. Overall evaluation of the vehicles cab compartment. The evaluation of the LUVW cab includes the following areas:
    - Ease of External Boarding and Movement
    - Ease of Cab Ingress and Egress - Driver's Station
    - Ease of Cab Ingress and Egress – Passengers' Stations
    - Ease of Cab Ingress and Egress - Gunner's Station
    - Cab Workstation - Driver and Passenger Seat Design
    - Cab Workstation - Weapon Station Hatch Seat Design
    - Cab Workstation - Driver's Station Design
    - Cab Workstation - Passenger Compartment Design
    - Cab Workstation - Gunner's Compartment Design
    - Cab Environment – Heating and Cooling
    - Cab Environment – Ventilation
    - Cab Environment – Noise
    - Cab Environment – Vibration
    - Cab Environment – General Safety
    - Vehicle Stowage
  - b. Overall evaluation of the vehicle's external visibility. The evaluation of the LUVW's external visibility includes the following areas
    - External Visibility – Driver
    - External Visibility - Gunner
  - c. Overall evaluation of the vehicle controls and control operations



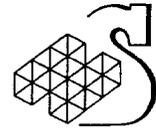
**Annex E:  
LUVW Human Factors Performance Requirements**

- d. Overall evaluation of the vehicle's instrumentation. The evaluation of the LUVW's instrumentation includes the following areas
  - Display, Instrument and Gauge Design
  - Internal Visibility
- e. Overall evaluation of the vehicle's handling characteristics
- f. Overall evaluation of the vehicle's ride characteristics
- g. Overall evaluation of the vehicle's maintainability
- h. Overall evaluation of the compatibility between the vehicle and operational tasks. The evaluation of the LUVW's compatibility with operational/support tasks includes the following areas:
  - User and maintenance manual acceptability
  - Task compatibility
  - Clothing and equipment compatibility

### **1.3. Tests**

Upon completion of the HF trial, users will be required to rate their acceptance of the LUVW bid vehicle for the following criteria:

- Overall evaluation of the vehicles cab compartment.
- Overall evaluation of the vehicle's external visibility.
- Overall evaluation of the vehicle controls and control operations
- Overall evaluation of the vehicle's instrumentation.
- Overall evaluation of the vehicle's handling characteristics
- Overall evaluation of the vehicle's ride characteristics
- Overall evaluation of the vehicle's maintainability
- Overall evaluation of the compatibility between the vehicle and operational tasks.



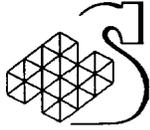
## **2. User / Maintenance Manual Acceptance**

### **2.1. Definition**

The extent to which users find the LUVW User and Maintenance Manuals acceptable for CF use.

### **2.2. Requirements**

1. Overall, the LUVW user manual's description (written and visual) describing vehicle components, vehicle operation and user maintenance should be judged acceptable by at least 75% of the users for usability and utility.
2. Overall, the LUVW maintenance manual's description (written and visual) should be judged acceptable by at least 75% of the maintainers for usability and utility.
3. Overall, the labels affixed to the LUVW (written and visual) for warnings or other purposes should be judged acceptable at least 75% of the users for usability and utility.



**Annex E:  
LUVW Human Factors Performance Requirements**

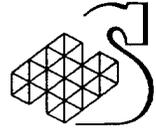
## **3. Ease of External Boarding and Movement**

### **3.1. Definition**

The relative ease with which users can gain access to and work on the upper side of the LUVW.

### **3.2. Requirements**

1. Adequate footholds should be provided for users to reach the roof of the LUVW. “No step” markings should be provided if applicable. Most users (at least 75%) should rate the footholds for gaining access to the roof as acceptable.
2. Adequate handholds should be provided for users to reach the roof of the LUVW. Most users (at least 75%) should rate the handholds for gaining access to the roof as acceptable.
3. Upper surfaces of the LUVW should be covered with non-slip paint or the surfaces should be designed to be non-slip. Most users (at least 75%) should rate the non-slip surfaces to be acceptable.



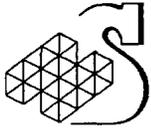
## 4. Ease of Cab Ingress and Egress - Driver's Station

### 4.1. Definition

The relative ease with which users (i.e. drivers) can enter and exit the LUVW driver's station.

### 4.2. Requirements

1. Users should be able to easily access the driver's station from the outside. Most users (at least 75%) should rate the ease of ingress as acceptable.
2. Users should be able to exit easily from the driver's station. Most users (at least 75%) should rate the ease of egress as acceptable.
3. Users should be able to open or close the driver's door easily under any condition of allowable vehicle tilt. Most users (at least 75%) should rate the ease of opening and closing the driver's door as acceptable.
4. The LUVW should not have any projections or obstructions that could cause snagging or injury to the driver during vehicle ingress or egress. Where necessary the LUVW should have sufficient padding to prevent contact injuries. Most users (at least 75%) should rate the comfort associated with vehicle ingress and egress as acceptable.



**Annex E:  
LUVW Human Factors Performance Requirements**

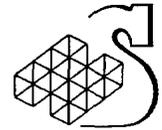
## **5. Ease of Cab Ingress and Egress – Passengers' Stations**

### **5.1. Definition**

The relative ease with which users can enter and exit the LUVW passenger stations.

### **5.2. Requirements**

1. Users should be able to easily access the front passenger's station from the outside. Most users (at least 75%) should rate the ease of access as acceptable.
2. Users should be able to exit easily from the front passenger's station. Most users (at least 75%) should rate the ease of egress as acceptable.
3. Users should be able to easily access the rear passenger's station from the outside. Most users (at least 75%) should rate the ease of access as acceptable.
4. Users should be able to exit easily from the rear passenger's station. Most users (at least 75%) should rate the ease of egress as acceptable.
5. Users should be able to open or close the passenger's doors easily under any condition of vehicle tilt. Most users (at least 75%) should rate the ease of opening and closing the passenger doors as acceptable.
6. The LUVW should not have any projections or obstructions that could cause snagging or injury to the passengers during vehicle ingress or egress. Where necessary the LUVW should have sufficient padding to prevent contact injuries. Most users (at least 75%) should rate the comfort associated with vehicle ingress and egress as acceptable.



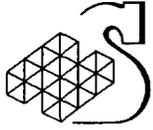
## 6. Ease of Cab Ingress and Egress - Gunner's Station

### 6.1. Definition

The relative ease with which users can enter and exit the LUVW weapon station from inside or outside.

### 6.2. Requirements

1. Users should be able to easily access the weapon station from the inside. Most users (at least 75%) should rate the ease of access as acceptable.
2. Users should be able to enter the interior cab easily from the weapon station. Most users (at least 75%) should rate the ease of egress from the weapon station as acceptable.
3. Users should be able to easily access the weapon station from the outside. Most users (at least 75%) should rate the ease of access as acceptable.
4. Users should be able to exit easily from weapon station to the outside. Most users (at least 75%) should rate the ease of egress as acceptable.
5. Users should be able to open or close the weapon station hatch easily under any condition of vehicle tilt. Most users (at least 75%) should rate the ease of opening and closing the hatch as acceptable.
6. The LUVW should not have any projections or obstructions that could cause snagging or injury to the passengers during weapon station ingress or egress. Where necessary the LUVW should have sufficient padding to prevent contact injuries. Most users (at least 75%) should rate the comfort associated with weapon station ingress and egress as acceptable.



**Annex E:  
LUVW Human Factors Performance Requirements**

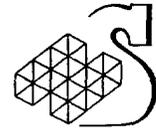
## **7. Cab Workstation - Driver and Passenger Seat Design**

### **7.1. Definition**

The LUVW driver's seat must have adequate seat adjustability to permit users to safely operate the vehicle. The LUVW driver's seat design geometry and seat-covering materials should promote user comfort.

### **7.2. Requirements**

1. The LUVW driver and passengers seat dimensions, clearances, and adjustments should be designed in accordance with paragraph 5.12.2 of MIL-STD-1472D.
2. The LUVW driver's seat should have adequate seat back recline, vertical seat height adjustment, and forward-rearward seat adjustment to permit users to safely reach and operate the vehicle. Most users (at least 75%) should rate the range of seat adjustment as acceptable. Users should consider the range and effort required.
3. The LUVW driver's seat design geometry should promote user comfort. The driver's seat should have adequate seat back and seat pan dimensions. Most users (at least 75%) should rate the geometry of the driver's seat as acceptable. Users should consider the angle and posture.
4. The LUVW driver's seat materials and padding should promote user comfort. The driver's seat should have adequate padding and seat-covering materials for acceptable user comfort during extended operations. Most users (at least 75%) should rate the comfort of the driver's seat as acceptable. Users should consider comfort, lower back support, and side-to-side support.



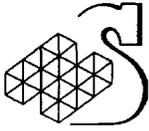
## 8. Cab Workstation - Weapon Station Hatch Seat Design

### 8.1. Definition

The LUVW weapon station should have a method for the gunner to safely and securely position himself/herself to carry out all operations other than firing the weapon necessary to operate the weapon system.

### 8.2. Requirements

1. Users should be able to easily access the gunner's station from the inside. Most users (at least 75%) should rate the ease of ingress as acceptable.
2. Users should be able to easily and safely secure themselves in the gunner's station. Most users (at least 75%) should rate the ease of securements as acceptable.
3. Users should be able to easily transition between a seated and a standing position in the gunner's station. Most users (at least 75%) should rate the ease of transition as acceptable.
4. The LUVW gunner's ring hatch seat should have adequate vertical adjustment, and forward-rearward adjustment to permit users to safely reach and operate the equipment. Most users (at least 75%) should rate the range of seat adjustment as acceptable. Users should consider the range and effort required.
5. The LUVW gunner's ring hatch seat should provide adequate user support when positioned in the weapon station. Most users (at least 75%) should rate the adequacy of support as acceptable.
6. The LUVW gunner's ring hatch seat design geometry should promote user comfort. This includes consideration of the angle and posture. Most users (at least 75%) should rate the geometry of the gunner's seat as acceptable.
7. The LUVW gunner's seat materials and padding should promote user comfort. The gunner's seat should have adequate padding and seat covering materials for acceptable user comfort during extended operations. Most users (at least 75%) should rate the comfort of the gunner's seat as acceptable. Users should consider comfort, lower back support, and side-to-side support.



**Annex E:  
LUVW Human Factors Performance Requirements**

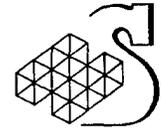
## **9. Cab Workstation - Driver's Station Design**

### **9.1. Definition**

The LUVW driver's workstation must have adequate room to permit users to safely and comfortably operate the vehicle. The LUVW driver's workstation design geometry and materials should promote user comfort.

### **9.2. Requirements**

1. The clearance around the LUVW driver's seat should be designed in accordance with Table XXVII of MIL-STD-1472D.
2. The LUVW driver workstations should have adequate headroom. Most users (at least 75%) should rate the amount of head clearance as acceptable.
3. The LUVW driver workstations should have adequate leg room (includes consideration of feet and knee). Design should provide adequate foot pedal clearance for largest size of mukluk. Most users (at least 75%) should rate the amount of leg clearance as acceptable.
4. The LUVW driver workstations should have adequate hip room. Most users (at least 75%) should rate the amount of hip clearance as acceptable.
5. The LUVW driver workstations should have adequate arm room (includes consideration of shoulder and elbow). Most users (at least 75%) should rate the amount of arm clearance as acceptable.



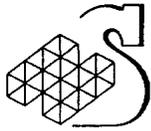
## 10. Cab Workstation - Passenger Compartment Design

### 10.1. Definition

The LUVW passenger workstations must have adequate room to permit users to be transported in the vehicle. The LUVW passenger workstations design geometry and materials should promote user comfort.

### 10.2. Requirements

1. The clearance around the LUVW passenger seats should be designed in accordance with Table XXVII of MIL-STD-1472D.
2. The LUVW passenger workstations should have adequate head room while wearing a soldier's helmet. Most users (at least 75%) should rate the amount of head clearance as acceptable.
3. The LUVW passenger workstations should have adequate leg room (includes consideration of feet and knee). Most users (at least 75%) should rate the amount of leg clearance as acceptable.
4. The LUVW passenger workstations should have adequate hip room. Most users (at least 75%) should rate the amount of hip clearance as acceptable.
5. The LUVW passenger workstations should have adequate arm room (includes consideration of shoulder and elbow). Most users (at least 75%) should rate the amount of arm clearance as acceptable.



**Annex E:  
LUVW Human Factors Performance Requirements**

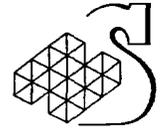
## **11. Cab Workstation - Gunner's Compartment Design**

### **11.1. Definition**

The LUVW weapon station must have adequate room to permit users to carry out all operations necessary to operate the weapon system. This includes both stationary and moving vehicle conditions.

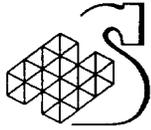
### **11.2. Requirements**

1. The LUVW gunner's station should have adequate headroom while wearing a soldier's helmet. Most users (at least 75%) should rate the amount of head clearance as acceptable.
2. The LUVW gunner's station should have adequate leg room (includes consideration of feet and knee). Most users (at least 75%) should rate the amount of leg clearance as acceptable.
3. The LUVW gunner's station should have adequate hip room. Most users (at least 75%) should rate the amount of hip clearance as acceptable.
4. The LUVW gunner's station should have adequate arm room (includes consideration of shoulder and elbow). Most users (at least 75%) should rate the amount of arm clearance as acceptable.
5. The LUVW gunner's station should not interfere with the rotation of the weapon ring. Most users (at least 75%) should rate the amount of interference with the weapon ring as acceptable.
6. The LUVW gunner's seat should not interfere with users firing the weapon from a standing position, and performing weapon mounting, dismounting, or handling drills (less firing). Most users (at least 75%) should rate the amount of seat interference as acceptable.
7. The LUVW weapon station should permit users the freedom to track and engage aerial and ground targets. Most users (at least 75%) should rate aerial and ground target tracking and engagement as acceptable.
8. The gunner should be able to traverse a horizontal arc of 3200 mils in less than three (3) seconds with either a C6 or a C9.
9. The LUVW weapon's station should not degrade the inherent accuracy of the C6 or C9 as compared to that achieved when the weapons are fired from a ground mount. Most users (at least 75%) should rate the amount of degradation as acceptable.



**Annex E:  
LUVW Human Factors Performance Requirements**

10. The LUVW's pintle connection should provide for easy installation and removal of the buffered mount from the mounting bracket. Most users (at least 75%) should rate the ease of installation and removal as acceptable.
11. The LUVW's weapon ring lock mechanism should permit one handed locking.. Most users (at least 75%) should rate the ease of locking the ring traverse as acceptable



**Annex E:  
LUVW Human Factors Performance Requirements**

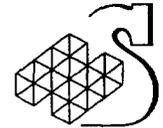
## **12. Display, Instrument and Gauge Design**

### **12.1. Definition**

The LUVW driver's station must provide unobstructed views to displays, instruments and gauges for all users. The design, location and readability of displays, instruments and gauges must be adequate for driving tasks during the day, night and in black-out conditions. Considerations should include scale markings, labeling and size.

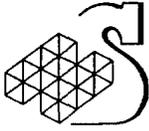
### **12.2. Requirements**

1. The LUVW's displays, instruments and gauges should be designed in accordance with paragraph 5.2 of Mil-STD-1472D.
2. The LUVW's speedometer's design, location and readability during vehicle operation must be acceptable. Most users (at least 75%) should rate the design, location and readability as acceptable.
3. The LUVW trip odometer's design, location and readability during vehicle operation must be acceptable. Most users (at least 75%) should rate the design, location and readability as acceptable.
4. The LUVW odometer's design, location and readability during vehicle operation must be acceptable. Most users (at least 75%) should rate the design, location and readability as acceptable.
5. The LUVW oil pressure gauge's design, location and readability during vehicle operation must be acceptable. Most users (at least 75%) should rate the design, location and readability as acceptable.
6. The LUVW water temperature gauge's design, location and readability during vehicle operation must be acceptable. Most users (at least 75%) should rate the design, location and readability as acceptable.
7. The LUVW fuel gauge's design, location and readability during vehicle operation must be acceptable. Most users (at least 75%) should rate the design, location and readability as acceptable.
8. The LUVW battery charging/discharging display's design, location and readability during vehicle operation must be acceptable. Most users (at least 75%) should rate the design, location and readability as acceptable.
9. The LUVW transmission temperature gauge's design, location and readability during vehicle operation must be acceptable. Most users (at least 75%) should rate the design, location and readability as acceptable.
10. The LUVW coolant heater display's design, location and readability during vehicle operation must be acceptable. Most users (at least 75%) should rate the design, location and readability as acceptable.



**Annex E:  
LUVW Human Factors Performance Requirements**

11. The LUVW PLGR's location and readability during vehicle operation must be acceptable. Most users (at least 75%) should rate the location and readability as acceptable.
12. The LUVW park brake display's design, location and readability during vehicle operation must be acceptable. Most users (at least 75%) should rate the design, location and readability as acceptable.
13. The LUVW 4-wheel drive status display's design, location and readability during vehicle operation must be acceptable. Most users (at least 75%) should rate the design, location and readability as acceptable.
14. The LUVW differential lock status display's design, location and readability during vehicle operation must be acceptable. Most users (at least 75%) should rate the design, location and readability as acceptable.
15. The LUVW signal light display's design, location and readability during vehicle operation must be acceptable. Most users (at least 75%) should rate the design, location and readability as acceptable.
16. The LUVW 4-way flasher light display's design, location and readability during vehicle operation must be acceptable. Most users (at least 75%) should rate the design, location and readability as acceptable.
17. The LUVW head lamp indicator display's design, location and readability during vehicle operation must be acceptable. Most users (at least 75%) should rate the design, location and readability as acceptable.
18. The LUVW flame start/glow plug indicator display's design, location and readability during vehicle operation must be acceptable. Most users (at least 75%) should rate the design, location and readability as acceptable.
19. The LUVW low brake fluid level indicator display's design, location and readability during vehicle operation must be acceptable. Most users (at least 75%) should rate the design, location and readability as acceptable.



**Annex E:  
LUVW Human Factors Performance Requirements**

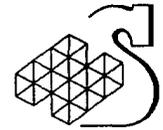
## **13. Control Design and Operation**

### **13.1. Definition**

The design and operation of the vehicle controls must permit the driver to safely and effectively operate the LUVW in the manner intended. The design, direction of control movement, location, spacing between controls, and effort required to operate the controls must be adequate. Considerations should include size shape and reach distance.

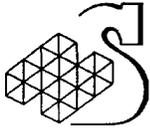
### **13.2. Requirements**

1. The LUVW's controls should be designed in accordance with paragraph 5.12.3 of MIL-STD-1472D.
2. The LUVW accelerator's design, spacing, location and effort required to operate must be acceptable. Most users (at least 75%) should rate the design, location and effort as acceptable.
3. The LUVW brake pedals design, spacing, location and effort required to operate must be acceptable. Most users (at least 75%) should rate the design, spacing, location and effort as acceptable.
4. The LUVW transmission lever's design, location and effort required to operate must be acceptable. Most users (at least 75%) should rate the design, spacing, location and effort as acceptable.
5. The LUVW all-wheel drive control's design, spacing, location and effort required to operate must be acceptable. Most users (at least 75%) should rate the design, spacing, location and effort as acceptable.
6. The LUVW steering wheel's design, location and effort required to operate (while stopped and at various speeds) must be acceptable. Most users (at least 75%) should rate the design, location and effort as acceptable.
7. The LUVW emergency / parking brake's design, location and effort required to operate must be acceptable. Most users (at least 75%) should rate the design, location and effort as acceptable.
8. The LUVW heater/ventilation control design, location and effort required to operate must be acceptable. Most users (at least 75%) should rate the design, location and effort as acceptable.
9. The LUVW starter/ignition switch's design, location and effort required to operate must be acceptable. Most users (at least 75%) should rate the design, location and effort as acceptable.
10. The LUVW cold start control design, location and effort required to operate must be acceptable. Most users (at least 75%) should rate the design, location and effort as acceptable.



**Annex E:  
LUVW Human Factors Performance Requirements**

11. The LUVW hand throttle control's design, location and effort required to operate must be acceptable. Most users (at least 75%) should rate the design, location and effort as acceptable.
12. The LUVW horn's design, location and effort required to operate must be acceptable. Most users (at least 75%) should rate the design, location and effort as acceptable.
13. The LUVW master disconnect switch's design, location and effort required to operate must be acceptable. Most users (at least 75%) should rate the design, location and effort as acceptable.
14. The LUVW window opening control design, location and effort required to operate must be acceptable. Most users (at least 75%) should rate the design, location and effort as acceptable.
15. The LUVW windshield wipers/washer design, location and effort required to operate must be acceptable. Most users (at least 75%) should rate the design, location and effort as acceptable.
16. The LUVW 4-way flasher control's design, location and effort required to operate must be acceptable. Most users (at least 75%) should rate the design, location and effort as acceptable.
17. The LUVW headlights / parking lights control design, location and effort required to operate must be acceptable. Most users (at least 75%) should rate the design, location and effort as acceptable.
18. The LUVW interior lights control design, location and effort required to operate must be acceptable. Most users (at least 75%) should rate the design, location and effort as acceptable.
19. The LUVW headlights dimmer control design, location and effort required to operate must be acceptable. Most users (at least 75%) should rate the design, location and effort as acceptable.
20. The LUVW turn signal control design, location and effort required to operate must be acceptable. Most users (at least 75%) should rate the design, location and effort as acceptable.
21. The LUVW SMP light control panel's location must be acceptable. Most users (at least 75%) should rate the location as acceptable.



**Annex E:  
LUVW Human Factors Performance Requirements**

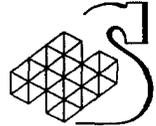
## **14. External Visibility – Driver**

### **14.1. Definition**

The LUVW should provide the driver with an unobstructed view both to the front and to the sides of the vehicle. Considerations should include field of view and freedom from glare.

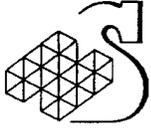
### **14.2. Requirements**

1. The LUVW should possess the vehicle visibility requirements detailed at paragraph 5.12.5 of MIL-STD-1472D.
2. The LUVW should provide adequate vision to the driver's front for all users. The driver should have an unobstructed forward field of view that is free of glare and distortion. Most users (at least 75%) should rate the forward visibility as acceptable.
3. The LUVW should provide adequate vision to the driver's front for all users. The driver should have adequate close-in vision. Most users (at least 75%) should rate the viewing distance to the closest point of the vehicle as acceptable.
4. The LUVW should provide adequate vision to the driver's rear for all users. The driver should have an adequate rear field of view that is free of glare and distortion. Most users (at least 75%) should rate the rear visibility as acceptable.
5. The LUVW should provide adequate vision to the driver's left and right for all users. The driver should have an unobstructed lateral field of view that is free of glare and distortion. Most users (at least 75%) should rate the lateral visibility as acceptable.
6. The LUVW should permit the proper and effective use of night vision equipment. Most users (at least 75%) should rate the compatibility between the LUVW and night vision systems as acceptable.
7. The LUVW should possess sun visors to reduce veiling glare. The sunvisors should be located and designed such that they can accomplish their intended mission. Sunvisors should be designed such that they can provide forward coverage and lateral coverage when required. Most users (at least 75%) should rate the adequacy of the sunvisor as acceptable.
8. The LUVW should possess mirrors to provide adequate vision to the driver's rear for all users. Most users (at least 75%) should rate the adequacy of the mirrors as acceptable. Users should consider the size, number, severity of vehicle blind spots, location, range of adjustment and freedom from vibration.
9. The LUVW should possess headlights to provide adequate vision to the driver's front for all users. Most users (at least 75%) should rate the headlight effectiveness (both high and low beam) as acceptable.



**Annex E:  
LUVW Human Factors Performance Requirements**

10. The LUVW should possess windshield wipers to provide adequate vision to the driver's front for all users. Most users (at least 75%) should rate the windshield wiper effectiveness as acceptable.
11. The LUVW should possess windshield defrost to provide adequate vision to the driver's front for all users. Most users (at least 75%) should rate the windshield defrost effectiveness as acceptable.



**Annex E:  
LUVW Human Factors Performance Requirements**

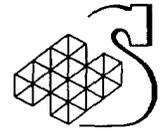
## **15. External Visibility - Gunner**

### **15.1. Definition**

The LUVW should provide the gunner with a 6400 mil azimuth field of view and weapon traverse. The LUVW should permit a minimum of 800 mils of elevation with the weapon system and a minimum of 35 mils of depression.

### **15.2. Requirements**

1. The LUVW should provide adequate gunner vision to the vehicle's front for all users. Most users (at least 75%) should rate the forward field of view as acceptable.
2. The LUVW should provide adequate gunner vision to the vehicle's rear for all users. Most users (at least 75%) should rate the rearward field of view as acceptable.
3. The LUVW should provide adequate gunner vision to the vehicle's sides for all users. Most users (at least 75%) should rate the sideward field of views as acceptable
4. The LUVW should provide the gunner with an adequate weapon arc of elevation/fire for the entire horizontal arc. Most users (at least 75%) should rate the weapon arc of elevation/fire as acceptable
5. The LUVW should provide the gunner with an adequate weapon arc of depression/fire for the entire horizontal arc. Most users (at least 75%) should rate the weapon arc of depression/fire as acceptable



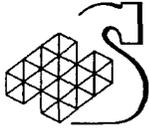
## **16. Internal Visibility**

### **16.1. Definition**

The LUVW should provide the users with sufficient interior lighting in nighttime conditions to conduct tasks in the cab workstation.

### **16.2. Requirements**

1. The LUVW should possess interior lighting for nighttime conditions. Most users (at least 75%) should rate the interior lighting effectiveness as acceptable. Considerations shall include the brightness and adjustability to operate controls, read maps, and viewing of instruments.



**Annex E:  
LUVW Human Factors Performance Requirements**

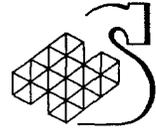
## **17. Cab Environment – Heating and Cooling**

### **17.1. Definition**

The LUVW should provide the vehicle crew with adequate heating and cooling.

### **17.2. Requirements**

1. Dry-bulb air temperature requirements are detailed in paragraph 5.8.1 of MIL-STD-1472D. The LUVW should provide adequate heating to the crew while operating in extreme cold environments (NATO C2). Most users (at least 75%) should rate the heating provided as acceptable. Most users (at least 75%) should rate the variable heat control system as acceptable. Most users (at least 75%) should rate the distribution of heat as acceptable.
2. Dry-bulb air temperature requirements are detailed in paragraph 5.8.1 of MIL-STD-1472D. The LUVW should provide adequate cooling to the crew while operating in extreme hot environments (NATO A2). Most users (at least 75%) should rate the cooling provided as acceptable. Most users (at least 75%) should rate the variable cooling/air conditioner control system as acceptable. Most users (at least 75%) should rate the distribution of cooling as acceptable.



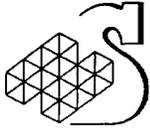
## 18. Cab Environment – Ventilation

### 18.1. Definition

The LUVW should provide the vehicle crew with adequate ventilation.

### 18.2. Requirements

1. Ventilation requirements are detailed in paragraph 5.81 of MIL-STD-1472D. The LUVW should provide adequate ventilation to the crew while operating in extreme environments. Most users (at least 75%) should rate the ventilation provided at the driver's station as acceptable. Most users (at least 75%) should rate the adequacy of the vent controls (airflow rate/direction) as acceptable at the driver's station.
2. Ventilation requirements are detailed in paragraph 5.81 of MIL-STD-1472D. The LUVW should provide adequate ventilation to the crew while operating in extreme environments. Most users (at least 75%) should rate the ventilation provided at the front passenger's station as acceptable. Most users (at least 75%) should rate the adequacy of the vent controls (airflow rate/direction) as acceptable at the front passenger's station.
3. Ventilation requirements are detailed in paragraph 5.81 of MIL-STD-1472D. The LUVW should provide adequate ventilation to the crew while operating in extreme environments. Most users (at least 75%) should rate the ventilation provided at the rear passenger's station as acceptable. Most users (at least 75%) should rate the adequacy of the vent controls (airflow rate/direction) as acceptable at the rear passenger's station.
4. Ventilation requirements are detailed in paragraph 5.81 of MIL-STD-1472D. The LUVW should provide adequate ventilation to the crew while operating in extreme environments. Most users (at least 75%) should rate the ventilation provided at the gunner's station as acceptable. Most users (at least 75%) should rate the adequacy of the vent controls (airflow rate/direction) as acceptable at the gunner's station.
5. The LUVW should prevent noxious substances from the engine, heater exhaust and weapon firing from accumulating in the vehicle cab. Sufficient ventilation must be provided to prevent the hazardous accumulation of carbon monoxide (CO). Sufficient ventilation must be provided to prevent the hazardous accumulation of nitrogen oxides (NO<sub>2</sub>, N<sub>2</sub>O<sub>4</sub>). Sufficient ventilation must be provided to prevent the hazardous accumulation of ammonia (NH<sub>3</sub>). Sufficient ventilation must be provided to prevent the hazardous accumulation of sulfur compounds (SO<sub>2</sub>).



**Annex E:  
LUVW Human Factors Performance Requirements**

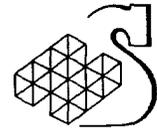
## **19. Cab Environment – Noise**

### **19.1. Definition**

The LUVW should provide an acoustic environment that will not cause personnel injury, interfere with voice or any other communications, cause fatigue, or in any way degrade overall system effectiveness.

### **19.2. Requirements**

1. The LUVW should not generate hazardous steady-state noise. The eight hour equivalent noise levels measured at the driver's ears shall not exceed 85 dB(A) in accordance with Category D of MIL-STD-1474. The eight hour equivalent noise levels measured at the driver's ears should not exceed 75 dB(A).
2. The LUVW should not generate hazardous steady-state noise. The eight hour equivalent noise levels measured at the front and rear passengers ears shall not exceed 85 dB(A) in accordance with Category D of MIL-STD-1474. The eight hour equivalent noise levels measured at the passenger's ears should not exceed 75 dB(A).
3. The LUVW should not generate hazardous steady-state noise. The eight hour equivalent noise levels measured at the gunner's ears shall not exceed 85 dB(A) in accordance with Category D of MIL-STD-1474. The eight hour equivalent noise levels measured at the gunner's ears should not exceed 75 dB(A).
4. The workspace noise generated in the LUVW should be reduced to levels that permit necessary direct (person to person) communication. The eight hour equivalent noise levels measured at the speaker and receiver's ears should not exceed 75 dB(A).
5. Firing the C6 or C9 weapon from the LUVW should not amplify impulse noise hazards amongst the crew. The eight hour equivalent noise levels (steady state and impulse) measured at the crew's ears should not exceed 85 dB(A).
6. The LUVW should not generate annoying sounds (loudness, frequency). Most users (at least 75%) should rate the noise generated by the LUVW as acceptable.
7. The LUVW's internal acoustic environment should be compatible with TCCCS radio communications.



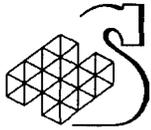
## **20. Cab Environment – Vibration**

### **20.1. Definition**

The LUVW should be designed to control the transmission of whole body and arm-hand vibration to levels that permit safe operation and maintenance. The LUVW should provide a mechanical environment, which will prevent motion sickness to crewmembers.

### **20.2. Requirements**

1. Whole body vibrations should not exceed the fatigue–decreased proficiency levels described in Paragraph. 5.8.4.1 of MIL-STD-1472 for the eight-hour task duration and the frequencies indicated.
2. Whole body vibrations should not exceed the comfort–decreased proficiency levels described in Paragraph. 5.8.4.1 of MIL-STD-1472 1472 for the eight-hour task duration and the frequencies indicated.
3. Driver hand-arm vibrations should not exceed  $1 \text{ m/s}^2$  for a daily eight-hour exposure. Most users (at least 75%) should rate the vibration generated by the steering wheel as acceptable.
4. The LUVW should not cause motion sickness amongst its crew. Most users (at least 75%) should rate the motion sickness caused by the LUVW as acceptable.



**Annex E:  
LUVW Human Factors Performance Requirements**

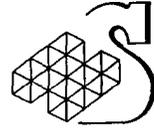
## **21. Cab Environment – General Safety**

### **21.1. Definition**

The LUVW should be designed such that the crew can carry out all actions to operate the vehicle in a safe and effective manner.

### **21.2. Requirements**

1. The LUVW design should be free of sharp corners, protruding knobs and levers, etc. The LUVW should have adequate padding to prevent contact injury. Most users (at least 75%) should rate the inherent safety of the vehicle's interior as acceptable.
2. The LUVW design should possess adequate safeguards to prevent accidental heater contact burn injuries. Most users (at least 75%) should rate the safeguards of the vehicle's heater as acceptable
3. The LUVW's weapon station hatch should have a positive locking system to prevent accidental hatch closing. Most users (at least 75%) should rate the weapon station hatch safety lock as acceptable.
4. The LUVW design should provide cab roll over protection in the event of an accident.
5. The LUVW design should incorporate devices and measures to secure all internal stowage items (mounting brackets, stowage bins, cargo netting, etc.) in the event of an accident or severe cross-country driving.



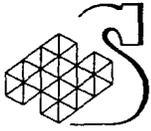
## 22. Vehicle Stowage

### 22.1. Definition

The LUVW should provide internal and external stowage.

### 22.2. Requirements

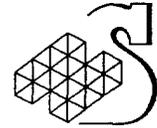
1. The LUVW shall possess a door compartment for the stowage of maps, route cards etc. Most users (at least 75%) should rate the design and stowage capacity of the door compartment as acceptable.
2. The LUVW shall possess a glove compartment for crew related equipment. The glove compartment should be securable. Most users (at least 75%) should rate the design and stowage capacity of the glove compartment as acceptable.
3. The LUVW shall provide interior stowage for personal and crew related equipment. The stowage area(s) should be equipped with interior tie-down points or brackets. Most users (at least 75%) should rate the system for securing "loose" kit as acceptable.
4. The LUVW shall possess a tool compartment for the stowage of tire changing equipment, wrenches, screw-drivers etc. The tool compartment should be securable. Most users (at least 75%) should rate the design and stowage capacity of the tool compartment as acceptable.
5. The LUVW shall reserve space for personal weapon mounts. The placement of the weapon mounts should not hinder access to or egress from the vehicle or interfere with vehicle controls. The secured weapon should not cause comfort problems with the vehicle occupants. Most users (at least 75%) should rate the ease of access of personal weapons secured in the weapons mount as acceptable. Most users (at least 75%) should rate the clash between stored weapons and vehicle controls as acceptable. Most users (at least 75%) should rate the ease of ingress and egress from the vehicle with personal weapons secured in the weapons mounts as acceptable. Most users (at least 75%) should rate the comfort associated with the stowage of personal weapons as acceptable.
6. The LUVW should possess a mounting space for an NBC decontamination kit. The placement of the mount and NBC decontamination kit should not hinder access to or egress from the vehicle or interfere with vehicle controls. The mounted NBC decontamination kit should not cause comfort problems with the vehicle occupants. Most users (at least 75%) should rate the ease of access of the NBC decontamination kit as acceptable. Most users (at least 75%) should rate the clash between stored NBC kit and vehicle controls as acceptable. Most users (at least 75%) should rate the ease of ingress and egress from the vehicle with NBC decontamination kit as acceptable.
7. The LUVW should possess a mounting space for a fire extinguisher. The placement of the mount and fire extinguisher should not hinder access to or egress from the



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vehicle or interfere with vehicle controls. The mounted fire extinguisher should not cause comfort problems with the vehicle occupants. Most users (at least 75%) should rate the ease of access of the fire extinguisher as acceptable. Most users (at least 75%) should rate the clash between stored fire extinguisher and vehicle controls as acceptable. Most users (at least 75%) should rate the ease of ingress and egress from the vehicle with fire extinguisher as acceptable.

8. The LUVW should possess a space for a first aid kit. The placement of the first aid kit should not hinder access to or egress from the vehicle or interfere with vehicle controls. The stored first aid kit should not cause comfort problems with the vehicle occupants. Most users (at least 75%) should rate the ease of access of the first aid kit as acceptable. Most users (at least 75%) should rate the clash between stored first aid kit and vehicle controls as acceptable. Most users (at least 75%) should rate the ease of ingress and egress from the vehicle with first aid kit as acceptable.
9. The LUVW shall possess a space for a night viewing aid(s). The placement of the night viewing aid(s) should not hinder access to or egress from the vehicle or interfere with vehicle controls. The stored night viewing aid(s) should not cause comfort problems with the vehicle occupants. Most users (at least 75%) should rate the ease of access of the night viewing aid(s) as acceptable. Most users (at least 75%) should rate the clash between stored night viewing aid(s) and vehicle controls as acceptable. Most users (at least 75%) should rate the ease of ingress and egress from the vehicle with the stowed night viewing aid(s) as acceptable.
10. The LUVW should provide exterior stowage for personal and vehicle related equipment. The stowage area(s) should be equipped with separate, individual, lockable stowage containers or brackets/tie-downs. Most users (at least 75%) should rate the number and location of external tie-down points as acceptable. Most users (at least 75%) should rate the number, design and location of external stowage containers as acceptable.



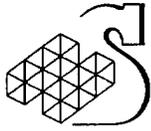
## 23. Vehicle Handling Characteristics

### 23.1. Definition

The LUVW should be capable of sustained and effective combat and support operations. The LUVW should be capable of effective maneuvering such that it can complete assigned missions in all weather conditions.

### 23.2. Requirements

1. The LUVW (with APS) should possess acceptable cornering abilities at low speeds and at high speeds. Most users (at least 75%) should rate the cornering ability at low and high speed as acceptable. Users should consider the turning radius of the vehicle.
2. The LUVW (with APS) should possess acceptable braking abilities at high speeds. Most users (at least 75%) should rate the ability to make a quick stop as acceptable. Most users (at least 75%) should rate the braking effort required to stop the LUVW as acceptable.
3. The LUVW (with APS) should possess acceptable control characteristics (weaving, rear-end breaking loose) while braking. Most users (at least 75%) should rate the controllability of the LUVW while braking as acceptable.
4. The LUVW (with APS) should possess acceptable road feel. Most users (at least 75%) should rate the ability to feel the road surface through the steering wheel as acceptable.
5. The controllability of the LUVW (with APS) at low speeds on hard and soft terrain should be acceptable. Most users (at least 75%) should rate the controllability of the LUVW at low speeds as acceptable.
6. The controllability of the LUVW (with APS) at high speeds on hard and soft terrain should be acceptable. Most users (at least 75%) should rate the controllability of the LUVW at high speeds as acceptable.
7. The controllability of the LUVW (with APS) traversing mud, very soft ground, side slopes, and during fording should be acceptable. Most users (at least 75%) should rate the controllability of the LUVW through these terrain as acceptable.
8. The LUVW (with APS) should possess acceptable acceleration abilities. Most users (at least 75%) should rate the ability to accelerate from a dead stop to highway speeds as acceptable. Users shall consider the amount of engine power and the responsiveness of the vehicle to the accelerator inputs.



**Annex E:  
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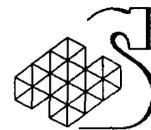
## **24. Vehicle Ride Quality**

### **24.1. Definition**

The LUVW should be capable of sustained and effective combat and support operations. The vehicle ride quality should minimize detrimental effects to vehicle components, personnel and payload.

### **24.2. Requirements**

1. The LUVW should provide an acceptable quality of ride (freedom from up-down, side-to-side, front-to-rear vibrations, smoothness, stability) at low and high speeds on hard roads. Most users (at least 75%) should rate the LUVW's ride quality at low and high speeds on hard roads as acceptable.
2. The LUVW should provide an acceptable quality of ride (freedom from up-down, side-to-side, front-to-rear vibrations, smoothness, stability) at low and high speeds off-road. Most users (at least 75%) should rate the LUVW's ride quality at low and high speeds off-road as acceptable.



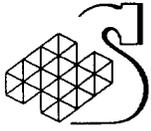
## 25. Vehicle Maintainability

### 25.1. Definition

The ease and effectiveness with which a user (operator or 1<sup>st</sup> line maintainer) can effect minor and major maintenance, repairs and cleaning in field or garrison conditions. The LUVW should be reliable, available, maintainable and durable.

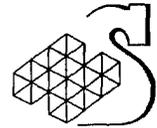
### 25.2. Requirements

1. The vehicle must be maintainable and repairable by a trained user without special tools under normal operational conditions. Most operators or 1<sup>st</sup> line maintainers (at least 75%) should rate the ease of maintaining and/or servicing the vehicle as acceptable (i.e.  $\geq 4$ ). The evaluation of the LUVW for ease of maintenance includes the following areas:
  - Ease of tire replacement
  - Ease of reading dipsticks, levels, gauges
  - Accessibility to light bulbs, lamps, ease of replacement
  - Accessibility to fluid drain valves, ease of fluid replacement (1<sup>st</sup> line)
  - Accessibility to oil, transmission, air, fuel filters, ease of inspection, ease of replacement
  - Accessibility to batteries/terminals, ease of inspection, ease of replacement
  - Accessibility to engine compartment, ease of inspection, ease of fault diagnosis, ease of adjustment, ease of component replacement (1<sup>st</sup> line)
  - Accessibility to braking system, ease of inspection, ease of fault diagnosis, ease of component replacement (1<sup>st</sup> line)
  - Accessibility to HVAC system, ease of inspection, ease of fault diagnosis, ease of component replacement (1<sup>st</sup> line)
  - Accessibility to steering system, ease of inspection, ease of fault diagnosis, ease of component replacement (1<sup>st</sup> line)
  - Accessibility to suspension system, ease of inspection, ease of fault diagnosis, ease of lubrication, ease of component replacement (1<sup>st</sup> line)
  - Accessibility to fuel system, ease of refueling, ease of inspection, ease of fault diagnosis, ease of replacement (1<sup>st</sup> line)
  - Accessibility of electrical system, ease of inspection, ease of fault diagnosis, ease of replacement (1<sup>st</sup> line)



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- Accessibility of engine coolant system, ease of inspection, ease of fault diagnosis, ease of replacement (1<sup>st</sup> line)
  - Ease of performing routine maintenance/inspection checks
  - Ease of performing biannual maintenance checks
2. Trained personnel must be able to conduct a Military Equipment Inspection within 90 minutes
- Participants should rate the ease and adequacy of cleaning the vehicle as acceptable.



## **26. Task Compatibility**

### **26.1. Definition**

The ease and effectiveness with which a soldier can conduct typical operational tasks. The LUVW should provide be compatible with combat and support operations.

### **26.2. Requirements**

1. Trained personnel must be able to conduct representative operational tasks. Most soldiers (at least 75%) should rate the ease of performing vehicle and operational tasks as acceptable (i.e.  $\geq 4$ ).
2. Trained personnel must be able to easily access and use clothing, equipment and weapons during representative operational tasks. Most soldiers (at least 75%) should rate the vehicle compatibility with clothing, equipment and weapons as acceptable.

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