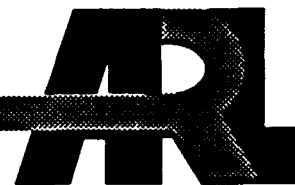


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ARMY RESEARCH LABORATORY



A Compilation of Data Relative to the Future Design of the Combat Vehicle Crewman's Helmet DH-132

Thomas H. Oblak
Samson V. Ortega, Jr.

ARL-TN-31

December 1993

FEB 23 1994

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94-06043



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1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE December 1993	3. REPORT TYPE AND DATES COVERED Final	
4. TITLE AND SUBTITLE A Compilation of Data Relative to the Future Design of the Combat Vehicle Crewman's Helmet DH-132			5. FUNDING NUMBERS PR: AH70 PE: 62716	
6. AUTHOR(S) Oblak, T. H.; Ortega, S. V. Jr.				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Research Laboratory Human Research & Engineering Directorate Aberdeen Proving Ground, MD 21005-5425			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Research Laboratory Human Research & Engineering Directorate Aberdeen Proving Ground, MD 21005-5425			10. SPONSORING/MONITORING AGENCY REPORT NUMBER ARL-TN-31	
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) A study was conducted to provide information about the combat vehicle crewman helmet, DH-132, to the U.S. Army Natick Research, Development, and Engineering Center (NRDEC). The Human Research and Engineering Directorate (HRED) of the U.S. Army Research Laboratory (ARL) collected data, including compatibility, comfort, fit, safety, protection, steady state and impulse noise, about the DH-132 and the types of vehicles and radios in which the helmet is used. The information and user feedback in this report will be used for a future design of the advanced prototype combat vehicle crewman helmet by NRDEC.				
14. SUBJECT TERMS combat vehicle DH-132 crewman's helmet helmet			15. NUMBER OF PAGES 106	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT	

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Aberdeen Proving Ground, Maryland

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A COMPILATION OF DATA RELATIVE TO THE FUTURE DESIGN OF THE
COMBAT VEHICLE CREWMAN'S HELMET DH-132

INTRODUCTION

At the conclusion of Operation Desert Storm (ODS), shortcomings were noted with the first extensive war-time use of the combat vehicle helmet DH-132 (see Figure 1), which was introduced in 1976. The helmet was uncomfortable and hot after extended wear in the desert. The helmet needs improvements in its communication system and more options for sizing. After the reported death of a tank commander, who was hit in the helmet by shrapnel, the combat developers wanted more ballistic protection. In addition, some sort of maxilla facial protection is desired to reduce bump injuries to the face.

In anticipation of funding for a joint program to develop a new combat vehicle crewman (CVC) helmet, the U.S. Army Natick Research, Development, and Engineering Center (NRDEC) requested the Human Research and Engineering Directorate (HRED) of the U.S. Army Research Laboratory (ARL) to collect data to support a development program designed to replace the current DH-132. The developers at NRDEC needed information about the current use of the DH-132 and some user feedback. Since the only background information about the development of CVC helmets was McKenzie (1969), NRDEC needs updated information. The objectives of this study are to

1. Determine the compatibility of the helmet with current and near-term vehicle crew stations;
2. Identify current and future vehicles in which the CVC DH-132 helmet is and will be worn;
3. Identify the communication systems that currently interface with the CVC DH-132, including dismounted radios;
4. Provide the available steady state and impulse noise data from various crew stations to establish the aural protection required for a helmet user;
5. Determine what eye and maxilla facial protection data are required for the combat vehicle crewman;
6. Provide user feedback concerning the comfort and fit of the CVC DH-132 helmet; and
7. Provide injury data and safety concerns applicable to the CVC helmet.

APPROACH AND RESULTS

There was a unique approach for each area. The approach and results follow.



Figure 1. CVC DH-132 helmet.

Compatibility of the CVC DH-132 Helmet With Current and Near-Term Vehicle Crew Stations

Approach

Three approaches were taken. First, a user questionnaire (see Appendix A) was used to gather information from soldiers who wear the CVC. The questionnaire was given to soldiers of the 2nd Brigade, 1st Infantry Division, stationed at Ft. Riley, Kansas, who had just completed a National Training Center (NTC) rotation. Two hundred fifty-three (253) soldiers participated and represented every unit in the division that uses armored vehicles. An assumption was made that these soldiers would draw from that recent training experience at the NTC when answering the questionnaire. However, it was recognized that other experiences might also influence their responses. For instance, more than half of these soldiers had participated in Operation Desert Storm as armored vehicle crewmen.

The second approach was to consult with the HRED Crew Station Integration Team for their opinion about the impact of the current CVC DH-132 configuration on future and near-term armored vehicles.

Third, the Bradley fighting vehicle (BFV) Systems Team of the U.S. Army Tank-Automotive Command (TACOM) was consulted about the available mechanical drawings of the current and future sighting systems on armored vehicles, which may interact with the CVC DH-132 helmet.

Results

The questionnaire results (see Appendix A) indicated that the current helmet physical configuration (excluding the communication system) interacts well with most work stations of the 1st Infantry Division's armored vehicles.

During the debriefing of soldiers from the 1st Infantry Division, several explained a problem with the interaction of other devices (i.e., night vision goggles (NVG); regular sand, wind, and dust goggles; and the NOMEX hood), which are needed in the operation of the unit's vehicles. The NVGs are worn by the vehicle commander during movement as an aid to the driver who has a night vision device attached to a periscope slot in the driving compartment. The commander is supposed to wear the head harness for the NVG (AN/PVS-7 or AN/PVS-5). However, the tight fit of the helmet makes the harness uncomfortable, and the commander often holds the goggles in his hand and uses them like binoculars. Therefore, his hands are not always free to brace himself or use the controls in an M1 Abrams tank or M2 BFV at the commander's station. Several soldiers also said that the regular sand, wind, and dust goggles do not seal properly on the face, thus allowing sand or dust to get into the eyes of the wearer, causing a safety hazard. Also, several soldiers said that the NOMEX hood is made of a heavy material, and the helmet fits tightly on the wearer's head. As a result, hearing sensitivity is reduced and the level of discomfort is increased.

Artillerymen

The primary complaint of the 41 artillerymen surveyed in the study is that while they wore the CVC during firing, the "spaghetti cords" (communication cables) got in the way when the artillerymen operated inside the vehicle. The cords, which hang down from the radio and are connected to the helmet, get caught on equipment inside the cannon turret housing.

In the opinion of the HRED Crew Station Integration Team, the CVC helmet in its current configuration will not pose any problems with near-term vehicles. Future "two-person crew" vehicles will probably use video monitors for driving and sighting, which will greatly reduce any interaction between the helmet and the sighting systems. Both crew members are seated at least 2 feet from the monitors they are required to watch. Current vehicles use sight reticles and brow pads that interact directly with the helmet or soldier's eyes and forehead.

FMC (formerly Farm Manufacturing Company), General Dynamics (Land Division), TACOM, and the Directorate of Combat Developments at the Armor Center, Fort Knox, Kentucky, were contacted to provide input about the impact of helmets on future vehicles. Their opinions reinforced the HRED Crew Station Integration Team's description of future vehicle design.

Appendix B contains drawings of current sighting systems on the M2 BFV. TACOM provided these drawings to show the depth and breadth measurements that need to be considered if the Army designs a new CVC helmet.

Identity of Current and Future Vehicles in Which the CVC DH-132 Helmet will be Worn

Approach

Army Regulation (AR) 738-50 (Headquarters, Department of the Army, 1991) was reviewed to identify the current armored vehicles in which the CVC DH-132 helmet is worn and to determine the future armored vehicles in which the CVC helmet will be worn. In addition, information was received from the weapons systems managers of TACOM and the Tracked Vehicle Branch of the U.S. Marine Corps Logistics Agency of Albany, Georgia, to ensure completeness of the list.

Results

Table 1 is divided into two segments. One segment lists armored vehicles belonging to the U.S. Army and the U.S. Marine Corps (USMC). This list also contains the future armored vehicles in which the CVC helmet will be worn. The other segment contains armored vehicles that are specifically for the USMC. The USMC is not planning a future armored vehicle. The DH-132 is compatible with all the vehicles.

Communication Systems That Currently Interface With the CVC DH-132 Helmet, Including Dismounted Radios

Approach

The developer wanted to know what radios are commonly used in armored vehicles. The goal was to identify the communication systems that currently interface with the CVC DH-132 helmet. The following armored vehicle technical manuals (TMs) were examined: TM 9-2350-264-10-2, Tank, Combat M1A1; TM 9-2350-284-10-2, Fighting Vehicle, Infantry M2A2; TM 9-2350-311-10, Howitzer, Medium Self-propelled (SP) 155mm M109A4; and TM 9-2350-261-10, Carrier, Personnel M113, M557, M106, M125.

Table 1
U.S. Army and USMC Armored Vehicles

Model number	Nomenclature
Current Armored Vehicles	
M1/M1IP/M1A1/M1A2	Tank combat, full
M2/M2A1/M2A2	Infantry fighting vehicle
M3/M3A1/M3A2	Cavalry fighting vehicle
M5	Bulldozer
M9	Tank, bulldozer (armored combat engineer [ACE])
M48A2/M48A5 AVLB	Launcher, bridge
M60A1 AVLB	Launcher, bridge
M60/M60A1/M60A2	Tank combat, full
M60A1 (RISE)A3	Tank combat, full
M60A1E3/M60A1PAS	Tank combat, full
M60A3 (TTS)	Tank combat, full
M88A1	Recovery vehicle
M106A1	Carrier, self-propelled 107mm mortar
M107	Gun, self propelled
M109A1/M109A2	Howitzer, self propelled
M109A3/M109A3E2	Howitzer, self propelled
M110A1/M110A2	Howitzer, self propelled
M113A1/M113A2/M113A3	Carrier, personnel
M125A2	Carrier, mortar, 81mm
M548/M548A1	Carrier, cargo
M551A1	Armor, reconnaissance, assault vehicle
M577A1/M577A2	Carrier, command post
M578	Recovery vehicle
M667	Carrier, missile, LANCE
M728	Combat engineer vehicle
M730/M730A1/M730A2	Carrier, guided missile
M901	Improved tube-launched, optically tracked, wire-guided (TOW) vehicle
M973	Carrier, cargo
M992	Carrier, ammunition
M992	Carrier, cargo
M1015	Carrier, signal Intel/electronic warfare (EW)
M1050	Carrier, ammunition
M1059	Carrier, smoke generator
M1065	Carrier, cargo
M1066	Carrier, cargo
M1067	Carrier, cargo
FOX	Armored nuclear, biological, chemical (NBC) reconnaissance vehicle
M270	Multiple launch rocket system (MLRS)
M741A1	Vulcan
M992	Field artillery armored support vehicle (FAASV)

Future Family of Vehicles (FFV)

Block II tank (M1 System)
 Block III tank
 Armored gun system
 Line of sight/antitank (LOSAT)
 Future infantry fighting vehicle (FIFV)
 Product improvement plan (PIP) for Bradley optics

Table 1 (continued)

Model number	Nomenclature
USMC Specific Armored Vehicles	
Light Armored Vehicle (LAV)	
LAV 25	Reconnaissance vehicle
LAV C2	Command and control
LAVM	81mm mortar
LAVR	Recovery vehicle
LAVAT	Antitank TOW
LAVL	Logistic vehicle
Amphibious Assault Vehicles (AAV)	
AAV P7A1	Personnel carrier
AAV C7A1	Command and control
AAV R7A1	Recovery vehicle

Results

Table 2 is a list of communication equipment in armored vehicles, all of which is compatible with the CVC, for both the U.S. Army and the USMC. The CVC helmet is connected through a quick disconnection that is common to all the radio sets.

Table 2

Communications Equipment on Armored Vehicles, U.S. Army and USMC

Radio Set VRC 12	(AN/VRC 46, AN/VRC 47, AN/VRC 64)
Radio Set AN/VRC 54	
Radio Set AN/VRC 89	
Radio Set AN/VRC 114	
Radio Set AN/ARC 131	
Radio Set AN/GRC 39	
Radio Set AN/GRC 160,	includes the (PRC-77) dismounted radio
Radio Set AM/1780	
Radio PRC-126	
Radio Set single-channel ground/airborne radio system (SINGARS)	AN/GRC 213
Multi-subscriber equipment	
INTERCOM's C-10456/2298	
Secure device, KY 57	

Available Steady State and Impulse Noise Data From Various Crew Stations

Approach

The U.S. Army Combat Systems Test Activity (CSTA) at Aberdeen Proving Ground (APG) has conducted several acoustical studies about various armored vehicles to evaluate hearing protection requirements (see Appendix C).

The information was collected during a variety of vehicle conditions (i.e., hatches opened, closed, engine idling, vent blowers on or off, etc.), vehicle positions (i.e., driver, commander, gunner, cargo, etc.), types of roads, and various weather conditions.

Results

A list of armored vehicles for which steady state and impulse noise data have been collected is given in Table 3. The peak threshold for steady state noise is 131 dB and for impulse noise, 189 dB. Detailed results from CSTA tests for each vehicle are contained in Appendix C.

Table 3
Armored Vehicles for Which Steady State and Impulse
Noise Data Have Been Collected

Vehicle type	<u>Available acoustical data</u>		<u>High end level (dB)</u>
	steady state	impulse	steady state/impulse
M60 Tank combat, full	X	X	128/169
M1A1 Tank combat, full	X	X	122/180
M2A2 Infantry fighting vehicle	X	X	129/168
M2A1 Infantry fighting vehicle	_a	X	/168
M109A3 Howitzer, self propelled	X	_a	120/
M109A2 Howitzer, self propelled	_a	X	/149
M110A2 Howitzer, self propelled	X	X	119/170
M741A1 Vulcan	X	X	130/137
M270 Multiple launch rocket system	X	X	131/125
M992 FAASV	_a	X	/134
M9 Bulldozer ACE	X	_a	112/
M901 Improved TOW vehicle	_a	X	/156
LAV 25	X	_a	116/

_a Acoustical data not available.

Eye and Maxilla Facial Protection Data Required for the Combat Vehicle Crewman

Approach

A literature review was conducted to determine the availability of information regarding eye protection and the need for eye protection in armored vehicles or when CVC helmets are worn. The ARL library conducted the search, referencing helmet wear in armored vehicles, eye protection for armor vehicles and eye protection with helmets. There is no known document that relates specifically to eye protection for the CVC. However, Hickey (1986) was referenced to determine the need for ballistic eye protection for combat personnel in general. As a note, armored vehicle crewman are issued goggles that are used to reduce the effects of sand, wind, and dust.

There are no known data that relate to the maxilla facial protection for the CVC. The only data that relate to injuries, as a result of wearing the CVC without any maxilla facial protection, are available from the U.S. Army Safety Center (USASC) at Fort Rucker. This is discussed in Appendix D.

Discussion

The need for ballistic eye protection was established by a tri-service joint working group (JWG) for eye armor in 1982. The group concluded that most disabling eye injuries can be prevented by providing some form of polycarbonate eye armor. They also concluded that personnel wearing corrective eyewear were afforded some level of eye protection. Since 80% of U.S. combat arms personnel do not require corrective eyewear because they have normal vision, they are at greatest risk (Hickey, 1986).

User Feedback Concerning the Comfort and Fit of the CVC DH-132 Helmet

Approach

To obtain the user feedback concerning the comfort and fit of the CVC DH-132 helmet, ARL relied on the responses to the questionnaire (see Appendix A) that was given to the 253 soldiers of the 2nd Brigade, 1st Infantry Division stationed at Ft. Riley, Kansas (see Table 4). Their responses were sorted by category (i.e., comfort, performance, etc.) and are listed in the Results section.

Table 4
Some Demographics of the Questionnaire Participants

MOS	Number responding	RANK	Number responding	Months wearing helmet	Number responding	Type vehicle	Number responding
Infantry	69	PVT/PFC	81	1 to 6	47	M1	49
Engineer	23	SPC/CPL	95	7 to 12	45	M2/3	75
Artillery	41	SGT	43	13 to 18	35	M9	4
Armor	60	SSG	15	19 to 24	29	AVLB	1
Communicator	2	SFC	3	more than 24	84	M109	16
Mechanic	11	LT	6			M113	30
NBC	10	CPT	2			M557	6
Medic	17					M578	5
Other	11					M728	3
						M992	1
						M993	10
						M1059	2
						OTHER	32
Average age 23.5							
Average weight 176 pounds							
Average height 69 inches							
Average time in a vehicle 23 months							
Average time wearing helmet 20 months							

Results

The responses to the questionnaire were collated into seven categories that best represent an evaluation of comfort and fit requirements for the CVC DH-132 helmet. Table 5 is a categorized list of the collated concerns and comments provided by the soldiers.

Table 5
Collated Concerns and Comments of the Soldiers

	Percentage of total respondents
Concerns about comfort:	
The helmet is uncomfortable when worn for extended periods	42%
Hot to wear in warm weather	39%
Not always getting the right size	25%
Cords become disconnected	11%
Boom microphone gets caught	10%
Spaghetti cords get in the way, especially for artillery vehicles.	8%
Concerns about performance:	
Hard to hear anyone over engine noise	44%
Can't talk to anyone inside the vehicle when outside the vehicle	20%
Communication problems, difficult to maintain	15%
Standard items worn under the CVC:	
NOMEX Balaclava	worn by all
Cold weather items, ski mask, pile cap, wool scarf, etc.	worn by all
Scarf for dust	worn by all
Goggles	worn by all
Glasses	worn by all
NVG harness	worn by all
Protective mask	worn by all
Problems with sighting systems:	
Tilting of the helmet to properly sight in	35%
Using NVGs is difficult	18%
Helmet rests on brow pad	12%
Boom Microphone gets in the way of sighting	2%
Looking at the ground positioning system readout in an M1A1 is difficult with the CVC	1%
Goggles and multiple integrated laser engagement system fall off when looking through the sights	1%
List of concerns with the use of a possible ballistic facial protection and sighting systems:	
Protective mask must fit underneath	100%
M1 and M2 gunners and commanders are concerned with peripheral vision loss	100%
Facial protection is needed	30%
Concerns with correct alignment with the sights	20%
Facial protection would get in the way	15%
Would be OK if removable	4%
Make it see through	3%

Table 5 (continued)

Compiled suggestions to improve the CVC:

- Improve comfort
- Built-in sun and eye protection
- Cooler, more ventilation and circulation. Could you vent from the NBC system?
- Make it lighter, it's already heavy enough. Helmet could get heavier if it got more comfortable
- More padding (non-specific)
- More size options, currently one size fits all (Air up system)
- More ballistic protection. Especially for the vehicle commander
- Issue the helmet as personnel equipment, not as part of the vehicle
- Neck protection (non-specific)
- Air holes, air vents, in the helmet for cooling
- More cushion around the ears
- Adjustable ear cups
- Chin strap redesign, reduce chaffing
- More durable (non-specific)
- Facial protection
- Facial protection is not needed for every position, make it removable
- See through facial protection, to prevent loss of field of view
- Wireless communication system between helmet and vehicle
- More reliable communication system
- Better boom microphone, fewer moving parts
- Better disconnect between the plugs on the helmet with the cords to the vehicle
- Ear plug type speakers

Other concerns:

- Goggles: Better fit, attach to helmet
- NVG (PVS-7B), attachment for the helmet
- Consider soldiers who wear glasses
- Incorporate MILES head harness

Injury Data and Safety Concerns Applicable to the CVC Helmet

Approach

ARL asked the U.S. Army Aeromedical Research Laboratory (USAARL) to provide information regarding head injury information for the CVC helmet. To provide the requested information, ARL conducted a data search detailing injuries from the USASC data base for head injury in vehicles in which a CVC was worn. In addition, ARL solicited questionnaires and received briefings about the the M1 Abrams tank and the M2 BFV at the unit training equipment site at Fort Rucker and at the 1st Battalion, 29th Infantry at Fort Benning (see Appendix D). This was done in an effort to gain first-hand knowledge of the environment for a CVC helmet wearer.

Another source was the questionnaire (see Appendix A) completed by the soldiers of the 2nd Brigade, 1st Infantry Division, of Ft. Riley, Kansas. (Most of the responses are verbatim, as written by the soldiers.)

Results

The information provided by ARL indicated that during an 8-year period, approximately 23% of 2,902 serious armored vehicle mishaps resulted in head or facial injuries. Because the injury report form is not detailed, it is not known if a CVC helmet was worn during the time of the injury, because the person may have been wearing a ground soldier's helmet. The results of the 2,902 mishaps include 31 deaths, 643 non-fatal injuries, and more than 15,000 lost work days for the U.S. Army. The types of injuries included lacerations, skull and facial fractures, concussions, and burns. ARL suggested that a follow-up study could determine the risk of head and face injuries for armored vehicle crewmen, by expanding and detailing this current report. Note. Not all injuries to armored vehicle crewmen are reported. In the authors' opinion, only those injuries of substantial severity tend to be reported.

Table 6 is a list of subjective comments obtained from the 41 soldiers who responded to the "head injury" question on the questionnaire ("If you have ever had a head injury of any type or severity (including the face), briefly explain").

Table 6
Comments From Soldiers Who Answered the "Head Injury" Question

Soldiers' responses (41 total)	Number of respondents	(Percent of the 41 who responded)
Cut chin or face while driving in rough terrain	13	32.0%
Headaches from wearing the helmet too long	10	25.0%
Just bugs, dust, rain, hail, rocks, tree branches, and snow hitting the face while driving	8	20.0%
Ears got sore with prolonged use	4	10.0%
Hit eyes or chin on the sights during sudden stops	4	10.0%
Minor bumps on the head	5	12.5%
Bumped nose inside the vehicle	5	12.5%
50-cal. mount swung around and hit face (some broke their noses)	4	10.0%
Teeth broken after hitting edge of vehicle's 50-cal. mount	4	10.0%
Hit my lip several times when making quick stops	3	7.5%
Bottomed out the vehicle going down hill; hit face on the front of the driver's hatch	2	5.0%
Once wrecked an armored vehicle launched bridge (AVLB) (M48) while towing another in the collision, I hit my jaw into the hatch and cracked my CVC cover on the backlash	1	2.5%
The goggles don't seal; get sand in my face	1	2.5%

Table 6 (continued)

Soldiers' responses (41 total)	Number of respondents	(Percent of the 41 who responded)
Accelerator stuck on Bradley and it ran into a ditch; driver suffered a frontal super orbital fracture and fractured sinus	1	2.5%
Hit periscopes inside driver's hatch after landing	1	2.5%
Thrown into the hatch hole several times while driving in the dark. Face took the brunt of the blow.	1	2.5%
Bumped head hard on the brow pad	1	2.5%
Hit a ditch, face bumped the hatch at the boom microphone. Only minor injury, but if the vehicle had been going faster, would have lost some teeth.	1	2.5%
Driving around at night, got bumped on the head, the hatch latch poked through at the ear cup	1	2.5%
Hit face on the external machine gun mount	1	2.5%
Scratched eye because of low branches	1	2.5%
Broke jaw when the vehicle hit a ditch	1	2.5%
I would rather suffer with the same little problems than get my tank killed because some face protector prevents my gunner or me (TC) from getting a good quick sight picture of the enemy--comment from a Desert Storm veteran	1	2.5%
Driving at night, I hit my nose on the night sight (VVS-2), causing a bloody nose	1	2.5%

SUMMARY

With only one type of helmet to base opinions upon, it is difficult to conduct an analysis of the DH-132. Most of the information requested by NRDEC was already available. This report compiles that requested information.

From the available data relative to the design of the CVC DH-132 helmet, the current helmet design appears to fulfill its intended use for most of the armored vehicles. The current helmet has some incompatibilities with a few armored vehicles and with certain personal equipment (i.e., NVG, sand and dust goggles, etc.).

The area where a major design change should be made in the CVC helmet includes maxilla facial protection. The injury data in Appendix D and the results of the questionnaires in Appendix A indicate that several deaths and non-fatal injuries resulted when the current CVC helmet was worn. These refer only to substantially severe injuries. Therefore, the total number of injuries is probably much greater. Also, the number of comments from the soldiers of armored vehicles who had some sort of injury while wearing the CVC

helmet further indicates that improvements need to be made to enhance facial protection. Most of the injury comments related to facial injuries (i.e., broken teeth, cut chin, bumped nose, etc). There is also a strong indication that some sort of eye protection needs to be considered in a future helmet. Eye protection is a major concern throughout the Army community, especially laser protection.

Design changes should be made to provide the CVC helmet with eye and maxilla facial protection while allowing the wearer to use the sighting systems of current and future armored vehicles, without interference, as suggested by the comments provided by soldiers. Changes in the DH-132 and or the design of a future CVC helmet should also consider the compatibility of the helmet with current and future NVGs, goggles, and the protective mask.

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APPENDIX A
USER FEEDBACK QUESTIONS AND ANSWERS

USER FEEDBACK QUESTIONS AND ANSWERS

Note. The number after each answer is the number responding for that question.

1. What is your primary military occupation speciality (MOS)?

11 (Infantry)/69	12 (Engineer)/23	13 (Artillery) /41
19 (Armor)/60	27 (Air Defense)/0	31 (Communications)/2
43 (Ordnance)/0	44 (Ordnance)/0	54 (Chemical)/10
63 (Ordnance)/11	76 (Quartermaster)/0	88 (Transportation)/0
91 (Medical)/17	92 (Intelligence)/1	Other/11

2. What is your duty MOS?

11/69	12/24	13 /41	19/59	27/0	31/2
43/0	44/0	54/10	63/11	76/0	88/1
91/16	92/1	Other/10			

3. What is your age? **The average age was 23.69 years old.**

4. What is your rank?

0 PVT/PFC/81	0 SPC/CPL/95	0 SGT/43	0 SSG/15	0 SFC/3
0 LT /6	0 CPT/2			

5. What is your weight (in pounds)? **Average weight was 176 pounds.**

6. What is your height? **Average height was 69.3 inches.**

7. How long have you been in the Army?

0 1-12 Months/18
0 13-24 Months/70
0 25-36 Months/67
0 4-6 years/34
0 Over 6 years/45

Average time in the Army, just over 4 years.

8. What size CVC helmet, DH-132 do you wear?

0 Small/24	0 Medium/159	0 Large/58
------------	--------------	------------

9. How long have you been wearing the helmet CVC DH-132?

0 1-6 Months/47
0 7-12 Months/45
0 13-18 Months/35
0 19-24 Months/29
0 Over 24 Months/84

Average months wearing the helmet is 20.

10. What type vehicle are you a crew member in (answer more than one if applicable)?

0 M1/49	0 M2/61	0 M3/14	0 M9/4	0 M48 AVLB/1
0 M60A3/1	0 M109/16	0 M113/30	0 M557/6	0 M578/5
0 M728/3	0 M992/1	0 M993/10	0 M1059/2	0 Other /32

11. How long have you been working with this vehicle(s)?

0 1-6 Months/37
0 7-12 Months/36
0 13-18 Months/33
0 19-24 Months/37
0 Over 24 Months/100

Average time in a vehicle, 23 months.

12. What is is your crew position?

0 Vehicle Commander/60
0 Gunner/50
0 Driver/101
0 Loader/5
0 Observer/5
0 RTO/6
0 Other/15

13. Are you issued the Kevlar, PASGT, ground soldier's helmet?

0 Yes/234 0 No/11

14. Do you ever wear the Kevlar, PASGT Helmet in conjunction with your duties as an armor vehicle crewman?

0 Yes/162 0 No/81

15. Do you wear a PASGT helmet whenever you get out of the vehicle?

0 All the Time/79
0 Most of the Time/91
0 Sometimes/45
0 Hardly Ever/14
0 Never/12

16. How often do you wear the CVC DH-132 during field training?

0 2-4 Hours a Day/36
0 4-6 Hours a Day/52
0 6-8 Hours a Day/61
0 8-12 Hours a Day/54
0 12-18 Hours a Day/30
0 18 to 24 Hours a Day/1

The average is 6 hours a day.

17. Do you normally use the chin strap on the CVC DH-132?

- 0 All the Time/37
- 0 Most of the Time/50
- 0 Sometimes/51
- 0 Hardly Ever/41
- 0 Never/66

18. How tight do you wear the chin strap on the CVC?

- 0 As tight as possible./17
- 0 Just enough so to seal over the ear cups./108
- 0 So the strap touches my chin./20
- 0 Don't tighten it at all./7
- 0 Just let it hang loose so it looks like you have it on./5
- 0 Never wear it fastened./76

Note. The not wearing of chin straps is a leadership problem in the units. Soldiers are required to fasten the chin strap when wearing the helmet, but if they get away with not using it, they do.

19. Do you wear ear plugs when wearing the CVC DH-132?

- 0 Most of the time./0
- 0 Sometimes./20
- 0 Only during live fires./20
- 0 Hardly ever./14
- 0 Never./166

20. Have you experienced a facial accident in an armored vehicle that may have been prevented by a facial shield?

- 0 Yes/60
- 0 No/184

21. Do you think facial protection is necessary for the CVC DH-132?

- 0 All the Time/60
- 0 Most of the Time/47
- 0 Sometimes/100
- 0 Hardly Ever/19
- 0 Never/19

22. Should facial protection be removable from or permanent on the CVC DH-132?

- 0 Removable/204
- 0 Permanent/31

23. If the CVC DH-132 had removable facial protection of some sort, you would use it . . .?

- 0 All the Time/58
- 0 Most of the Time/91
- 0 Sometimes/71
- 0 Hardly Ever/16
- 0 Never/8

24. Which is the most important for the CVC DH-132 to have?
- 0 Ballistic protection /20
 - 0 Just bump protection/50
 - 0 Both are equally important/171
25. Would you prefer the CVC DH-132 to be lighter weight?
- 0 Yes/124 0 No/45 0 Don't care/73
26. How do you rate the comfort of the CVC DH-132?
- 0 Very Comfortable/2
 - 0 Comfortable/62
 - 0 Neither Comfortable or Uncomfortable/87
 - 0 Uncomfortable/78
 - 0 Very Uncomfortable/16
27. In warm weather, do you feel the CVC is uncomfortably hot to wear?
- 0 Yes/187 0 No/53
28. Do you use the CVC DH-132 for command and control?
- 0 All the Time/88
 - 0 Most of the Time/86
 - 0 Sometimes/41
 - 0 Hardly Ever/12
 - 0 Never/17
29. How comfortable are the ear cups on the CVC DH-132?
- 0 Very Comfortable/4
 - 0 Comfortable/79
 - 0 Neither Comfortable or Uncomfortable/66
 - 0 Uncomfortable/78
 - 0 Very Uncomfortable/15
30. Would you like to see a more adjustable head harness for the CVC DH-132?
- 0 Yes/207 0 No/7 0 Don't care/24
31. Would you like to see a more comfortable helmet?
- 0 Yes/229 0 No/0 0 Don't care/11
32. Would you like to have more adjustments on the helmet (i.e., adjustments at the ear cups, chin strap, head harness, neck support)?
- 0 Yes/215 0 No/10 0 Don't care, the current version is fine./15
33. Did you participate in Operation Desert Storm as an armored vehicle crewman who wore the CVC (if Yes to Question 33, answer 34 - 35; if No, skip to Question 36)?
- 0 Yes/119 0 No /120

34. Did you feel the current CVC provided you the protection you needed in combat?

- 0 All the Time/14
- 0 Most of the Time/24
- 0 Sometimes/34
- 0 Hardly Ever/20
- 0 Never/28

35. Did you ever wear your Kevlar PASGT helmet?

- 0 Whenever I dismounted the vehicle./86
- 0 Sometimes/21
- 0 Hardly Ever/4
- 0 Never/10

Answers to Subjective Questions. () at end of each answer is the number of soldiers who answered the same or similar. If no () then only one soldier made the comment.

36. Do you have any comments about your experience with the CVC either during Desert Storm or your recent rotation here at National Training Center?

The helmet gets uncomfortable after wearing it for a while, too tight. (31)

The spaghetti cord gets in the way during operations in all the crew positions (16) (One reason is the location of the control boxes plus the cord becomes disconnected at times due to movement in the vehicle.)

Can't talk to anyone when getting out of the vehicle. (9) (When you have to dismount the vehicle, for ground guiding, maintenance, security, or to quickly talk to someone, you still need to maintain communication with crew and other elements. You can't do that with the current communicator system.)

CVC is very hot and uncomfortable in warm weather. (26)

The ear pads are very uncomfortable. (17)

Sometimes hard to hear the radio over the engine noise. (13)

Boom microphone wires get loose often and get caught on something. (12)

Spaghetti cords become disconnected easily. (11)

Communication problems or difficult to maintain. (9)

The CVC helmet was very hard to keep assembled, ear cups always falling off or out. (5)

Communication wires from CVC to "spaghetti cord" work only 50% of the time. (3)

Vehicle commanders need some type of attachment to protect them from the elements. (3)

I am relatively satisfied with it. (3)

Didn't feel safe wearing the CVC. (4)

The DH-132 is outdated. (2)

When I sweat, the ear cups collect water. (7)

Spaghetti cords get heavy. (4)

Communicator cord breaking at the earpiece. (2)

Too much static over the communication system. (4)

When water or sand gets into the microphone, communication is difficult. (4)

While driving the vehicle at night, hitting ruts, ran into holes, and slammed a face into the hatch. (5)

Can't find a CVC that fits; have to take the one that's in the vehicle. (3)

Goggles hard to get sealed. (5)

Too heavy. (3)

The goggles scratch too easily. (4)

Replacement parts were hard to get, and cleaning was a problem during ODS. (5)

Crashing into the vehicle in front during convoy operations at night, in the fog. (2)

Artillery crewmen, the communicator cord is not long enough to work inside the vehicle with the helmet on all the time.

Spend a lot of time adjusting the helmet for comfort while driving down the tank trail.

Had to wear the helmet for 22 hours straight during road march in Desert Storm; got real uncomfortable.

It wasn't much of a war, but still, I wasn't completely at ease as far as ballistic capability, and it got pretty unbearable during extremely hot weather.

Yes, my M3 Bradley was shot by an M1 with a 120mm gun during Desert Storm; I was wearing my CVC at the time and suffered only burns to the face. I was thrown out of the burning vehicle, and the fall was easier because of the protection of the CVC shell

37. *Do you ever wear anything under your CVC DH-132, what are they (i.e., Ski Mask, Balaclava)?*

I wear a NOMEX Balaclava. (40) (Makes the helmet fit too tight.)

Ski cap or mask. (33)

Scarf for dust. (27)

Not very often; any time you wear anything under the helmet, it gets too uncomfortable. (16)

Hard to hear when wearing anything under the helmet. (15)

Cold weather or pile cap. (14)

Goggles, sun, wind, dust. (13)

Cold weather face mask. (12)

Sleeping cap hood for warmth. (9)

Balaclava or bandana around neck and mouth. (8)

Glasses or sunglasses. (6)

I wear ski masks and the balaclava, but because the CVC is not adjustable, it makes it uncomfortable to wear. (4)

A rag around my head in the summer time. (6)

BDU cap. (6)

NVG harness. (3)

Wear nothing. (8)

A towel around my head to add cushion and collect sweat. (2)

No, I already get headaches from wearing the helmet for so long.

Protective mask, gets too hot under the helmet.

Helmet fits too tight to wear anything under it.

Headphones from a walkman!

Wool scarf.

Protective Mask. (Everyone)

38. If you are someone who uses sighting devices (i.e., ISU, periscopes, VVS, brow pads), does the current helmet get in the way of using any of them?

Having to tilt the CVC back to use the sights or brow pad. (24) (When this happens, the helmet digs in the back of the neck and the ear cups become uncomfortable).

Sometimes, it's hard to use sights required; the helmet rests on sights or brow pads and presents problems when wearing the helmet. (22)

Using night vision goggles is difficult. (12) (Have to hold in one hand.)

When driving with the night vision goggles, the harness is strapped over your head and the CVC doesn't fit right or is falling off all the time. (8)

Helmet rests on the brow pad. (7)

Loss of peripheral vision. (3)

Because of the adjustment when using the VVS, the helmet will move and become uncomfortable. (2)

Using night driving scope on M113 series vehicles means you have to place the microphone below your chin to see through the scope; communication is difficult.

Wearing glasses and using the sights is difficult; pressure to my head. (3)

The boom microphone gets in the way of the gunner's sight. (2)

The spaghetti cord gets knotted.

Only when used with the protective mask is it difficult.

The ground positioning system on the M1A1 is in such a way that sometimes you can't use it while wearing the CVC. (4)

Tankers need a smaller helmet; it makes using the sighting devices easier to use; head room is limited. (2)

When looking through some of the periscopes, I sometimes take the shell off.

Sometimes, the boom microphone gets in the way of the sight unit.

Goggles and MILES keep falling off when using the sights.

39. If you are in a position that must use fire control devices (i.e., weapon control box, turret control box) would facial protection get in the way of your viewing these panels or devices?

Facial protection would or might get in the way. (36)

Make it impossible to observe through sights on M1. (3)

It would be OK if it were removable or slid back. (9)

Could not see the control box or panel by glancing down; would have to take my eyes off the target. (9)

Not if the facial protection were see-through. (6)

Should be removable. (6)

Around the eyes, it would get in the way. (3)

Would not be able to look through the sight with a face shield on. (8)

A face shield would make more difficult to fit the face into the correct alignment to use the sight. (16)

Only if the facial protection won't fog up the sights.

At the gunner's station on the M728 CEV, you cannot get a good sight picture through the M105 and M32C sights, because the forehead rest and the brim of the CVC interfere with each other.

I don't think it would.

Facial protection probably not a problem in an artillery vehicle. (3)

In the FISTV, would take the CVC off to use the sights to get accurate picture.

Facial protection should not make the helmet any hotter than it is.

Facial protection is needed to block wind, sand, dust, and prevent injuries. The tank commander (maybe the loader), need facial protection the most; a shield must be able to flip up to allow the tank commander to look at sights.

Facial protection needed for the tank commander (TC) of multiple launch rocket system who exposes himself outside the hatch when driving.

Goggles sometimes get in the way.

40. Could you make any suggestions to improve the CVC DH-132?

COMFORT AND FIT

Make the helmet more comfortable. (37)

Have a built-in clear and sun shield for the eyes like the flight helmet, with possible seal device around edges. (35)

Make the helmet cooler, more air circulation or ventilation. (31)

Make it lighter; it's heavy enough. (36)

Make the CVC more adjustable. (24)

Make the padding inside the helmet better. (22)

One size fits all. The CVCs now are assigned to the unit, not the crew. It's hard to find the right size to fit.

You never know which CVC you will get from day to day, need to issue the helmet to an individual, not to the vehicle.

Why do you need more protection on the helmet; you have the vehicle around you?

More size options. (12)

Use one size fits all. By using an air-up system or form fitting. This would allow for a better fit and a more comfortable wear. (8)

Need some sort of neck support or protection. (7)

CVC is more comfortable than the Kevlar, so I wear the CVC more often outside the vehicle.

Would be nice if it could be used as a dismount helmet also.

Need a thicker stronger shell. (6)

More ballistic or head protection. (17)

Ballistic protection needed for Bradley, tank, or vehicle commanders only.

Ballistic protection to the ears. (3)

Helmet could get heavier if comfort were increased. (3)

Don't make the helmet wider. (2) (M1 crewman)

Shell needs to be similar to Navy flight deck helmet, multiple hard shell pieces for flexibility.

Remove the bumps on the rubber padding. (4)

Could you use the NBC ventilation system in the M1A1 to ventilate the CVC also? Small hoses that connect into the helmet.

Air vents for the top of the head. (4)

Air holes for the head. (4)

More cushion on the ear cups. (19)

Ear cup pads keep falling off. (8)

Ear cups more adjustable. (12)

More room for the ears. (3)

Make the padding one solid piece.

Jell pads for cushion.

Sweat band.

Better chin strap.

Form fit chin pad or cup. (8)

Use velcro on chin strap; get rid of the snap. (2)

More durable. (Since the helmet stays with the vehicle, there is less care taken overall by the crew members, versus if the CVC were issued to an individual.)

FACIAL PROTECTION

Facial protection is a good idea. (31)

Facial protection is not needed for gunners. (9)

Not needed all the time. (3)

Incorporate a dust mask with the facial protection. (6)

See-through facial protection. (9) (Football style helmet)

Make a jaw guard, like a motorcycle helmet or NASCAR driver. (3)

Flip-up or removable. (6)

Make sure facial protection can incorporate the protective mask M25.

COMMUNICATIONS

Wireless or cordless communication system. (43) (Makes it easier for "outside the vehicle tasks," ground guiding, reloading operations, maintaining the vehicle while still listening to the radio, dismounting the TC to do short reconnaissance.)

When working with the M9 ACE, hands are busy at the controls and the vehicle is very loud. Soldiers must work with their heads outside the vehicle; if someone starts talking on the radio, the soldier must stop the vehicle to listen.

Weatherproofing, especially the communicator. (5)

Put microphone in the facial protection. (2)

Need a smaller/better boom microphone. (11) (throat mic?)

Better communication system. (18) (More reliable)

Better wire connection, to prevent cords becoming separated. (9)

Better electrical wiring to prevent shorts in communication between commander and crew. (4)

I don't like the fact that I have to un-key my microphone when the TC needs to call out. (2)

The cord connections with the helmet come apart too easily.

Make the quick disconnection at the control box.

Relocate the switch on the ear cup; it gets bumped and sometime keys the system unnoticed. (2)

The vibrations in the driver's position make it difficult to hear properly. (2)

Need to be able to hear better; vehicle noise sometimes drowns out the voice communication. (9)

A switch to block out radio noise, be able to just hear inter-vehicle commands, at the driver station.

Ear plug type speakers for the ears.

OTHER CONCERNS

The goggles don't fit tight to your head. (5)

Design new sand, wind, dust goggles that fit on the helmet or attach to the helmet. (5)

Attachment for the PVS-7B's right on the helmet. (11) (All types of NVGs)

Make it easier to clean and maintain. (8)

Consider female soldiers.

Consider soldiers who wear glasses. CVC is uncomfortable while wearing glasses, especially around the ear cups. (9)

Incorporate a Nomex hood or fire protection in the helmet.

User-issued helmets and more operator level maintenance. Some type of modular replacement part system.

Some way to incorporate the MILES head harness.

41. *If you have ever had a head injury of any type or severity (including the face), briefly explain.*

Cut chin or face while driving in rough terrain. (13)

Headaches from wearing the helmet too long. (10)

Ears get sore with prolonged use. (4)

Hit eyes or chin on the sights during sudden stops. (4)

Once wrecked an AVLB (M48) while towing another. In the collision, I hit my jaw into the hatch and cracked my CVC cover on the backlash.

Just bugs, dust, rain, hail, rocks, tree branches, and snow hitting the face while driving. (8)

The goggles don't seal, get sand in my face.

Accelerator stuck on a Bradley and it ran into a ditch. Driver suffered a frontal super orbital fracture and fractured sinus.

Hit periscopes inside driver's hatch after landing hard.

Thrown into the hatch hole several times while driving in the dark. Face took the brunt of the blow.

Minor bumps to the head. (5)

Bumped head hard on the brow pad.

Bumped nose inside the vehicle. (5)

Bottomed out the vehicle going down hill, hit face on the front of the driver's hatch. (2)

Hit a ditch, face bumped the hatch at the boom microphone. Only minor injury, but if vehicle had been going faster, would have lost some teeth.

Hit my lip several times when making quick stops. (3)

Driving around at night, got bumped on the head; the hatch latch poked through at the ear cup.

50-cal. mount swung around and hit face. (4) (Some broke their nose)

Broken teeth after hitting edge of vehicle or 50-cal. mount. (4)

Hit face on MG mount.

Scratched eye because of branches.

Broke jaw when the vehicle hit a ditch.

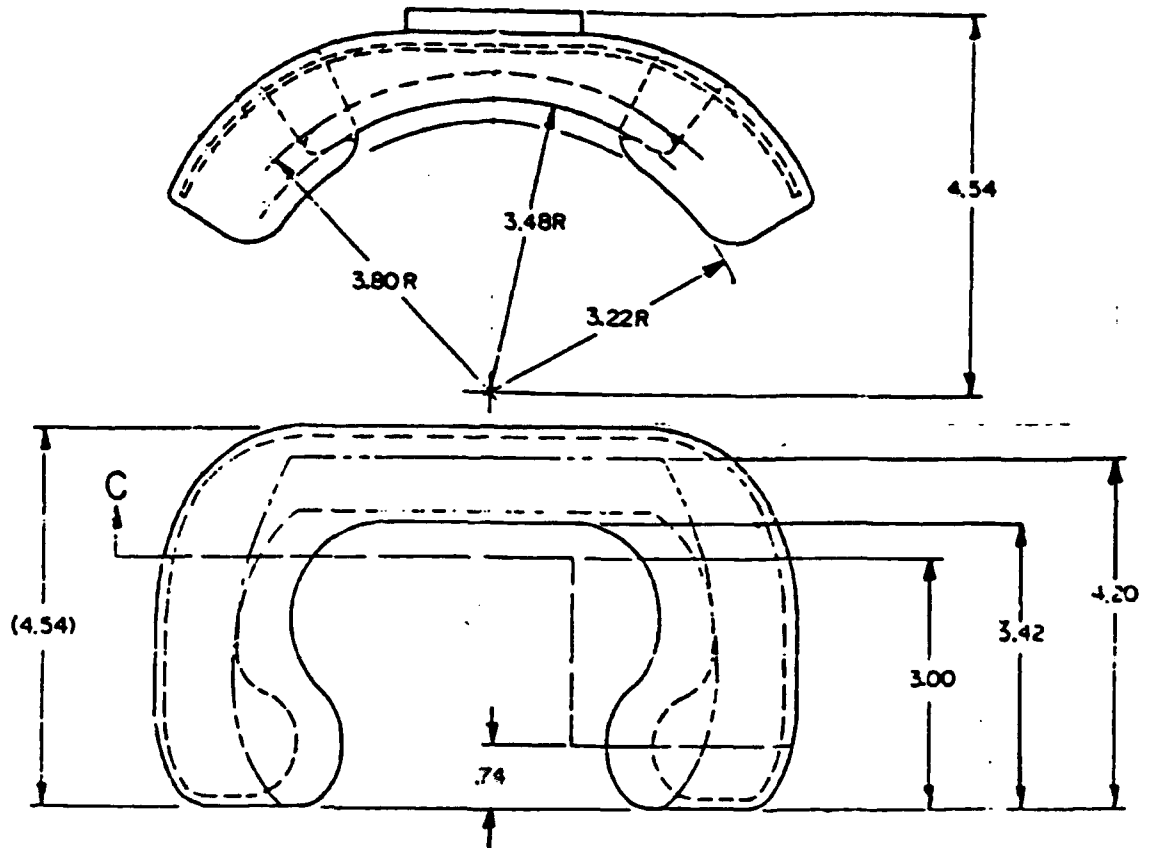
I would rather suffer with the same little problems, than get my tank killed because some face protector prevents my gunner or me (TC) from getting a good, quick sight picture of the enemy (comment from a Desert Storm veteran)

Driving at night, I hit my nose on the night sight (VVS-2), causing a bloody nose.

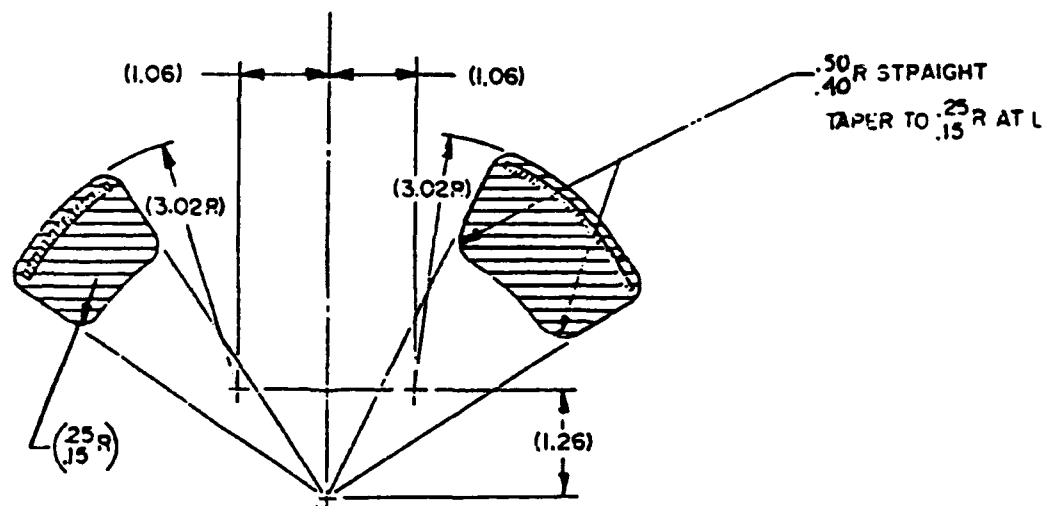
With a lot of luck, I haven't had any serious injuries.

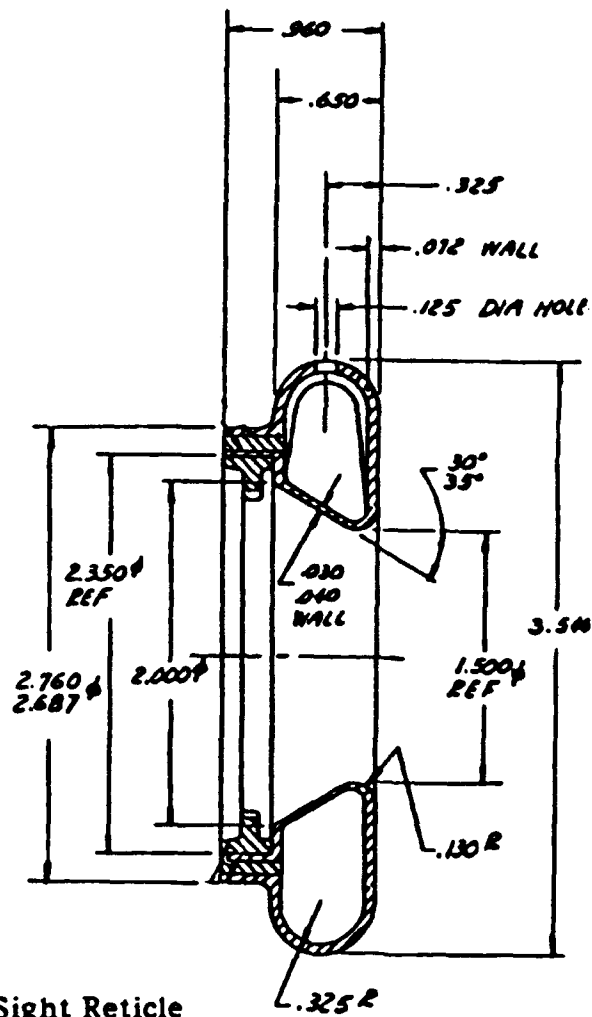
APPENDIX B
DRAWINGS OF CURRENT SIGHTING SYSTEMS

DRAWINGS OF CURRENT SIGHTING SYSTEMS

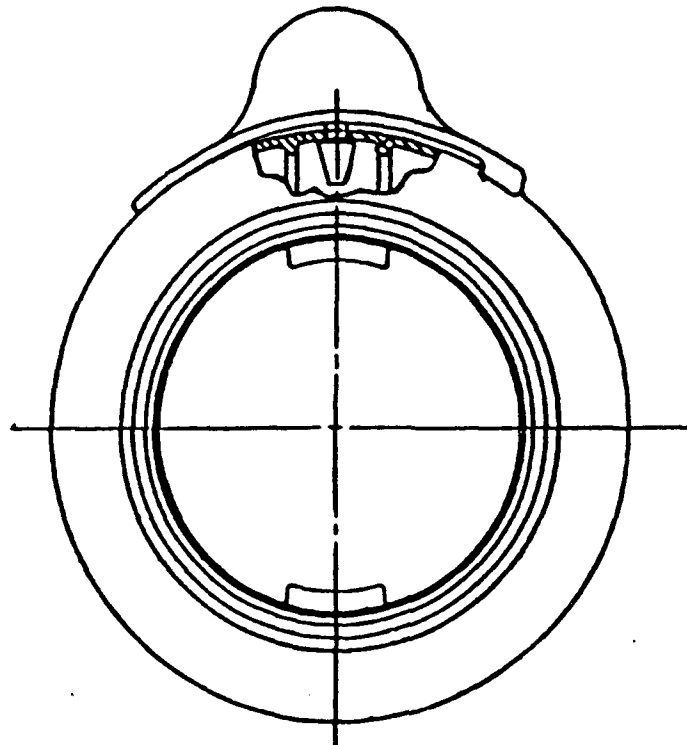


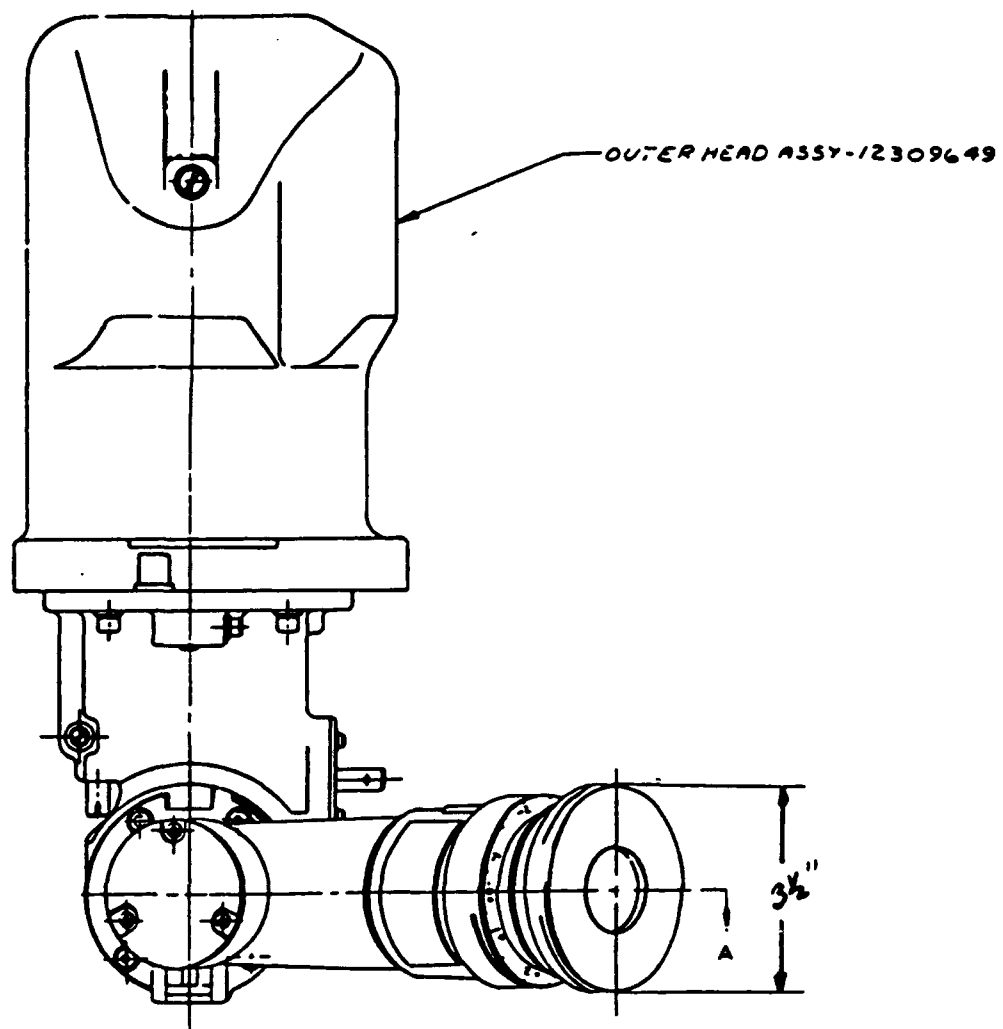
Brow Pads for Gunners and Commanders in M1 and M2/M3 Armor Vehicle



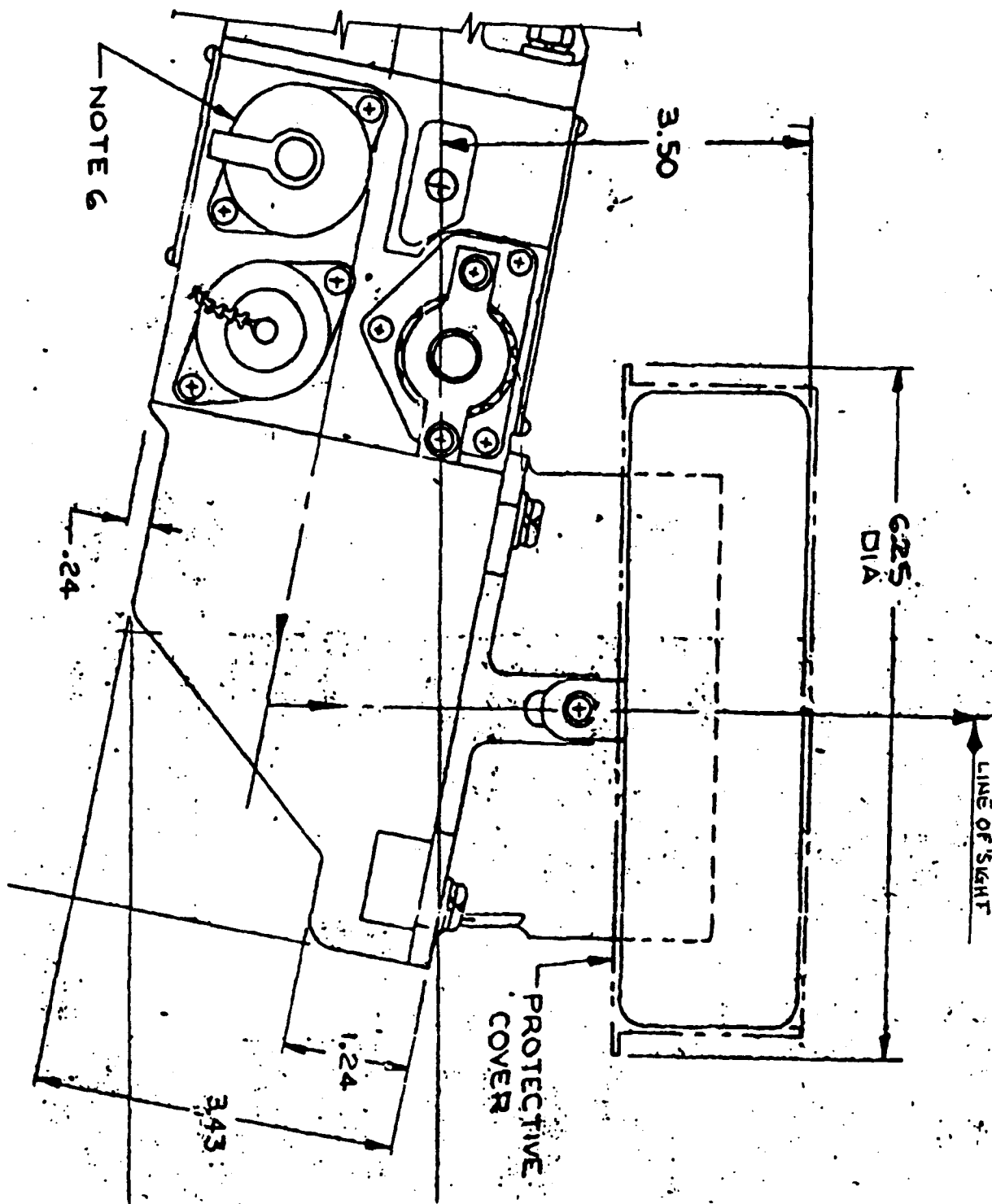


Eye Cup for Sight Reticle





Auxiliary Sight Unit, with Reticle



Driver's Night Vision Periscope for M2

APPENDIX C

AVAILABLE STEADY STATE AND IMPULSE NOISE
DATA FROM VARIOUS CREW STATIONS

AVAILABLE STEADY STATE AND IMPULSE NOISE
DATA FROM VARIOUS CREW STATIONS

ACOUSTICAL TEST DATA

TIME: 1000		DATE: 15 NOV 1988		TEST ITEM: BFVS/M2A2 500HP	
TEST CONDUCTED BY: M. CARLSON			TEST ITEM OPERATOR: MR. KESTLER		REG./MODEL NO:
SERIAL NO. P004		ODOMETER: 1811		HOUR METER: N/A	
TEMPERATURE: 53 DEG F		HUMIDITY: 74%		TEST SITE: PERRYMAN	
TERRAIN: FLAT		BAROMETRIC PRESSURE: 1027.2		SKY COVER: SCATTERED	
WIND SPEED: 4 KNOTS		TAPE RECORDER: RACAL 7 CH		OCTAVE ANALYZER: B&K 2131	
MICROPHONE: 4155		STATIONARY OPERATION ()		HIGHWAY DRIVING (X)	
INTERIOR (X)		EXTERIOR ()		MICROPHONE LOCATION: DRIVER'S POSITION	

OCTAVE BAND CENTER FREQUENCIES (HZ)					
GEAR	RPM	SPEED KM/HR	dBA	d3B	dBC
			ALL PASS	31.5	63
				125	250
				500	1000
				2000	4000
				8000	

HATCHES OPEN

N	IDLE	83	90	93	99	92	97	84	80	80	78	76	65	60
D	16	102*	108	112	113	105	110	104	105*	101	93	89	79	76
D	32	108*	117	125	125	110	125*	109	109*	108*	99	96	88	83
D	48	110*	116	119	120	110	116	113*	113*	109*	104*	100	91	84
D	61	113*	119	122	122	114	116	117*	116*	113*	106*	102*	94	85

HATCHES CLOSED

N	IDLE	83	91	100	103	102	92	90	81	78	79	76	67	63
D	16	106*	113	118	120	117	108	112*	110*	105*	98	91	81	76
D	32	113*	121	127	127	112	126*	116*	115*	113*	104*	100	93	90
D	48	115*	121	125	126	114	122*	119*	118*	114*	108*	104*	91	86
D	61	117*	123	126	126	115	113	124*	118*	115*	111*	106*	95	89

MAXIMUM ALLOWABLE LIMITS OF MIL-STD-1474B(MI), TABLE 2, CATEGORY B

100 121 111 103 102 100 100 100 100
*LEVELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY B

ACOUSTICAL TEST DATA

TIME: 1000	DATE: 15 NOV 1988	TEST ITEM: BFVS/M2A2 500HP	
TEST CONDUCTED BY: M. CARLSON		TEST ITEM OPERATOR: MR. KESTLER	REG./MODEL NO:
SERIAL NO. P004	ODOMETER: 1811	HOUR METER: N/A	TEST ITEM CONDITION: TILES INSTALLED
TEMPERATURE: 53 DEG F	HUMIDITY: 74%	TEST SITE: PERRYMAN	SURFACE: PAVED
TERRAIN: FLAT	BAROMETRIC PRESSURE: 1027.2	SKY COVER: SCATTERED	WIND DIRECTION: NE
WIND SPEED: 4 KNOTS	TAPE RECORDER: RACAL 7 CH	OCTAVE ANALYZER: B&K 2131	SOUND LEVEL METER:
MICROPHONE: 4155	STATIONARY OPERATION HIGHWAY DRIVING DRIVE-BY () (X) ()		
INTERIOR (X)	EXTERIOR ()	MICROPHONE LOCATION: GUNNER'S POSITION	

						OCTAVE BAND CENTER FREQUENCIES (HZ)									
GEAR	RPM	SPEED KM/HR	dBA	dBB	dBc	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000

HATCHES OPEN

N	IDLE	78	92	100	101	81	100	84	73	71	72	68	59	58
D	16	98	106	112	113	107	109	107	101	94	92	88	80	74
D	32	105*	117	125	125	102	125*	110	103	101	98	96	89	84
D	48	107*	114	119	120	106	117	114*	109*	103*	100	99	89	83
D	61	109*	116	120	120	105	112	119*	111*	105*	102*	100	94	84

HATCHES CLOSED

N	IDLE	80	92	98	99	89	97	93	75	72	72	69	60	58
D	16	101*	110	115	116	110	113	110	105*	95	95	89	82	75
D	32	107*	116	122	123	108	122*	116*	107*	102	100	98	92	88
D	48	109*	118	124	125	113	123*	118*	113*	103*	103*	100	92	86
D	61	115*	125	129	130	112	116	129*	113*	105*	103*	101*	93	87

MAXIMUM ALLOWABLE LIMITS OF MIL-STD-1474B(MI), TABLE 2, CATEGORY B

100 121 111 103 102 -100 100 100 100
*LEVELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY B

ACOUSTICAL TEST DATA

TIME: 1000	DATE: 15 NOV 1988	TEST ITEM: BFVS/M2A2 500HP
TEST CONDUCTED BY: M. CARLSON	TEST ITEM OPERATOR: MR. KESTLER	REG./MODEL NO:
SERIAL NO. P004	ODOMETER: 1811	HOUR METER: N/A
TEMPERATURE: 53 DEG F	HUMIDITY: 74%	TEST SITE: PERRYMAN
TERRAIN: FLAT	BAROMETRIC PRESSURE: 1027.2	SKY COVER: SCATTERED
WIND SPEED: 4 KNOTS	TAPE RECORDER: RACAL 7 CH	OCTAVE ANALYZER: B&K 2131
MICROPHONE: 4155	STATIONARY OPERATION HIGHWAY DRIVING DRIVE-BY () (X) ()	
INTERIOR (X)	EXTERIOR ()	MICROPHONE LOCATION: CMDR'S POSITION

OCTAVE BAND CENTER FREQUENCIES (HZ)															
GEAR	RPM	SPEED KM/HR	dBA	dBB	dBC	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000

HATCHES OPEN

N	IDLE	80	93	102	102	81	102	79	78	74	73	69	61	59
D	16	99	106	112	114	109	111	102	103	97	93	88	82	76
D	32	107*	118	126	127	104	127*	106	107*	104*	99	96	91	86
D	48	109*	115	119	120	108	117	111	113*	106*	103*	100	91	84
D	61	110*	117	120	120	107	114	116*	115*	107*	102*	101*	96	85

HATCHES CLOSED

N	IDLE	79	90	98	99	89	98	87	77	74	72	69	62	59
D	16	100	107	114	115	110	112	103	104*	98	95	88	82	75
D	32	107*	114	121	122	108	122*	107	107*	105*	101*	97	93	86
D	48	109*	116	122	123	114	121	114*	112*	106*	101*	100	91	84
D	61	111*	120	124	124	112	116	123*	113*	108*	102*	101*	95	87

MAXIMUM ALLOWABLE LIMITS OF MIL-STD-1474B(MI), TABLE 2, CATEGORY B

LEVELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY B

ACOUSTICAL TEST DATA

TIME: 1000		DATE: 15 NOV 1988		TEST ITEM: BFVS/M2A2 500HP											
TEST CONDUCTED BY: M. CARLSON			TEST ITEM OPERATOR: MR. KESTLER			REG./MODEL NO:									
SERIAL NO. POO4		ODOMETER: 1811		HOUR METER: N/A		TEST ITEM CONDITION: TILES INSTALLED									
TEMPERATURE: 53 DEG F		HUMIDITY: 74%		TEST SITE: PERRYMAN		SURFACE: PAVED									
TERRAIN: FLAT		BAROMETRIC PRESSURE: 1027.2		SKY COVER: SCATTERED		WIND DIRECTION: NE									
WIND SPEED: 4 KNOTS		TAPE RECORDER: RACAL 7 CH		OCTAVE ANALYZER: B&K 2131		SOUND LEVEL METER:									
MICROPHONE: 4155		STATIONARY OPERATION ()		HIGHWAY DRIVING (X)		DRIVE-BY ()									
INTERIOR (X)		EXTERIOR ()		MICROPHONE LOCATION: RIGHT FRONT CREW POSITON.											

OCTAVE BAND CENTER FREQUENCIES (HZ)															
GEAR	RPM	SPEED KM/HR	dBA	dBB	dBC	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000

HATCHES OPEN

N	IDLE	77	87	94	95	89	94	85	76	73	70	67	59	55
D	16	105*	111	116	118	115	110	108	110*	102	97	94	90	87
D	32	110*	116	123	123	109	122*	112*	111*	107*	102*	101*	98	94
D	48	114*	120	123	124	110	120	116*	118*	111*	106*	105*	100	96
D	61	115*	120	122	123	111	113	117*	119*	113*	107*	106*	102*	97

HATCHES CLOSED

N	IDLE	76	86	94	95	92	91	84	76	73	69	67	59	55
D	16	105*	111	115	116	110	109	108	109*	102	97	94	91	86
D	32	111*	120	128	128	107	128*	113*	113*	109*	103*	102*	99	96
D	48	115*	120	124	124	107	121	117*	118*	112*	107*	105*	101*	97
D	61	115*	120	122	122	108	113	116*	119*	113*	107*	105*	102*	97

MAXIMUM ALLOWABLE LIMITS OF MIL-STD-1474B(MI), TABLE 2, CATEGORY B

	100	121	111	103	102	-100	100	100	100
*LEVELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY B									

ACOUSTICAL TEST DATA

TIME: 1000		DATE: 15 NOV 1988		TEST ITEM: BFVS/M2A2 500HP											
TEST CONDUCTED BY: M. CARLSON			TEST ITEM OPERATOR: MR. KESTLER		REG./MODEL NO:										
SERIAL NO. P004		ODOMETER: 1811	HOUR METER: N/A		TEST ITEM CONDITION: TILES INSTALLED										
TEMPERATURE: 53 DEG F		HUMIDITY: 74%	TEST SITE: PERRYMAN		SURFACE: PAVED										
TERRAIN: FLAT		BAROMETRIC PRESSURE: 1027.2		SKY COVER: SCATTERED	WIND DIRECTION: NE										
WIND SPEED: 4 KNOTS		TAPE RECORDER: RACAL 7 CH		OCTAVE ANALYZER: B&K 2131	SOUND LEVEL METER:										
MICROPHONE: 4155		STATIONARY OPERATION HIGHWAY DRIVING DRIVE-BY () (X) ()													
INTERIOR (X)		EXTERIOR ()		MICROPHONE LOCATION: LEFT REAR CREW POSITION											

OCTAVE BAND CENTER FREQUENCIES (HZ)															
GEAR	RPM	SPEED KM/HR	dBA	dBB	dBC	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000

HATCHES OPEN

N	IDLE	80	90	98	99	91	98	84	76	76	74	70	68	68
D	16	106*	112	117	118	115	111	109	110*	104*	98	96	92	89
D	32	110*	117	123	123	110	122*	112*	111*	109*	102*	101*	97	93
D	48	115*	121	125	125	110	123*	118*	118*	114*	108*	106*	101*	96
D	61	117*	122	125	126	112	116	123*	119*	115*	108*	107*	102*	98

HATCHES CLOSED

N	IDLE	79	85	93	96	94	87	85	76	76	73	70	68	68
D	16	106*	112	116	117	111	112	110	109*	104*	99	97	92	87
D	32	111*	118	123	124	108	123*	113*	113*	110*	103*	102*	96	94
D	48	117*	122	126	127	110	124*	120*	118*	115*	109*	107*	103*	98
D	61	117*	123	126	126	110	114	124*	118*	115*	108*	106*	102*	97

MAXIMUM ALLOWABLE LIMITS OF MIL-STD-1474B(MI), TABLE 2, CATEGORY B

100 121 111 103 102 - 100 100 100 100
*LEVELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY B

FIRING SCENARIO FOR 25-mm M242 CANNON

Test Condition	Hatches				Turret Position (mils)	Cannon Elevation (mils)
	Driver	Commander	Gunner	Cargo		
1	closed	closed	closed	closed	0	0
2	closed	closed	closed	closed	0	500
3	closed	closed	closed	closed	0	990
4	full open	full open	full open	straight up	4980	0
5	full open	full open	full open	straight up	4980	500
6	full open	full open	full open	straight up	4980	990
7	popped	full open	full open	popped	4980	0
8	popped	full open	full open	popped	4980	500
9	popped	full open	full open	popped	4980	990
10	full open	full open	full open	straight up	4390	0
11	full open	full open	full open	straight up	4390	500
12	full open	full open	full open	straight up	4390	990
13	popped	full open	full open	popped	4390	0
14	popped	full open	full open	popped	4390	500
15	popped	full open	full open	popped	4390	990
16	full open	full open	full open	straight up	2110	0
17	full open	full open	full open	straight up	2110	500
18	full open	full open	full open	straight up	2110	990
19	popped	full open	full open	popped	2110	0
20	popped	full open	full open	popped	2110	500
21	popped	full open	full open	popped	2110	990
22	full open	full open	full open	straight up	20	0
23	full open	full open	full open	straight up	20	300
24	full open	full open	full open	straight up	20	500
25	full open	full open	full open	straight up	20	990
26	popped	full open	full open	popped	20	0
27	popped	full open	full open	popped	20	300
28	popped	full open	full open	popped	20	500
29	popped	full open	full open	popped	20	990

PEAK SOUND PRESSURE LEVELS AND EXPOSURE LIMITS (M3A1)

<u>Position</u>	<u>Round</u>	<u>Peak (dB)</u>	<u>Duration</u>		<u>Test Condition</u>	<u>Maximum Allowable Exposures per Day</u>	
			<u>"A" (msec)</u>	<u>"B" (msec)</u>		<u>Single</u>	<u>Double</u>
Driver	1	145	6.98	170.94	1	> 1000	> 1000
	2	145	8.62	172.34	1	> 1000	> 1000
	3	145	6.66	171.68	1	> 1000	> 1000
Gunner	1	146	3.94	181.56	1	> 1000	> 1000
	2	145	4.68	181.26	1	> 1000	> 1000
	3	144	3.40	181.02	1	> 1000	> 1000
Left Rear	1	140	6.40	182.32	1	> 1000	> 1000
	2	139	5.50	182.76	1	> 1000	> 1000
	3	138	5.80	>200.00	1	> 1000	> 1000
Right Rear	1	141	5.70	152.76	1	> 1000	> 1000
	2	141	5.26	153.24	1	> 1000	> 1000
	3	140	6.12	154.32	1	> 1000	> 1000
Driver	1	144	1.36	195.94	2	> 1000	> 1000
	2	144	9.64	>200.00	2	> 1000	> 1000
	3	144	2.26	>200.00	2	> 1000	> 1000
Gunner	1	146	2.00	170.30	2	> 1000	> 1000
	2	146	1.93	170.66	2	> 1000	> 1000
	3	146	1.96	170.58	2	> 1000	> 1000
Left Rear	1	136	5.82	>200.00	2	> 1000	> 1000
	2	135	9.12	>200.00	2	> 1000	> 1000
	3	136	7.62	>200.00	2	> 1000	> 1000
Right Rear	1	140	1.34	158.30	2	> 1000	> 1000
	2	140	2.26	177.62	2	> 1000	> 1000
	3	139	2.20	169.04	2	> 1000	> 1000
Driver	1	142	7.88	>200.00	3	> 1000	> 1000
	2	143	8.64	>200.00	3	> 1000	> 1000
	3	142	8.06	188.22	3	> 1000	> 1000
Gunner	1	143	8.20	176.22	3	> 1000	> 1000
	2	143	8.24	176.54	3	> 1000	> 1000
	3	143	9.10	176.38	3	> 1000	> 1000
Left Rear	1	136	3.64	>200.00	3	> 1000	> 1000
	2	137	6.63	>200.00	3	> 1000	> 1000
	3	138	3.92	>200.00	3	> 1000	> 1000
Right Rear	1	135	10.02	>200.00	3	> 1000	> 1000
	2	138	7.50	176.28	3	> 1000	> 1000
	3	135	17.50	>200.00	3	> 1000	> 1000

PEAK SOUND PRESSURE LEVELS AND EXPOSURE LIMITS

<u>Position</u>	<u>Round</u>	<u>Peak (dB)</u>	<u>Duration</u>		<u>Test Condition</u>	<u>Maximum Allowable Exposures per Day</u>	
			<u>"A" (msec)</u>	<u>"B" (msec)</u>		<u>Single</u>	<u>Double</u>
Driver	1	166	0.94	44.13	4	> 1000	> 1000
	2	166	0.94	44.15	4	> 1000	> 1000
	3	165	0.92	61.27	4	> 1000	> 1000
Gunner	1	159	2.75	65.46	4	> 1000	> 1000
	2	160	2.31	65.30	4	> 1000	> 1000
	3	160	2.31	65.08	4	> 1000	> 1000
Left Rear	1	140	6.98	102.32	4	> 1000	> 1000
	2	140	7.04	102.46	4	> 1000	> 1000
	3	140	7.00	99.88	4	> 1000	> 1000
Right Rear	1	157	1.81	29.58	4	> 1000	> 1000
	2	157	0.50	19.32	4	> 1000	> 1000
	3	156	0.36	7.53	4	> 1000	> 1000
Driver	1	164	1.66	40.43	5	> 1000	> 1000
	2	163	1.81	30.84	5	> 1000	> 1000
	3	166	0.48	16.66	5	> 1000	> 1000
Gunner	1	161	2.18	45.89	5	> 1000	> 1000
	2	161	1.68	45.92	5	> 1000	> 1000
	3	162	1.70	45.83	5	> 1000	> 1000
Left Rear	1	156	1.93	81.12	5	> 1000	> 1000
	2	157	2.43	80.95	5	> 1000	> 1000
	3	157	2.01	81.01	5	> 1000	> 1000
Right Rear	1	163	1.76	29.52	5	> 1000	> 1000
	2	163	0.50	19.32	5	> 1000	> 1000
	3	166	0.44	9.25	5	> 1000	> 1000
Driver	1	162	1.60	30.63	6	> 1000	> 1000
	2	163	1.47	37.73	6	> 1000	> 1000
	3	165	1.56	28.44	6	> 1000	> 1000
Gunner	1	165	1.12	46.06	6	> 1000	> 1000
	2	165	1.54	46.03	6	> 1000	> 1000
	3	165	1.00	46.05	6	> 1000	> 1000
Left Rear	1	152	4.34	99.69	6	> 1000	> 1000
	2	152	4.45	99.56	6	> 1000	> 1000
	3	152	4.35	102.54	6	> 1000	> 1000
Right Rear	1	162	1.60	41.75	6	> 1000	> 1000
	2	162	1.71	39.45	6	> 1000	> 1000
	3	164	1.72	28.48	6	> 1000	> 1000

PEAK SOUND PRESSURE LEVELS AND EXPOSURE LIMITS

Position	Round	Peak (dB)	Duration		Test Condition	Maximum Allowable Exposures per Day	
			"A" (msec)	"B" (msec)		Single	Double
Driver	1	163	0.49	24.65	7	> 1000	> 1000
	2	163	0.49	23.74	7	> 1000	> 1000
	3	163	0.47	24.18	7	> 1000	> 1000
Gunner	1	165	2.00	79.41	7	747	> 1000
	2	165	2.34	79.45	7	746	> 1000
	3	166	2.22	78.96	7	635	> 1000
Left Rear	1	149	3.28	118.11	7	> 1000	> 1000
	2	149	2.85	117.27	7	> 1000	> 1000
	3	148	3.03	117.34	7	> 1000	> 1000
Right Rear	1	162	0.55	23.66	7	> 1000	> 1000
	2	163	0.53	41.71	7	> 1000	> 1000
	3	163	0.51	22.22	7	> 1000	> 1000
Driver	1	164	1.64	41.23	8	> 1000	> 1000
	2	164	1.69	41.30	8	> 1000	> 1000
	3	164	1.69	36.11	8	> 1000	> 1000
Gunner	1	168	1.95	44.86	8	504	> 1000
	2	168	2.04	44.83	8	553	> 1000
	3	168	2.15	44.95	8	503	> 1000
Left Rear	1	151	2.00	115.33	8	> 1000	> 1000
	2	151	3.33	115.35	8	> 1000	> 1000
	3	151	3.62	115.50	8	> 1000	> 1000
Right Rear	1	164	1.78	39.32	8	> 1000	> 1000
	2	164	1.72	40.26	8	> 1000	> 1000
	3	164	1.67	40.30	8	> 1000	> 1000
Driver	1	161	1.62	42.85	9	> 1000	> 1000
	2	160	1.62	43.34	9	> 1000	> 1000
	3	161	1.55	43.05	9	> 1000	> 1000
Gunner	1	165	1.02	45.55	9	> 1000	> 1000
	2	165	1.51	45.60	9	> 1000	> 1000
	3	165	0.97	45.49	9	> 1000	> 1000
Left Rear	1	153	2.28	113.26	9	> 1000	> 1000
	2	152	2.89	115.02	9	> 1000	> 1000
	3	152	2.93	113.44	9	> 1000	> 1000
Right Rear	1	160	1.84	43.32	9	> 1000	> 1000
	2	160	1.89	46.52	9	> 1000	> 1000
	3	160	1.70	43.29	9	> 1000	> 1000

PEAK SOUND PRESSURE LEVELS AND EXPOSURE LIMITS

Position	Round	Peak (dB)	Duration		Test Condition	Maximum Allowable Exposures per Day	
			"A" (msec)	"B" (msec)		Single	Double
Driver	1	160	2.65	>200.00	10	> 1000	> 1000
	2	160	0.80	>200.00	10	> 1000	> 1000
	3	159	2.29	>200.00	10	> 1000	> 1000
Gunner	1	158	3.72	65.53	10	> 1000	> 1000
	2	157	3.30	46.29	10	> 1000	> 1000
	3	158	3.24	46.29	10	> 1000	> 1000
Left Rear	1	157	0.71	87.48	10	> 1000	> 1000
	2	157	0.69	84.68	10	> 1000	> 1000
	3	157	0.75	85.24	10	> 1000	> 1000
Right Rear	1	166	1.60	25.20	10	> 1000	> 1000
	2	166	1.33	25.30	10	> 1000	> 1000
	3	166	1.09	26.42	10	> 1000	> 1000
Driver	1	159	2.35	>200.00	11	> 1000	> 1000
	2	160	2.55	>200.00	11	> 1000	> 1000
	3	159	2.30	>200.00	11	> 1000	> 1000
Gunner	1	160	2.48	45.75	11	> 1000	> 1000
	2	160	2.43	45.79	11	> 1000	> 1000
	3	160	2.50	45.76	11	> 1000	> 1000
Left Rear	1	158	1.05	62.81	11	> 1000	> 1000
	2	158	1.10	83.23	11	> 1000	> 1000
	3	158	1.03	83.23	11	> 1000	> 1000
Right Rear	1	166	1.50	26.19	11	> 1000	> 1000
	2	166	1.54	26.16	11	> 1000	> 1000
	3	166	1.65	31.85	11	> 1000	> 1000
Driver	1	165	1.10	>200.00	12	316	> 1000
	2	164	1.10	>200.00	12	457	> 1000
	3	162	1.10	>200.00	12	871	> 1000
Gunner	1	164	2.18	63.66	12	> 1000	> 1000
	2	163	2.11	70.00	12	> 1000	> 1000
	3	163	2.31	64.07	12	> 1000	> 1000
Left Rear	1	155	2.29	101.56	12	> 1000	> 1000
	2	155	2.38	101.74	12	> 1000	> 1000
	3	155	2.59	101.84	12	> 1000	> 1000
Right Rear	1	166	1.29	34.90	12	> 1000	> 1000
	2	166	1.27	34.89	12	> 1000	> 1000
	3	166	0.51	24.82	12	> 1000	> 1000

ACOUSTICAL TEST DATA

TIME: 1030	DATE: 20 MAR 1987	TEST ITEM: M1A1	
TEST CONDUCTED BY: P. PATTERSON	TEST ITEM OPERATOR: B. PARKER	REG./MODEL NO: A1	
SERIAL NO. A1	ODOMETER: 927	HOUR METER: 114	TEST ITEM CONDITION: COMBAT LOADED
TEMPERATURE: 8.8 Deg. C.	HUMIDITY: 36%	TEST SITE: PERRYMAN TEST COURSE	SURFACE: ASPHALT
TERRAIN: FLAT	BAROMETRIC PRESSURE: 1030.54 mb	SKY COVER: CLEAR	WIND DIRECTION: N
WIND VELOCITY: 9 KNOTS	TAPE RECORDER: R&K 7006	OCTAVE ANALYZER: B&K 2131	SCUND LEVEL METER:
MICROPHONE: B&K 4135	STATIONARY OPERATION HIGHWAY DRIVING DRIVE-BY 		

OCTAVE BAND CENTER FREQUENCIES (HZ)															
GEAR	RPM	SPEED KM/HR	dBA	dBB	dBC	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000

HATCHES OPEN

DRIVER

N	0	0	88	89	89	90	70	74	77	81	82	81	85	77	69
N	950	0	90	92	93	93	72	76	80	84	90	82	84	79	70
N	1350	0	92	93	93	94	76	79	79	84	85	86	87	79	70
D	1300	16	100	107	112	114	110	107	106	103	98	98	89	80	81
D	2200	32	105*	112	115	116	100	110	112*	109*	103*	97	93	91	87
D	2300	48	109*	117	121	121	99	117	116*	115*	106*	99	95	96	89
D	3000	64	111*	117	119	120	106	111	112*	116*	110*	102*	98	99	91
D	3100	69	113*	119	121	121	103	112	114*	118*	110*	103*	99	101*	92

LOADER

N	0	0	84	84	85	85	64	69	72	75	78	76	81	69	61
N	950	0	89	91	91	92	71	78	76	78	90	82	82	73	64
N	1350	0	88	90	90	91	76	79	77	77	87	82	82	77	65
D	1300	16	99	107	117	120	119	107	107	101	96	93	89	94	77
D	2200	32	104*	115	121	122	111	121	113*	107*	100	96	93	90	85
D	2300	48	108*	114	117	119	99	114	111	112*	105*	102*	99	96	90
D	3000	64	111*	115	118	120	108	110	113*	113*	109*	105*	99	93	86
D	3100	69	111*	116	118	119	107	110	114*	113*	106*	106*	99	94	87

MAXIMUM ALLOWABLE LIMITS OF CATEGORY B, TABLE 2 OF MIL-STD-1474B(III)

100 101 111 103 102 100 100 101 100
LEVELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY B

ACOUSTICAL TEST DATA

TIME: 1030	DATE: 20 MAR 1937	TEST ITEM: M1A1
TEST CONDUCTED BY: P. PATTERSON	TEST ITEM OPERATOR: B. PARKER	REG./MODEL NO: A1
SERIAL NO. A1	ODOMETER: 927	HOUR METER: 114
TEMPERATURE: 8.8 Deg. C.	HUMIDITY: 36%	TEST SITE: PERRYMAN TEST COURSE
TERRAIN: FLAT	BAROMETRIC PRESSURE: 1030.54 mb	SKY COVER: CLEAR
WIND VELOCITY: 9 KNOTS	TAPE RECORDER: B&K 7006	OCTAVE ANALYZER: B&K 2131
MICROPHONE: B&K 4155	STATIONARY OPERATION (X)	HIGHWAY DRIVING (X)
INTERIOR (X)	EXTERIOR ()	MICROPHONE LOCATION: AS DESCRIBED IN TABLE 2.4

OCTAVE BAND CENTER FREQUENCIES (HZ)															
GEAR	RPM	SPEED KM/HR	dBA	dBB	dBC	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000

HATCHES OPEN

COMMANDER

0	0	81	82	83	84	62	69	72	78	75	75	78	66	57
950	0	80	90	90	91	70	79	75	80	85	81	76	72	61
1350	0	89	92	93	94	84	83	80	82	91	80	78	74	64
1300	15	98	106	116	119	118	110	105	99	95	92	86	82	77
2200	32	103*	115	122	123	111	122*	112*	106*	99	94	90	87	85
2300	48	106*	113	117	118	99	116	109	110*	104*	99	95	92	87
3000	64	110*	117	120	121	107	113	117*	113*	108*	102*	96	91	86
3100	69	111*	118	121	122	106	113	119*	114*	109*	103*	95	92	87

GUNNER

0	0	83	83	84	84	55	68	73	76	76	78	79	71	61
950	0	84	87	87	88	55	70	66	68	87	72	74	66	57
1350	0	92	93	94	96	84	83	81	80	92	82	86	78	68
1300	16	98	104	111	113	110	107	104	97	95	93	89	86	77
2200	32	104*	112	118	119	105	117	112*	104*	100	97	93	91	84
2300	48	108*	114	117	118	94	112	115*	108*	105*	101*	98	95	88
3000	64	110*	114	116	117	101	108	112*	110*	110*	104*	99	94	86
3100	69	110*	114	116	117	99	108	112*	110*	109*	103*	99	96	87

MAXIMUM ALLOWABLE LIMITS OF CATEGORY B, TABLE 1 OF MIL-STD-1474B

100 121 111 103 102 100 100 100 100

ELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY B

ACOUSTICAL TEST DATA

TIME: 1030	DATE: 20 MAR 1987	TEST ITEM: M1A1
TEST CONDUCTED BY: P. PATTERSON	TEST ITEM OPERATOR: B. PARKER	REG./MODEL NO: A1
SERIAL NO. A1	ODOMETER: 927	HOUR METER: 114
TEMPERATURE: 0.8 Deg. C.	HUMIDITY: 36%	TEST SITE: PERRYMAN TEST COURSE
TERRAIN: FLAT	BAROMETRIC PRESSURE: 1030.54 mb	SKY COVER: CLEAR
WIND VELOCITY: 9 KNOTS	TAPE RECORDER: B&K 7006	OCTAVE ANALYZER: B&K 2131
MICROPHONE: B&K 4155	STATIONARY OPERATION (X) HIGHWAY DRIVING () DRIVE-BY ()	
INTERIOR (X)	EXTERIOR ()	MICROPHONE LOCATION: AS DESCRIBED IN TABLE 2.4

						OCTAVE BAND CENTER FREQUENCIES (Hz)									
GEAR	RPM	SPEED KM/HR	dBA	dBE	dBC	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000

HATCHES CLOSED

DRIVER

0	0	89	89	90	90	72	78	77	80	82	82	85	76	69
950	0	91	92	93	93	75	82	80	82	89	84	85	79	70
1350	0	91	92	92	93	75	81	80	83	87	84	87	80	73

LOADED

0	0	82	82	83	84	59	73	72	75	75	77	78	70	62
950	0	89	91	92	92	62	82	77	77	90	81	80	75	64
1350	0	89	91	91	92	63	81	78	77	89	83	82	74	65

COMMANDER

0	0	82	84	85	85	62	71	72	80	78	70	77	67	60
950	0	87	89	89	90	64	78	76	81	87	82	78	73	63
1350	0	87	89	90	90	66	80	76	82	87	81	79	76	64

GUNNER

0	0	83	83	84	85	56	71	74	76	76	76	78	70	62
950	0	93	95	95	95	58	79	77	77	94	82	85	77	65
1350	0	90	92	92	93	60	78	77	77	91	82	83	79	70

MAXIMUM ALLOWABLE LIMITS OF CATEGORY B, TABLE 2 OF MIL-STD-1474B(M1)

100 121 111 103 102 100 100 100 100 100

IMPULSE NOISE LEVELS

Rd No.	Condition	Interior Commander				Interior Loader				Interior Gunner			
		Firing Tank				Firing Tank				Firing Tank			
		P	B	S	D	P	B	S	D	P	B	S	D
1	Hatches open,	168	168	69	E	171	130	32	642	168	154	112	E
2	0 degree	167	159	113	E	170	130	53	E	167	156	122	E
3	elevation.	169	157	59	E	169	140	64	E	167	154	117	E
4		168	158	72	E	169	131	88	E	167	185	101	E
5		168	158	103	E	169	131	70	E	167	185	122	E
6	Hatches open,	168	127	96	E	169	131	77	E	168	155	97	E
7	17 degree	171	94	47	943	169	120	65	E	167	127	159	E
8	elevation.	171	95	41	817	171	119	35	692	168	126	97	E
9		170	95	78	E	170	121	62	E	169	126	84	E
10		171	94	47	942	170	118	63	E	168	127	106	E
11	Hatches	F	F	F	F	F	F	F	F	F	F	F	F
12	closed,	154	G	E	E	156	G	E	E	154	162	E	E
13	17 degree	154	G	E	E	152	G	E	E	153	G	E	E
14	elevation	151	G	E	E	155	187	E	E	152	G	E	E
15		156	161	E	E	153	163	E	E	155	153	E	E
16	Hatches	153	G	E	E	149	G	E	E	152	G	E	E
17	closed,	152	G	E	E	149	G	E	E	152	G	E	E
18	0 degree	152	G	E	E	149	G	E	E	152	G	E	E
19	elevation	152	G	E	E	148	G	E	E	153	199	E	E
20		154	G	E	E	150	G	E	E	153	197	E	E

Rd No.	Condition	Exterior Commander				Exterior Loader				Exterior Rear Deck			
		Firing Tank				Firing Tank				Firing Tank			
		P	B	S	D	P	B	S	D	P	B	S	D
1	Hatches open,	174	162	0	0	176	86	0	0	170	F	F	F
2	0 degree	174	75	13	266	175	56	16	315	170	55	170	E
3	elevation.	175	49	19	371	177	47	7	143	170	93	69	E
4		175	51	19	384	175	67	9	186	170	142	43	866
5		174	50	28	552	174	81	13	254	170	99	70	E
6	Hatches open,	175	78	10	202	173	93	17	332	173	142	12	239
7	17 degree	175	45	18	351	178	70	0	0	172	81	38	761
8	elevation.	177	42	7	146	181	58	0	0	172	63	49	971
9		175	44	17	339	179	41	0	0	173	83	20	390
10		177	43	8	162	179	43	0	0	172	176	11	226
11	Hatches	Data Not Collected								F	F	F	F
12	closed,									172	90	29	581
13	17 degree									173	57	34	674
14	elevation									172	95	22	449
15										172	107	21	419
16	Hatches	Data Not Collected								170	94	114	E
17	closed,									170	88	86	E
18	0 degree									169	129	71	E
19	elevation									170	103	76	E
20										169	130	85	E

Rd No.	Condition	Exterior Commander <u>Adjacent Tank</u>				Exterior Loader <u>Adjacent Tank</u>				Interior Driver <u>Firing Tank</u>			
		P	B	S	D	P	B	S	D	P	B	S	D
1	Hatches open,	175	33	28	581	176	49	13	255	169	142	63	E
2	0 degree	175	38	21	423	175	40	22	441	163	169	791	E
3	elevation.	176	59	10	191	177	48	8	162	169	145	51	E
4		176	39	11	229	175	56	14	272	169	142	57	E
5		176	47	12	240	175	89	8	161	169	142	57	E
6	Hatches open,	179	46	0	0	180	76	0	0	170	130	47	933
7	17 degree	178	41	0	0	180	37	0	0	170	87	70	E
8	elevation.	179	40	0	0	180	40	0	0	173	84	18	363
9		180	30	0	0	180	40	0	0	173	84	18	364
10		179	31	0	0	180	42	0	0	173	84	17	332
11	Hatches	F	F	F	F	F	F	F	F	F	F	F	F
12	closed,	179	45	0	0	180	109	0	0	163	132	954	E
13	17 degree	179	42	0	0	180	112	0	0	164	103	E	E
14	elevation	179	41	0	0	180	120	0	0	167	120	179	E
15		179	45	0	0	180	127	0	0	171	102	37	737
16	Hatches	173	47	36	728	175	193	0	0	172	124	18	359
17	closed,	175	48	15	309	175	183	0	0	157	130	E	E
18	0 degree	175	56	15	301	175	184	0	0	159	122	E	E
19	elevation	174	49	26	519	175	165	0	0	157	135	E	E
20		174	46	28	555	175	G	0	0	158	136	E	E

P = Peak magnitude (dB).

B = "B"-duration (msec).

S = Number of allowable exposures per day wearing single hearing protection.

D = Number of allowable exposures per day wearing double hearing protection.

E = Number of allowable exposures per day exceeds 1000.

F = Data unreducible or incomplete.

G = "B"-duration exceeds 200 milliseconds.

Environmental Conditions

24 May, 1600 Hours

Temperature 81 F, Humidity 66%

Pressure 1007 mb, Wind 9 knots

26 May, 1400 Hours

Temperature 66 F, Humidity 46%

Pressure 1200 mb, Wind 3 knots

NOTE: Round type and ammo lot number will be supplied by test director.

Impulse Noise Data

Position		Driver		Passenger		Gunner	
Muzzle ^a Direction	Rd No.	Peak	B-duration	Peak	B-duration	Peak	B-duration
		(dB)	(msec)	(dB)	(msec)	(dB)	(msec)
0°	1	168	26.15	168	30.07	163	30.35
	2	169	26.65	169	29.63	163	30.08
	3	168	25.47	168	29.91	163	29.75
	4	169	26.58	169	27.45	163	27.62
	5	168	28.10	168	23.16	162	29.83
	Avg.	168	26.59	168	28.04	163	29.53
30°	1	169	23.15	168	17.78	-	-
	2	170	23.42	167	18.30	157	25.81
	3	170	23.30	167	21.28	155	29.92
	4	170	21.96	168	22.50	153	36.26
	5	170	23.37	167	18.29	154	34.24
	Avg.	170	23.04	167	19.63	155	31.56
60°	1	170	18.95	157	26.98	155	26.54
	2	170	19.07	157	27.57	155	43.06
	3	170	18.90	158	27.02	155	51.05
	4	170	19.07	158	27.50	155	50.68
	5	170	18.95	158	27.92	155	46.50
	Avg.	170	18.99	158	27.40	155	43.57
90°	1	160	27.30	151	29.63	156	33.64
	2	160	30.14	151	30.62	156	64.67
	3	161	29.29	151	29.54	156	64.49
	4	160	30.28	151	28.63	156	58.35
	5	159	29.43	152	28.56	156	47.96
	Avg.	160	29.29	151	29.40	156	53.82

^aFront of vehicle oriented at 0°. Muzzle direction in clockwise direction.

Weapon: 20-mm Vulcan S/N 01 Ammo Lot No. LC 82J 281 012 (M246 HEIT-SD)
 Atmospheric Conditions: Temp 33 °C, Wind 6.0 Km/hr, Relative humidity 85%
 Barometric Pressure 1014mb

ACOUSTICAL TEST DATA

TIME: 1000 DATE: 26 July 85

TEST ITEM: Vulcan Wheeled Carrier TEST CONDUCTED BY: TEST ITEM OPERATOR: G. Powers
Patterson/Cleaver

REG./MODEL NO: SERIAL NO: ODOMETER: HOUR METER: TEST ITEM CONDITION:

TEMPERATURE: 31°C HUMIDITY: 78% TEST SITE: SURFACE: Dirt TERRAIN: Flat

BAROMETRIC PRESSURE: 1014mb SKY COVER: Clear STATIONARY OPERATION (X) HIGHWAY DRIVING () DRIVE-BY ()

WIND DIRECTION: NNE WIND VELOCITY: 5 Km/hr INTERIOR (X) EXTERIOR () TAPE RECORDER: B&K 7006 OCTAVE ANALYZER: B&K 2131

SOUND LEVEL METER: N/A MICROPHONE: B&K 4155 MICROPHONE LOCATION: As indicated with guns over right side (30° Azimuth, 0° elevation)

GEAR	PRM	SPEED km/hr	ALL			OCTAVE BAND CENTER FREQUENCY (in Hz)										REMARKS
			dBA	dBB	dBC	PASS	31	63	125	250	500	1k	2k	4k	8k	
Driver's Position																
			129	131	133	133	115	124	127	127	126	123	122	120	119	Burst #1
			128	131	132	132	109	124	126	126	125	123	121	120	119	Burst #2
			129	131	133	133	111	124	127	127	126	124	122	121	120	Burst #3
Passenger's Position																
			134	135	136	136	110	119	124	129	129	131	127	125	123	Burst #1
			135	136	137	137	114	120	124	130	130	131	128	125	124	Burst #2
			135	136	136	136	111	119	124	130	129	131	128	125	124	Burst #3
Gunner's Position																
			128	130	131	131	109	116	122	123	127	124	119	116	113	Burst #1
			129	131	131	131	107	115	122	124	127	124	120	116	113	Burst #2
			129	131	131	132	107	117	122	123	128	124	120	117	113	Burst #3

ACOUSTICAL TEST DATA

TIME: 1400	DATE: 26 MARCH 1987	TEST ITEM: M110A2 CREW BALLISTIC SHELTER
TEST CONDUCTED BY: E. RICHARDSON	TEST ITEM OPERATOR: SGT. ROSE	REG./MODEL NO: M110A2
SERIAL NO. #2	ODOMETER:	HOUR METER:
TEMPERATURE: 65 F	HUMIDITY: 46%	TEST SITE: PERRYMAN
TERRAIN: FLAT	BAROMETRIC PRESSURE: 1011 mb	SKY COVER: CLEAR
WIND VELOCITY: 6 KNOTS	TAPE RECORDER: B&K 7006	OCTAVE ANALYZER: B&K 2131
MICROPHONE: B&K 4155	STATIONARY OPERATION ()	HIGHWAY DRIVING (X)
INTERIOR (X)	EXTERIOR ()	MICROPHONE LOCATION: ASSISTANT GUNNER

OCTAVE BAND CENTER FREQUENCIES (HZ)														
YEAR	RPM	SPEED KM/HR	dBA	dBB	dBC	ALL PASS	31.5	63	125	250	500	1000	2000	4000

WINDOWS, DOORS AND REAR CANVAS OPEN

	IDLE	84	93	97	97	88	82	96	87	79	7-	70	63	56
1	8	97	101	103	104	91	95	97	100	93	92	87	79	68
2	16	101	105	109	110	101	101	104	104	98	95	92	86	76
3	24	103	109	114	115	102	113	106	106	100	97	93	88	79
4	32	104	109	113	114	97	110	107	107	100	97	93	87	79
5	40	105	110	113	114	98	108	107	108	102	98	94	88	79
6	48	105	111	113	114	99	106	108	109	103	97	96	89	82
7	56	108	114	116	116	100	105	112	112*	105	101	98	93	86

WINDOWS, DOORS AND REAR CANVAS CLOSED

	IDLE	86	94	97	98	91	85	94	92	79	75	70	63	55
1	8	104	108	111	113	105	103	106	106	100	99	96	89	80
2	16	104	110	114	116	113	106	107	108	100	93	95	88	80
3	24	107	114	119	121	114	117	109	112*	102	100	96	90	82
4	32	105	111	115	116	107	111	109	108	101	99	95	89	81
5	40	108	114	117	118	108	111	112	112*	104	101	98	91	81
6	48	108	114	117	119	110	111	113	112*	105	102	99	92	83
7	56	110*	116	119	120	110	109	116	114*	106	103	101	94	85

MAXIMUM ALLOWABLE LIMITS OF CATEGORY A, TABLE 2 OF MIL-STD-1474B(M1)

108
IS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY A

ACOUSTICAL TEST DATA

TIME: 1400	DATE: 26 MARCH 1987	TEST ITEM: M110A2 CREW BALLISTIC SHELTER
TEST CONDUCTED BY: E. RICHARDSON	TEST ITEM OPERATOR: SGT. ROSE	REG./MODEL NO: M110A2
SERIAL NO. #2	ODOMETER:	HOURLY METER: SEE BELOW
TEMPERATURE: 65 F	HUMIDITY: 46%	TEST SITE: PERRYMAN
TERRAIN: FLAT	BAROMETRIC PRESSURE: 1011 mb	SKY COVER: CLEAR
WIND VELOCITY: 6 KNOTS	TAPE RECORDER: B&K 7006	OCTAVE ANALYZER: B&K 2131
MICROPHONE: B&K 4155	STATIONARY OPERATION ()	HIGHWAY DRIVING (X)
INTERIOR (X)	EXTERIOR ()	MICROPHONE LOCATION: LOADER

						OCTAVE BAND CENTER FREQUENCIES (HZ)										
YEAR	RPM	SPEED KM/HR	dBA	dBB	dBC	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000	

WINDOWS, DOORS AND REAR CANVAS OPEN

	IDLE	82	90	94	96	91	82	93	83	79	75	69	61	56
R	8	98	103	106	107	90	97	101	102	94	93	89	83	72
R	16	102	107	111	112	99	104	108	102	99	96	93	88	78
R	24	104	110	114	115	102	113	109	104	102	99	95	90	81
R	32	104	110	114	115	100	111	109	104	102	99	95	90	81
R	40	105	110	113	115	100	110	109	104	103	100	96	90	81
R	48	106	110	114	116	104	109	110	105	104	101	96	90	82
R	56	108	113	116	118	108	108	113	108	106	102	99	93	86

WINDOWS, DOORS AND REAR CANVAS CLOSED

	IDLE	81	87	93	95	93	83	87	83	80	75	71	63	56
2	8	104	106	108	110	102	101	101	101	100	99	97	92	83
3	16	104	107	111	113	109	103	104	102	101	99	96	90	82
3	24	106	110	115	117	112	112	106	104	103	101	98	92	84
3	32	105	108	111	112	103	105	105	103	102	100	96	91	83
3	40	107	110	113	114	105	108	108	106	105	102	99	93	83
3	48	108	112	114	116	106	107	110	106	106	103	100	94	85
3	56	110*	114	116	117	106	106	113	108	108*	105	102	96	87

MAXIMUM ALLOWABLE LIMITS OF CATEGORY A, TABLE 2 OF MIL-STD-1274B(MI)

108	130	119	110	106	105	112	110	110
IS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY A								

ACOUSTICAL TEST DATA

TIME: 1400	DATE: 26 MARCH 1987	TEST ITEM: M110A2 CREW BALLISTIC SHELTER	
TEST CONDUCTED BY: E. RICHARDSON		TEST ITEM OPERATOR: SGT. ROSE	REG./MODEL NO: M110A2
SERIAL NO. #2	ODOMETER:	HOOR METER:	TEST ITEM CONDITION: SEE BELOW
TEMPERATURE: 65 F	HUMIDITY: 46%	TEST SITE: PERRYMAN	SURFACE: PAVED
TERRAIN: FLAT	BAROMETRIC PRESSURE: 1011 mb	SKY COVER: CLEAR	WIND DIRECTION: SE
WIND VELOCITY: 6 KNOTS	TAPE RECORDER: B&K 7006	OCTAVE ANALYZER: B&K 2131	SOUND LEVEL METER:
MICROPHONE: B&K 4155	STATIONARY OPERATION HIGHWAY DRIVING DRIVE-BY () () (X) ()		
INTERIOR (X)	EXTERIOR ()	MICROPHONE LOCATION: GUNNER	

						OCTAVE BAND CENTER FREQUENCIES (HZ)									
YEAR	RPM	SPEED KM/HR	dBA	dBB	dBC	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000

WINDOWS, DOORS AND REAR CANVAS OPEN

	IDLE	84	92	96	97	90	82	94	87	80	78	73	64	58
2	8	96	100	102	103	92	96	96	97	91	92	88	82	75
2	16	103	107	109	110	93	103	104	104	98	98	95	89	80
2	24	105	110	114	115	102	112	108	106	101	100	97	91	83
2	32	105	110	113	114	90	109	105	107	101	100	97	92	83
2	40	107	111	114	115	99	110	107	108	102	101	99	92	84
2	48	107	111	114	115	101	109	109	108	104	102	100	93	87
2	56	110*	114	117	118	105	106	112	112*	105	104	102	96	91

WINDOWS, DOORS AND REAR CANVAS CLOSED

	IDLE	85	93	98	100	97	84	95	87	79	79	74	65	57
2	8	105	106	109	115	104	103	101	101	99	101	98	92	84
2	16	105	109	112	114	107	105	106	105	101	100	99	92	83
2	24	107	112	117	119	112	115	108	107	102	102	100	93	85
2	32	106	110	113	115	107	108	107	106	102	101	98	92	84
2	40	108	112	115	117	108	111	109	108	104	103	101	94	85
2	48	110*	114	117	119	110	113	111	109	106	105	103	96	88
2	56	111*	115	117	118	110	108	112	111*	107*	106*	104	97	89

MAXIMUM ALLOWABLE LIMITS OF CATEGORY A, TABLE 2 OF MIL-STD-1474B(M1)

108
115 EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY A 130 119 110 106 105 112 110 110

ACOUSTICAL TEST DATA

TIME: 1400	DATE: 26 MARCH 1987	TEST ITEM: M110A2 CREW BALLISTIC SHELTER	
TEST CONDUCTED BY: E. RICHARDSON		TEST ITEM OPERATOR: SGT. ROSE	REG./MODEL NO: M110A2
SERIAL NO. #2	ODOMETER:	HOUR METER:	TEST ITEM CONDITION: SEE BELOW
TEMPERATURE: 65 F	HUMIDITY: 46%	TEST SITE: PERRYMAN	SURFACE: PAVED
TERRAIN: FLAT	BAROMETRIC PRESSURE: 1011 mb	SKY COVER: CLEAR	WIND DIRECTION: SE
WIND VELOCITY: 6 KNOTS	TAPE RECORDER: B&K 7006	OCTAVE ANALYZER: B&K 2131	SOUND LEVEL METER:
MICROPHONE: B&K 4155	STATIONARY OPERATION HIGHWAY DRIVING DRIVE-BY () () ()		
INTERIOR (X)	EXTERIOR ()	MICROPHONE LOCATION: COMMANDER	

						OCTAVE BAND CENTER FREQUENCIES (HZ)										
GEAR	RPM	SPEED KM/HR	dBA	dBB	dBC	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000	

WINDOWS, DOORS AND REAR CANVAS OPEN

	IDLE	87	95	98	98	89	83	56	91	83	79	75	67	61
1	8	98	104	106	106	88	96	102	102	95	92	89	83	75
2	16	105	110	113	114	95	104	109	109	101	98	96	92	83
3	24	108	114	117	117	99	109	113	112*	104	100	97	94	85
4	32	108	114	116	117	95	110	111	112*	104	101	98	94	85
5	40	109*	115	117	117	95	107	112	113*	106	101	99	95	87
6	48	110*	115	117	118	96	110	114	112*	107*	102	101	96	92
7	56	112*	118	120	121	98	107	117	116*	109*	105	103	99	97

WINDOWS, DOORS AND REAR CANVAS CLOSED

	IDLE	87	96	100	101	93	81	99	90	83	78	73	64	57
1	8	105	108	110	111	98	100	105	103	102	100	99	93	84
2	16	106	111	113	114	101	102	109	108	104	100	98	91	83
3	24	108	112	115	116	105	110	110	110	106	102	99	93	84
4	32	107	112	114	115	99	106	110	109	104	101	98	93	84
5	40	109*	114	116	117	101	106	112	112*	107*	103	101	94	84
6	48	111*	115	118	118	102	110	114	113*	108*	105	102	96	88
7	56	112*	117	119	120	102	106	116	114*	109*	106*	103	97	89

MAXIMUM ALLOCABLE LIMITS OF CATEGORY A, TABLE 2 OF MIL-STD-1474B(M1)

108
130 119 110 106 105 112 110 110
115 EXCEEDING MAXIMUM ALLOCABLE LIMITS OF CATEGORY A

ACOUSTICAL TEST DATA

TIME: 1330		DATE: 20 MARCH 89		TEST ITEM: M60											
TEST CONDUCTED BY: R. WALRATH			TEST ITEM OPERATOR: D. KESTLER		REG./MODEL NO: 970										
SERIAL NO.		ODOMETER: 1702	HOUR METER: 121.7		TEST ITEM CONDITION: COMBAT WEIGHT										
TEMPERATURE: 45 DEGREES F		HUMIDITY: 45%	TEST SITE: PERRYMAN		SURFACE: PAVED										
TERRAIN: LEVEL		BAROMETRIC PRESSURE: 1026.4 MILIBARS		SKY COVER: OVERCAST	WIND DIRECTION: SW										
WIND SPEED: 10 KNOTS		TAPE RECORDER: RACAL		OCTAVE ANALYZER: B&K 2131	SCUND LEVEL METER:										
MICROPHONE: B&K 4155		STATIONARY OPERATION ()		HIGHWAY DRIVING (X)	DRIVE-BY ()										
INTERIOR (X)		EXTERIOR ()		MICROPHONE LOCATION: DRIVER'S HELMET											

OCTAVE BAND CENTER FREQUENCIES (HZ)															
GEAR	RPM	SPEED KM/HR	dBA	dBB	dBC	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000

HATCHES OPEN

N	IDLE	85	90	94	95	93	85	87	86	83	79	78	72	65
D	8	94	99	104	105	101	99	98	94	93	88	86	78	73
D	16	101*	107	111	112	108	105	107	102	100	94	91	87	79
D	24	108*	112	119	121	120	108	110	107*	106*	101*	99	97	91
D	32	108*	114	118	119	107	116	111	109*	106*	103*	97	94	87
D	40	109*	114	116	116	104	105	111	110*	110*	101*	96	93	87
D	48	113*	117	119	119	105	108	112*	114*	114*	106*	98	94	86
D	49	113*	117	119	119	104	111	113*	113*	114*	106*	98	95	86

HATCHES CLOSED

N	IDLE	86	91	95	96	92	85	90	88	84	78	77	74	66
D	8	95	101	106	107	101	100	102	96	93	88	84	78	77
D	16	103*	108	112	112	103	101	110	104*	99	97	94	90	82
D	24	108*	113	116	117	112	109	112*	107*	106*	102*	100	98	91
D	32	109*	114	117	117	107	109	113*	112*	106*	103*	98	95	89
D	40	111*	115	118	118	108	104	115*	111*	111*	103*	97	94	87
D	48	113*	118	120	120	107	108	115*	116*	112*	105*	98	95	87
D	49	114*	119	121	121	110	106	117*	116*	114*	106*	99	95	88

MAXIMUM ALLOWABLE LIMITS OF MIL-STD-1474B(M1), TABLE 2, CATEGORY B

100

121

111

103

102

100

100

100

100

*LEVELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY B

ACOUSTICAL TEST DATA

TIME: 1330	DATE: 20 MARCH 89	TEST ITEM: M60
TEST CONDUCTED BY: R. WALRATH	TEST ITEM OPERATOR: D. KESTLER	REG./MODEL NO: 970
SERIAL NO.	ODOMETER: 1702	HOUR METER: 121.7
TEMPERATURE: 45 DEGREES F	HUMIDITY: 45%	TEST SITE: PERRYMAN
TERRAIN: LEVEL	BAROMETRIC PRESSURE: 1026.4 MILIBARS	SKY COVER: OVERCAST
WIND SPEED: 10 KNOTS	TAPE RECORDER: RACAL	OCTAVE ANALYZER: B&K 2131
MICROPHONE: B&K 4155	STATIONARY OPERATION HIGHWAY DRIVING DRIVE-BY () (X) ()	
INTERIOR (X)	EXTERIOR ()	MICROPHONE LOCATION: LOADER'S HELMET

						OCTAVE BAND CENTER FREQUENCIES (HZ)									
GEAR	RPM	SPEED KM/HR	dBA	dBB	dBC	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000

HATCHES OPEN

	IDLE	83	91	96	97	93	87	93	86	81	75	72	64	62
	8	95	100	104	106	102	98	99	95	92	89	87	80	75
)	16	100	108	113	114	110	106	109	102	97	94	90	85	78
)	24	108*	112	118	120	118	108	110	106*	104*	101*	101*	97	91
)	32	109*	113	117	117	104	112	112*	109*	106*	103*	100	96	91
)	40	108*	112	114	115	104	101	110	109*	108*	102*	95	89	82
)	48	111*	116	119	119	103	107	116*	112*	112*	104*	97	91	84
)	49	111*	116	119	119	102	108	116*	112*	111*	106*	97	91	84

HATCHES CLOSED

	IDLE	83	91	95	96	90	87	93	86	81	75	72	64	62
)	8	93	99	104	105	98	99	100	95	92	86	84	77	73
)	16	101*	109	113	113	99	107	111	102	97	94	90	83	74
)	24	106*	110	114	115	110	110	108	103	104*	100	98	93	84
)	32	108*	112	114	114	99	104	108	109*	105*	102*	98	94	87
)	40	108*	112	114	114	99	98	109	108*	109*	103*	95	87	79
)	48	110*	114	116	116	98	102	110	112*	110*	103*	96	87	79
)	49	113*	117	119	120	103	111	114*	114*	112*	107*	100	92	85

MAXIMUM ALLOWABLE LIMITS OF MIL-STD-1474B(MI), TABLE 2, CATEGORY B

100 121 111 103 102 100 100 100 100
 LEVELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY B

ACOUSTICAL TEST DATA

TIME: 1330	DATE: 20 MARCH 89	TEST ITEM: M60
TEST CONDUCTED BY: R. WALRATH	TEST ITEM OPERATOR: D. KESTLER	REG./MODEL NO: 970
SERIAL NO.	ODOMETER: 1702	HOUR METER: 121.7
TEMPERATURE: 45 DEGREES F	HUMIDITY: 45%	TEST SITE: PERRYMAN
TERRAIN: LEVEL	BAROMETRIC PRESSURE: 1026.4 MILIBARS	SKY COVER: OVERCAST
WIND SPEED: 10 KNOTS	TAPE RECORDER: RACAL	OCTAVE ANALYZER: B&K 2131
MICROPHONE: B&K 4155	STATIONARY OPERATION HIGHWAY DRIVING DRIVE-BY () (X) ()	
INTERIOR (X)	EXTERIOR ()	MICROPHONE LOCATION: COMMANDER'S POSITION

OCTAVE BAND CENTER FREQUENCIES (HZ)															
GEAR	RPM	SPEED KM/HR	dBA	dBB	dBC	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000

HATCHES OPEN

V	IDLE	83	93	97	98	89	89	96	82	80	71	67	61	59
J	8	96	102	107	108	102	102	104	92	91	89	90	83	80
D	16	100	109	114	115	109	109	112*	97	96	92	91	88	85
D	24	110*	114	118	119	114	110	115*	104*	105*	102*	106*	102*	96

HATCHES CLOSED

N	IDLE	84	94	98	98	84	93	96	88	80	75	70	63	60
D	8	95	102	108	108	93	106	104	96	91	87	86	81	77
D	16	102*	110	114	115	96	107	113*	103	96	95	91	86	80
D	24	107*	112	117	118	110	115	113*	105*	101	101*	100	96	90

MAXIMUM ALLOWABLE LIMITS OF MIL-STD-1474B(M1), TABLE 2, CATEGORY B

100	121	111	103	102	100	100	100	100	100
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VELS EXCEEDING MAXIMUM ALLOWABLE LIM' CATEGORY B

ACOUSTICAL TEST DATA

TIME: 1300		DATE: 28 APRIL 89		TEST ITEM: M109 (HIP) HOWITZER	
TEST CONDUCTED BY: P. PATTERSON		TEST ITEM OPERATOR: S. SPANGLER		REG./MODEL NO: A3E2	
SERIAL NO. 2207		ODOMETER: 146		HOUR METER: 81.4	
TEMPERATURE: 18 DEGREES C		HUMIDITY: 33%		TEST ITEM CONDITION: COMBAT LOADED	
TERRAIN: LEVEL		BAROMETRIC PRESSURE: 1013 MILLIBARS		SKY COVER: PARTLY CLOUDLY	
WIND SPEED: 5 KNOTS		TAPE RECORDER: B&K 7006		OCTAVE ANALYZER: B&K 2131	
MICROPHONE: B&K 4155		STATIONARY OPERATION (X)		HIGHWAY DRIVING (X)	
INTERIOR (X)		EXTERIOR ()		MICROPHONE LOCATION: DRIVERS POSITION	

OCTAVE BAND CENTER FREQUENCIES (HZ)					
GEAR	RPM	SPEED KM/HR	dBA	dBB	dBC
			ALL PASS	31.5	63
				125	250
				500	1000
				2000	4000
				8000	

AMBIENT

58 59 64 70 64 56 55 47 48 54 48 50 53

HATCHES OPEN; NO EQUIPMENT ON

N 800 94 99 102 102 84 94 99 92 90 90 85 80 80

HATCHES OPEN; VENT BLOWER ON "INTAKE"

N 800 97 100 103 103 84 90 101 92 94 93 87 80 80

HATCHES OPEN; MCS ON "COOL"

N 800 97 100 103 103 83 92 100 93 94 93 88 81 80

HATCHES OPEN; MCS ON "COOL"; VENT BLOWER ON "INTAKE"; HYDRAULICS ON

N 800 97 100 102 103 85 96 99 92 94 94 88 82 80

HATCHES OPEN; MCS ON "COOL"; VENT BLOWER ON "INTAKE"

D	5	100	105	107	107	92	97	103	102	96	96	90	82	80
D	10	104*	106	109	109	99	103	103	100	101	100	94	90	90
D	15	108*	110	113	114	108	104	102	105*	105*	106*	98	91	90
D	20	109*	112	113	114	104	105	104	106*	108*	106*	100	92	90
D	25	114*	116	119	120	112	113	108	110*	112*	110*	104*	100	100
D	30	112*	115	118	119	104	114	108	111*	110*	107*	101*	94	90
D	35	114*	116	118	118	111	111	108	112*	112*	110*	104*	100	100

MAXIMUM ALLOWABLE LIMITS OF MIL-STD-1474B(MI), TABLE 2, CATEGORY B

100 121 111 103 102 100 100 100 100

*LEVELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY B

ACOUSTICAL TEST DATA

TIME: 1330	DATE: 20 MARCH 89	TEST ITEM: M60	
TEST CONDUCTED BY: R. VALRATH		TEST ITEM OPERATOR: D. KESTLER	REG./MODEL NO: 970
SERIAL NO.	ODOMETER: 1702	HOUR METER: 121.7	TEST ITEM CONDITION: COMBAT WEIGHT
TEMPERATURE: 45 DEGREES F	HUMIDITY: 45%	TEST SITE: PERRYMAN	SURFACE: PAVED
TERRAIN: LEVEL	BAROMETRIC PRESSURE: 1026.4 MILIBARS	SKY COVER: OVERCAST	WIND DIRECTION: SV
WIND SPEED: 10 KNOTS	TAPE RECORDER: RACAL	OCTAVE ANALYZER: B&K 2131	SOUND LEVEL METER:
MICROPHONE: B&K 4155	STATIONARY OPERATION HIGHWAY DRIVING DRIVE-BY () (X) ()		
INTERIOR (X)	EXTERIOR ()	MICROPHONE LOCATION: GUNNER'S POSITION	

						OCTAVE BAND CENTER FREQUENCIES (HZ)									
GEAR	RPM	SPEED KM/HR	dBA	dBB	dBC	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000

HATCHES OPEN

N	IDLE	86	96	100	101	94	93	98	91	82	73	68	60	60
D	8	98	105	110	110	104	106	105	100	93	91	90	78	72
D	16	103*	112	118	119	115	112	114*	107*	98	93	88	81	76
D	24	109*	117	122	124	121	113	118*	114*	105*	101*	99	93	88
D	32	109*	116	120	121	108	116	114*	114*	106*	101*	97	92	87
D	40	110*	117	120	120	107	111	117*	114*	108*	102*	93	85	80
D	48	115*	121	124	124	108	115	122*	117*	115*	105*	96	87	82
D	49	114*	121	125	125	106	120	122*	118*	111*	105*	95	87	82

HATCHES CLOSED

N	IDLE	87	97	101	102	90	93	100	91	81	75	69	60	60
D	8	95	103	108	109	101	105	104	99	92	86	82	74	71
D	16	103*	113	117	117	104	110	115*	107*	98	94	89	81	76
D	24	108*	115	120	121	116	114	116*	111*	105*	101*	98	92	86
D	32	110*	116	119	119	105	113	114*	114*	107*	103*	98	93	89
D	40	111*	117	120	120	105	113	117*	113*	110*	103*	94	86	81
D	48	114*	121	126	127	105	125*	119*	117*	113*	105*	96	88	83
D	49	117*	124	128	128	108	125*	120*	123*	112*	109*	97	88	83

MAXIMUM ALLOWABLE LIMITS OF MIL-STD-1474B(M1), TABLE 2, CATEGORY B

LEVELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY B 100 121 111 103 102 100 100 100 100

Impulse Noise Data for M60 Tank Firing 105-mm M456A2 HEAT Projectiles^a

TRIAL	POSITION 1			POSITION 2			POSITION 3			POSITION 4		
	DURATION		PEAK (dB)	DURATION		PEAK (dB)	DURATION		PEAK (dB)	DURATION		PEAK (dB)
	A	B		A	B		A	B		A	B	
1	169	5.79	54.20	170	6.27	63.49	164	9.33	88.72	161	28.44	139.30
2	168	6.23	62.30	169	6.30	63.05	166	9.91	74.55	160	28.66	158.48
3	169	5.97	61.57	169	6.09	58.15	164	9.10	88.65	160	27.96	160.32
4	168	6.08	59.94	169	6.10	62.38	165	9.39	87.88	160	28.20	143.38
5	168	5.92	63.94	169	6.14	62.98	166	9.46	86.16	160	28.78	150.86
AVG.	168	6.00	60.39	169	6.18	62.01	165	9.44	85.19	160	28.41	150.47

TRIAL	POSITION 5			POSITION 6			POSITION 7 ^b	POSITION 8		POSITION 9
	PEAK (dB)	DURATION (mS)		PEAK (dB)	DURATION (mS)			PEAK (dB)	PEAK (dB)	
		A	B		A	B				
1	163	18.44	165.92	161	31.02	162.74	-----	166	161	
2	163	17.88	167.18	160	30.68	153.00	-----	165	161	
3	162	17.54	164.14	161	24.96	152.56	-----	166	163	
4	163	17.16	163.92	160	29.94	151.76	-----	165	162	
5	163	17.82	163.24	160	31.08	151.98	-----	165	161	
AVG.	163	17.77	164.88	161	29.54	154.41	-----	165	162	

^a POSITION 1,2= 3 meters (10 ft) to the left (position 1) and right (position 2) of the rear corners of the tank, 1.5 meters (5 ft) above the ground.

POSITION 3 = Commander's Head Position (80 cm above seat)
 POSITION 4 = Loader's Head Position (80 cm above seat)
 POSITION 5 = Driver's Head Position (15 cm forward of driver's headrest)
 POSITION 6 = Gunner's Head Position (80 cm above seat)
 POSITION 7 = Commander's Head Position, Open Hatch Configuration (30 cm above hatch plane)
 POSITION 8 = 12.2 meters (40 ft) from tank along 225° (magnetic) radial relative to the center of the tank (tube at 0°), 1.5 meters (5 ft) above the ground.
 POSITION 9 = 24.4 meters (80 ft) from tank along 225° (magnetic) radial relative to the center of the tank (tube at 0°), 1.5 meters (5 ft) above the ground.

Note: Hatches for the Loader and Commander were open. Driver's hatch was closed.

^bNo valid data due to blast gage malfunction.

IMPULSE NOISE LEVELS (INTERIOR)

Position	Round No.											
	1				2				3			
	P ^a	B ^b	S ^c	D ^d	P ^a	B ^b	S ^c	D ^d	P ^a	B ^b	S ^c	D ^d
<u>Zone 5 - 800 mils</u>												
Commander	e -	-	-	-	159	>200.00	>1K	>1K	161	84.44	>1K	>1K
Loader	161	174.16	>1K	>1K	160	87.68	>1K	>1K	160	99.02	>1K	>1K
Gunner	160	88.94	>1K	>1K	159	81.64	>1K	>1K	158	91.96	>1K	>1K
Asst. Gunner	159	>200.00	>1K	>1K	159	128.78	>1K	>1K	-	-	-	-
<u>Zone 5 - 1069 mils</u>												
Commander	158	>200.00	>1K	>1K	159	195.60	>1K	>1K	158	>200.00	>1K	>1K
Loader	159	155.36	>1K	>1K	159	>200.00	>1K	>1K	159	>200.00	>1K	>1K
Gunner	158	143.38	>1K	>1K	158	179.88	>1K	>1K	158	166.62	>1K	>1K
Asst. Gunner	159	167.64	>1K	>1K	158	>200.00	>1K	>1K	157	>200.00	>1K	>1K
<u>Zone 9 - 200 mils</u>												
Commander	166	77.78	638	>1K	166	76.09	688	>1K	166	77.66	701	>1K
Loader	166	177.36	204	>1K	166	87.72	432	>1K	166	98.52	406	>1K
Gunner	166	96.56	380	>1K	167	82.18	374	>1K	166	78.26	480	>1K
Asst. Gunner	167	>200.00	120	>1K	168	135.32	133	>1K	168	>200.00	69	>1K
<u>Zone 9 - 800 mils</u>												
Commander	168	82.26	236	>1K	169	115.76	104	>1K	168	93.48	166	>1K
Loader	168	96.78	138	>1K	168	92.92	159	>1K	170	96.98	83	>1K
Gunner	167	82.76	354	>1K	167	83.44	367	>1K	167	129.08	171	>1K
Asst. Gunner	-	-	-	-	-	-	-	-	-	-	-	-
<u>Zone 9 - 1069 mils</u>												
Commander	168	188.88	75	>1K	168	73.22	263	>1K	166	>200.00	174	>1K
Loader	168	83.28	184	>1K	168	98.20	178	>1K	169	147.68	72	>1K
Gunner	166	111.88	328	>1K	166	124.64	311	>1K	166	141.58	209	>1K
Asst. Gunner	-	-	-	-	-	-	-	-	-	-	-	-

^a Peak decibels (dB)

^b "B" - duration (msec)

^c Maximum number of rounds allowed with single hearing protection.

^d Maximum number of rounds allowed with double hearing protection.

^e "-" indicates data were lost during recording.

ACOUSTICAL TEST DATA

TIME: 1300	DATE: 28 APRIL 89	TEST ITEM: M109 (HIP) HOWITZER
TEST CONDUCTED BY: P. PATTERSON	TEST ITEM OPERATOR: S. SPANGLER	REG./MODEL NO: A3E2
SERIAL NO. 2207	ODOMETER: 146	HOUR METER: 81.4
TEMPERATURE: 18 DEGREES C	HUMIDITY: 33%	TEST ITEM CONDITION: COMBAT LOADED
TERRAIN: LEVEL	BAROMETRIC PRESSURE: 1013 MILLIBARS	SKY COVER: PARTLY CLOUDLY
WIND SPEED: 5 KNOTS	TAPE RECORDER: B&K 7006	OCTAVE ANALYZER: B&K 2131
MICROPHONE: B&K 4155	STATIONARY OPERATION (X)	HIGHWAY DRIVING (X)
INTERIOR (X)	EXTERIOR ()	MICROPHONE LOCATION: LEFT CANNONEER SEAT

OCTAVE BAND CENTER FREQUENCIES (HZ)		
GEAR	RPM	SPEED KM/HR
		dBA dBB dBC
		ALL PASS
		31.5 63 125 250 500 1000 2000 4000 8000

AMBIENT

		57	58	63	67	63	57	51	42	46	54	46	48	51
		HATCHES OPEN; NO EQUIPMENT ON												
N	800	84	88	91	92	85	85	86	81	82	80	72	70	70
		HATCHES OPEN; VENT BLOWER ON "INTAKE"												
N	800	93	94	95	96	85	82	90	82	86	91	86	74	70
		HATCHES OPEN; MCS ON "COOL"												
N	800	88	91	93	94	84	86	88	84	87	83	80	75	70
		HATCHES OPEN; MCS ON "COOL"; VENT BLOWER ON "INTAKE"; HYDRAULICS ON												
N	800	96	97	99	99	85	92	94	86	89	93	80	80	80
		HATCHES OPEN; MCS ON "COOL"; VENT BLOWER ON "INTAKE"												
D	5	95	97	101	103	100	92	91	91	91	92	87	80	80
D	10	99	101	105	110	104	98	95	95	95	94	90	90	90
D	15	101*	107	118	121	121	101	100	100	99	95	92	90	90
D	20	104*	108	112	114	109	107	105	100	104*	98	95	90	90
D	25	111*	114	118	120	114	115	109	108*	110*	105*	102*	100	100
D	30	109*	113	115	116	106	106	108	105*	109*	103*	100	92	90
D	35	111*	114	116	116	108	109	109	109*	109*	104*	101*	100	100

MAXIMUM ALLOWABLE LIMITS OF MIL-STD-1474B(M1) TABLE 2, CATEGORY B

100

121 111 103

104

100

100

100

100

100

*LEVELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY B

ACOUSTICAL TEST DATA

TIME: 1300	DATE: 28 APRIL 89	TEST ITEM: M109 (HIP) HOWITZER
TEST CONDUCTED BY: P. PATTERSON	TEST ITEM OPERATOR: S. SPANGLER	REG./MODEL NO: A3E2
SERIAL NO. 2207	ODOMETER: 146	HOUR METER: 81.4
TEMPERATURE: 18 DEGREES C	HUMIDITY: 33%	TEST SITE: PERRYMAN TEST COURSE
TERRAIN: LEVEL	BAROMETRIC PRESSURE: 1013 MILLIBARS	SKY COVER: PARTLY CLOUDY
WIND SPEED: 5 KNOTS	TAPE RECORDER: B&K 7006	OCTAVE ANALYZER: B&K 2131
MICROPHONE: B&K 4155	STATIONARY OPERATION (X)	HIGHWAY DRIVING (X)
INTERIOR (X)	EXTERIOR ()	MICROPHONE LOCATION: RIGHT CANNONEERS SEAT

OCTAVE BAND CENTER FREQUENCIES (HZ)		
GEAR	RPM	SPEED KM/HR
		dBa
		dBb
		dBc
		ALL PASS
		31.5
		63
		125
		250
		500
		1000
		2000
		4000
		8000

AMBIENT														
		58	57	58	65	44	50	47	43	45	52	48	50	54
HATCHES OPEN; NO EQUIPMENT ON														
N	800	85	87	89	90	67	77	82	82	84	81	71	62	61
HATCHES OPEN; VENT BLOWER ON "INTAKE"														
N	800	96	96	96	97	66	81	83	82	89	94	87	73	64
HATCHES OPEN; MCS ON "COOL"														
N	800	91	93	94	94	66	81	81	84	92	84	80	71	66
HATCHES OPEN; MCS ON "COOL"; VENT BLOWER ON "INTAKE"; HYDRAULICS ON														
N	800	97	98	98	99	74	85	90	85	93	95	88	78	71
HATCHES OPEN; MCS ON "COOL"; VENT BLOWER ON "INTAKE"														
D	5	97	99	100	100	77	91	91	93	94	94	88	77	72
D	10	99	101	102	102	87	94	91	94	97	95	89	82	80
D	15	102*	105	107	107	97	100	96	101	101	95	92	83	80
D	20	105*	108	110	110	96	104	99	104*	105*	99	95	85	81
D	25	111*	113	115	116	105	108	103	108*	110*	106*	102*	93	90
D	30	110*	114	115	116	91	109	103	110*	110*	105*	100	90	82
D	35	111*	114	116	117	93	113	105	110*	110*	105*	101*	94	91

MAXIMUM ALLOWABLE LIMITS OF MIL-STD-1474B(MI), TABLE 2, CATEGORY B
 100 121 111 103 102 100 100 100 100
 LEVELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY B

ACOUSTICAL TEST DATA

TIME: 1300	DATE: 28 APRIL 89	TEST ITEM: M109 (HIP) HOWITZER
TEST CONDUCTED BY: P. PATTERSON	TEST ITEM OPERATOR: S. SPANGLER	REG./MODEL NO: A3E2
SERIAL NO. 2207	ODOMETER: 146	HOUR METER: 81.4
TEMPERATURE: 18 DEGREES C	HUMIDITY: 33%	TEST ITEM CONDITION: COMBAT LOADED
TERRAIN: LEVEL	BAROMETRIC PRESSURE: 1013 MILLIBARS	SKY COVER: PARTLY CLOUDY
WIND SPEED: 5 KNOTS	TAPE RECORDER: B&K 7006	SOUND LEVEL METER: B&K 2131
MICROPHONE: B&K 4155	STATIONARY OPERATION (X)	HIGHWAY DRIVING (X)
INTERIOR (X)	EXTERIOR ()	MICROPHONE LOCATION: COMMANDER'S POSITION

OCTAVE BAND CENTER FREQUENCIES (HZ)		
GEAR	RPM	SPEED KM/HR
		dBA dBB dBC
		ALL PASS
		31.5 63 125 250 500 1000 2000 4000 8000

AMBIENT

N		57	58	61	65	52	55	56	45	45	50	48	50	53
HATCHES OPEN; NO EQUIPMENT ON														
N	800	86	92	95	95	74	83	94	85	84	82	74	70	70
HATCHES OPEN; VENT BLOWER ON "INTAKE"														
N	800	94	96	98	98	74	83	94	84	87	92	88	77	70
HATCHES OPEN; MCS ON "COOL"														
N	800	94	97	98	99	75	89	92	86	95	86	86	78	70
HATCHES OPEN; MCS ON "COOL"; VENT BLOWER ON "INTAKE"; HYDRAULICS ON														
N	800	98	99	101	101	82	92	94	89	94	95	90	82	80
HATCHES OPEN; MCS ON "COOL"; VENT BLOWER ON "INTAKE"														
D	5	98	100	102	102	88	95	94	94	96	94	90	82	80
D	10	101*	104	107	107	94	100	103	95	98	95	92	90	90
D	15	103*	107	111	113	107	107	105	103	102	97	94	90	90
D	20	106*	111	114	114	99	109	108	106*	106*	100	97	90	90
D	25	109*	112	114	115	103	107	109	106*	108*	104*	101*	96	90
D	30	111*	115	118	118	97	112	112*	111*	111*	105*	101*	94	90
D	35	112*	116	119	120	101	116	112*	112*	111*	106*	103*	100	100

MAXIMUM ALLOWABLE LIMITS OF MIL-STD-1474-1 (PART 2, CATEGORY 1)
100 121 111 111 102 100 100 100 100 100

*LEVELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY: B

IMPULSE NOISE LEVELS OF THE M109A2 HELP HOWITZER

	<u>Crew Positions</u>				
	<u>Commander</u>	<u>Driver</u>	<u>Gunner</u>	<u>Loader</u>	<u>Assistant Gunner</u>
<u>Round 1</u>					
Peak (dB)	146	162	157	158	161
B Duration (msec)	200	172.9	200	194.6	196.1
Single ^a	1000	1000	1000	1000	1000
Double ^b	1000	1000	1000	1000	1000
<u>Round 2</u>					
Peak (dB)	148	162	160	157	160
B Duration (msec)	200	173.6	200	200	200
Single ^a	1000	1000	1000	1000	1000
Double ^b	1000	1000	1000	1000	1000
<u>Round 3</u>					
Peak (dB)	149	162	162	160	162
B Duration (msec)	200	118.1	200	200	200
Single ^a	1000	1000	1000	1000	1000
Double ^b	1000	1000	1000	1000	1000
<u>Round 4</u>					
Peak (dB)	149	162	160	158	161
B Duration (msec)	200	158	200	200	200
Single ^a	1000	1000	1000	1000	1000
Double ^b	1000	1000	1000	1000	1000
<u>Round 5 Peak (dB)</u>					
Peak (dB)	149	163	161	158	162
B Duration (msec)	200	126	200	200	200
Single ^a	1000	1000	1000	1000	1000
Double ^b	1000	1000	1000	1000	1000

- ^a Single hearing protection.
^b Double hearing protection.

ACOUSTICAL TEST DATA

TIME: 1350	DATE: 26 AUGUST 86	TEST ITEM: LIGHT ARMOR VEHICLE													
TEST CONDUCTED BY: R. MOODY JR	TEST ITEM OPERATOR: SP-4 REECE	REG./MODEL NO: LAV-25													
SERIAL NO. USMC 511706	ODOMETER: 995	HOUR METER: 43.4													
TEMPERATURE: 36 DEG C	HUMIDITY: 37%	TEST SITE: YUMA PROVING GROUND													
TERRAIN: FLAT	BAROMETRIC PRESSURE: 995.8 mbs	WIND DIRECTION: 194 DEG													
WIND VELOCITY: 4 KNOTS	TAPE RECORDER: B&K 7006	OCTAVE ANALYZER: B&K 2131													
MICROPHONE: B&K 4155	STATIONARY OPERATION ()	HIGHWAY DRIVING (X)													
INTERIOR (X)	EXTERIOR ()	MICROPHONE LOCATION: DRIVER													

OCTAVE BAND CENTER FREQUENCIES (HZ)															
GEAR	RPM	SPEED KM/HR	dBA	dBB	dBC	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000

TURRET POSITION 0 DEG

DR	10	97	100	104	106	102	96	98	92	91	93	91	85	74
DR	20	100	103	108	110	109	93	95	98	97	96	92	84	74
DR	40	99	101	106	109	105	97	98	95	92	96	93	86	74
DR	77	101*	105	109	114	108	98	103	101	97	96	94	85	75

TURRET POSITION 90 DEG

DR	10	97	100	103	106	101	96	97	95	90	93	92	81	73
DR	20	102*	103	106	108	105	96	92	96	95	96	98	84	80
DR	40	100	101	106	109	106	96	97	96	92	92	97	83	74
DR	77	102*	105	109	116	108	98	103	101	98	95	97	83	75

TURRET POSITION 180 DEG

DR	10	98	99	103	105	101	93	93	94	91	89	95	81	74
DR	20	101*	103	106	108	105	96	93	97	95	96	97	84	77
DR	40	98	101	106	109	106	97	97	96	93	91	93	82	74
DR	77	101*	105	109	113	108	98	102	101	99	94	95	83	75

TURRET POSITION 270 DEG

DR	10	99	102	106	108	104	100	94	94	94	94	83	76
DR	20	100	102	107	109	107	93	95	96	95	95	83	75
DR	40	100	102	106	109	105	97	99	96	96	94	85	77
DR	77	103*	106	110	114	108	98	104	100	101	96	84	77

MAXIMUM ALLOWABLE LIMITS OF CATEGORY B, TABLE 2 OF MIL-STD-1474B(M1)

100 121 111 103 102 100 100 100 100
*LEVELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY B

ACOUSTICAL TEST DATA

TIME: 1350	DATE: 26 AUGUST 86	TEST ITEM: LIGHT ARMOR VEHICLE	
TEST CONDUCTED BY: R. MOODY JR		TEST ITEM OPERATOR: SP-4 REECE	REG./MODEL NO: LAU-25
SERIAL NO. USMC 511706	ODOMETER: 995	HOUR METER: 143.4	TEST ITEM CONDITION: FULL PAYLOAD
TEMPERATURE: 36 DEG C	HUMIDITY: 37%	TEST SITE: YUMA PROVING GROUND	SURFACE: DIRT
TERRAIN: FLAT	BAROMETRIC PRESSURE: 995.8 mbs	SKY COVER:	WIND DIRECTION: 194 DEG
WIND VELOCITY: 4 KNOTS	TAPE RECORDER: E&K 7006	OCTAVE ANALYZER: E&K 2131	SOUND LEVEL METER:
MICROPHONE: B&K 4155	STATIONARY OPERATION HIGHWAY DRIVING DRIVE-BY () (X) ()		
INTERIOR	EXTERIOR	MICROPHONE LOCATION: REINFORCED	

OCTAVE BAND CENTER FREQUENCIES (HZ)			
GEAR	RPM	SPEED KM/HR	dB(A) dB(B) dB(C) ALL PASS 31.5 63 125 250 500 1000 2000 4000 8000

TURRET POSITION 0 DEG

DR	10	100	102	104	106	95	96	101	87	86	100	86	81	75
DR	20	93	99	102	104	99	96	89	88	89	95	89	84	75
DR	40	98	100	104	106	97	101	96	89	87	96	88	82	75
DR	77	97	100	104	113	100	101	96	95	90	95	87	83	75

TURRET POSITION 90 DEG

DR	10	96	98	102	104	94	99	96	91	90	89	91	80	74
DR	20	93	95	100	102	95	98	89	86	90	89	87	79	73
DR	40	95	98	103	106	99	100	95	90	89	90	91	79	74
DR	77	95	100	105	116	98	102	99	94	90	90	90	79	75

TURRET POSITION 180 DEG

DR	10	94	98	102	103	95	97	99	82	85	91	88	80	74
DR	20	94	95	100	102	96	97	90	83	85	88	90	79	74
DR	40	94	97	102	106	98	100	95	86	86	88	90	80	75
DR	77	95	99	105	112	99	103	99	91	87	90	91	81	75

TURRET POSITION 270 DEG

DR	10	94	97	102	104	95	100	96	86	85	90	89	82	74
DR	20	96	97	100	103	98	96	91	86	87	90	92	82	75
DR	40	94	97	102	106	97	99	96	86	86	89	90	81	75
DR	77	95	99	104	113	100	100	99	92	90	89	89	81	76

MAXIMUM ALLOWABLE LIMITS OF CATEGORY B, TABLE 2 OF MIL-STD-1474B(M1)

100 121 111 105 102 100 100 100 100 100

ACOUSTICAL TEST DATA

TIME: 1350		DATE: 126 AUGUST 86		TEST ITEM: LIGHT ARMOR VEHICLE											
TEST CONDUCTED BY: R. MOODY JR		TEST ITEM OPERATOR: SP-4 REECE		REG./MODEL NO: LAU-25											
SERIAL NO. USMC 511706		ODOMETER: 1995		HOUR METER: 143.4											
TEMPERATURE: 36 DEG C		HUMIDITY: 37%		TEST SITE: YUMA PROVING GROUND											
TERRAIN: FLAT		BAROMETRIC PRESSURE: 995.8 mbs		SKY COVER: 194 DEG											
WIND VELOCITY: 4 KNOTS		TAPE RECORDER: B&K 7006		OCTAVE ANALYZER: B&K 2131											
MICROPHONE: B&K 4155		STATIONARY OPERATION ()		HIGHWAY DRIVING (X)											
INTERIOR (X)		EXTERIOR ()		MICROPHONE LOCATION: COMMANDER											

OCTAVE BAND CENTER FREQUENCIES (HZ)															
GEAR	RPM	SPEED KM/HR	dBA	dBB	dBC	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000

TURRET POSITION 0 DEG

DR	10	99	100	101	103	93	92	95	89	84	97	94	85	73
DR	20	100	100	101	103	96	91	88	89	86	99	92	84	77
DR	40	100	101	104	108	100	100	97	91	88	98	93	85	75
DR	77	101*	103	108	114	106	102	100	97	92	98	93	85	82

TURRET POSITION 90 DEG

DR	10	98	101	103	104	90	93	101	95	89	94	92	81	73
DR	20	98	99	100	101	92	93	86	93	89	96	91	83	73
DR	40	95	98	100	103	94	95	94	92	89	92	87	81	74
DR	77	96	99	102	112	94	97	96	96	91	92	90	81	75

TURRET POSITION 180 DEG

DR	10	98	99	101	102	90	93	95	85	87	96	92	79	74
DR	20	96	97	98	100	91	92	86	85	89	95	88	81	75
DR	40	96	97	100	103	93	96	93	86	88	94	88	80	74
DR	77	97	99	103	108	95	99	96	92	90	95	88	80	75

TURRET POSITION 270 DEG

DR	10	100	101	103	104	90	99	93	92	89	96	97	80	74
DR	20	100	101	102	103	92	93	87	93	89	96	97	80	75
DR	40	99	100	102	104	92	96	94	95	90	95	94	80	75
DR	77	98	101	103	110	96	98	96	96	92	94	93	82	75

MAXIMUM ALLOWABLE LIMITS OF CATEGORY B, TABLE 2 OF MIL-STD-1474B(M1)

100 121 111 103 102 100 100 100 100

*LEVELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY B

ACOUSTICAL TEST DATA

TIME: 1350		DATE: 26 AUGUST 86		TEST ITEM: LIGHT ARMOR VEHICLE											
TEST CONDUCTED BY: R. MOODY JR		TEST ITEM OPERATOR: SP-4 REEDE		REG./MODEL NO: ILAU-25											
SERIAL NO. USMC 511206		ODOMETER: 1995		HOUR METER: 143.4											
TEMPERATURE: 36 DEG C		HUMIDITY: 37%		TEST ITEM CONDITION: FULL PAYLOAD											
TERRAIN: FLAT		BAROMETRIC PRESSURE: 1995.8 mbs		TEST SITE: YUMA PROVING GROUND											
WIND VELOCITY: 3 KNOTS		TAPE RECORDER: B&K 7006		OCTAVE ANALYZER: B&K 2131											
MICROPHONE: B&K 4155		STATIONARY OPERATION ()		HIGHWAY DRIVING (X)											
INTERIOR ()		EXTERIOR ()		MICROPHONE LOCATION: LEFT CREWMEN (FORWARD)											

OCTAVE BAND CENTER FREQUENCIES (HZ)															
GEAR	RPM	SPEED KM/HR	dB(A)	dB(B)	dB(C)	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000

TURRET POSITION 0 DEG

DR	10	99*	101	102	103	93	87	90	98*	89*	96*	93*	86*	77
DR	20	99*	100	102	103	98	91	85	95*	90*	96*	94*	85*	77
DR	40	99*	100	101	103	96	93	90	94*	90*	96*	92*	85*	76
DP	77	100*	102	104	107	99	95	98*	98*	92*	97*	94*	85*	76

TURRET POSITION 90 DEG

DR	10	101*	101	102	103	93	91	92	80	92*	96*	98*	86*	77
DR	20	100*	100	101	103	97	91	84	87	95*	93*	96*	87*	76
DR	40	100*	100	102	103	96	92	90	90*	94*	93*	97*	85*	77
DR	77	101*	102	104	108	97	95	97*	96*	95*	93*	97*	85*	77

TURRET POSITION 180 DEG

DR	10	101*	101	101	102	93	86	84	95*	89*	94*	98*	87*	80
DR	20	100*	100	102	103	97	90	85	94*	89*	96*	96*	86*	61
DR	40	99*	100	102	103	96	92	92	95*	89*	94*	94*	86*	81
DR	77	102*	102	104	107	99	95	95	97*	91*	95*	99*	85*	80

TURRET POSITION 270 DEG

DR	10	98*	99	101	102	94	92	90	93*	87*	93*	95*	82*	77
DR	20	97*	98	100	101	97	86	84	90*	89*	92*	94*	83*	77
DR	40	97*	98	100	102	95	91	89	90*	90*	90*	94*	83*	77
DR	77	98*	100	102	107	99	94	95	96*	92*	92*	93*	83*	77

MAXIMUM ALLOWABLE LIMITS OF CATEGORY D, TABLE 2 OF MIL-STD-1474B(M1)

<85
106 96 89 83 80 79 79 81
*LEVELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY D

ACOUSTICAL TEST DATA

TIME: 1350		DATE: 126 AUGUST 86		TEST ITEM: LIGHT ARMOR VEHICLE											
TEST CONDUCTED BY: R. MOODY JR		TEST ITEM OPERATOR: SP-4 REECE		REG./MODEL NO: LAU-25											
SERIAL NO. USMC 511706		ODOMETER: 1995		HOUR METER: 143.4											
TEMPERATURE: 30 DEG C		HUMIDITY: 132%		TEST SITE: YUMA PROVING GROUND											
TERRAIN: FLAT		BAROMETRIC PRESSURE: 1995.8 mbs		SKY COVER: 194 DEG											
WIND VELOCITY: 4 KNOTS		TAPE RECORDER: B&K 2006		OCTAVE ANALYZER: B&K 2131											
MICROPHONE: B&K 4155		STATIONARY OPERATION ()		HIGHWAY DRIVING (X)											
INTERIOR EXTERIOR		MICROPHONE LOCATION: RIGHT CREWMEN (FORWARD)													

OCTAVE BAND CENTER FREQUENCIES (HZ)															
GEAR	RPM	SPEED KM/HR	dBA	dBB	dBC	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000

TURRET POSITION 0 DEG

DR	10	107*	107	108	108	96	95	88	90*	88*	107*	93*	83*	75
DR	20	102*	102	103	105	99	93	86	88	88*	101*	95*	83*	75
DR	40	104*	104	105	106	99	93	90	91*	90*	103*	94*	86*	76
DR	77	105*	105	106	110	100	94	93	98*	92*	101*	100*	86*	76

TURRET POSITION 90 DEG

DR	10	100*	100	102	103	96	93	95	91*	89*	93*	97*	84*	78
DR	20	100*	100	101	103	98	90	85	89	90*	93*	97*	85*	79
DR	40	101*	101	102	104	99	92	89	91*	91*	95*	98*	84*	79
DR	77	100*	102	104	111	100	94	94	98*	94*	95*	96*	84*	80

TURRET POSITION 180 DEG

DR	10	98*	99	101	103	96	87	94	91*	89*	94*	93*	85*	79
DR	20	98*	98	101	104	99	90	92	91*	90*	93*	93*	85*	78
DR	40	97*	98	101	104	99	91	89	92*	90*	92*	93*	84*	79
DR	77	100*	102	104	107	100	94	96	99*	94*	93*	96*	84*	79

TURRET POSITION 270 DEG

DR	10	100*	101	103	104	95	92	97*	94*	90*	95*	96*	83*	76
DR	20	100*	100	102	104	100	89	84	95*	92*	93*	97*	82*	76
DR	40	101*	101	103	105	99	92	90	94*	91*	95*	98*	84*	76
DR	77	101*	103	105	110	100	94	95	98*	94*	95*	98*	83*	77

MAXIMUM ALLOWABLE LIMITS OF CATEGORY D, TABLE 2 OF MIL-STD-14748(MI)

<95

106

96

89

83

80

79

79

81

*LEVELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY D

ACOUSTICAL TEST DATA

TIME: 1350	DATE: 12 AUGUST 86	TEST ITEM: LIGHT ARMOR VEHICLE													
TEST CONDUCTED BY: R. MOODY JR	TEST ITEM OPERATOR: SP-4 REECE	REG./MODEL NO: LAU-25													
SERIAL NO. USMC 511706	ODOMETER: 1995	HOURLY METER: 143.4	TEST ITEM CONDITION: FULL PAYLOAD												
TEMPERATURE: 36 DEG C	HUMIDITY: 37%	TEST SITE: YUMA PROVING GROUND	SURFACE: DIRT												
TERRAIN: FLAT	BAROMETRIC PRESSURE: 1995.8 mb	SKY COVER:	WIND DIRECTION: 194 DEG												
WIND VELOCITY: 4 KNOTS	TAPE RECORDER: B&K 7006	OCTAVE ANALYZER: B&K 2131	SOUND LEVEL METER:												
MICROPHONE: B&K 4155	STATIONARY OPERATION ()	HIGHWAY DRIVING (X)	DRIVE-BY ()												
INTERIOR	EXTERIOR ()	MICROPHONE LOCATION: RIGHT CREW (REAR)													

OCTAVE BAND CENTER FREQUENCIES (HZ)															
GEAR	RPM	SPEED KM/HR	dBA	dBB	dBC	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000

TURRET POSITION 0 DEG

DR	10	97*	99	105	106	98	104	90	88	90*	94*	93*	84*	75
DP	20	96*	97	102	105	102	98	88	90*	88*	90*	91*	86*	74
DR	40	98*	99	104	106	102	101	92	89	92*	92*	94*	85*	75
DP	77	99*	101	105	110	103	101	95	93*	93*	94*	95*	84*	76

TURRET POSITION 90 DEG

DR	10	97*	99	103	105	99	100	96	86	89*	93*	92*	84*	79
DP	20	96*	97	102	104	101	96	86	87	89*	93*	91*	84*	78
DR	40	98*	99	104	106	102	100	90	88	89*	93*	94*	85*	79
DP	77	98*	100	105	113	103	101	96	95*	92*	91*	94*	84*	78

TURRET POSITION 180 DEG

DR	10	100*	100	103	105	98	95	95	87	86*	91*	98*	87*	78
DP	20	101*	100	103	106	101	96	93	87	87*	91*	99*	86*	78
DR	40	101*	101	104	106	102	99	90	88	88*	92*	98*	87*	78
DP	77	101*	102	106	109	103	102	96	96*	93*	92*	99*	85*	77

TURRET POSITION 270 DEG

DR	10	97*	99	102	104	98	96	98*	84	88*	89*	94*	83*	75
DP	20	97*	98	102	105	103	96	86	84	89*	93*	93*	83*	75
DR	40	99*	100	104	107	101	101	90	87	90*	94*	96*	83*	76
DP	77	101*	102	106	111	103	101	97*	92*	93*	93*	98*	86*	76

MAXIMUM ALLOWABLE LIMITS OF CATEGORY D, TABLE 2 OF MIL-STD-1474B(MI)

*LEVELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY D

ACOUSTICAL TEST DATA

TIME: 1100	DATE: 27 APR 89	TEST ITEM: M9 ACE													
TEST CONDUCTED BY: K. DICKHOFF	TEST ITEM OPERATOR: ROBERT PARKER	REG./MODEL NO:													
SERIAL NO. A038	ODOMETER: 589	HOUR METER: 273.9													
TEMPERATURE: 66 DEG F	HUMIDITY: 42%	TEST SITE: PERRYMAN													
TERRAIN: FLAT	BAROMETRIC PRESSURE: 1011.7 mb	SKY COVER: CLEAR													
WIND SPEED: 3 km/hr	TAPE RECORDER: 7006	OCTAVE ANALYZER: 2131													
MICROPHONE: 4155	STATIONARY OPERATION (X)	HIGHWAY DRIVING ()													
INTERIOR (X)	EXTERIOR ()	MICROPHONE LOCATION: DRIVER													

OCTAVE BAND CENTER FREQUENCIES (HZ)															
GEAR	RPM	SPEED KM/HR	dBA	dBB	dBC	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000

HATCH OPEN/FAN OFF

N	800	0	83	88	93	95	92	88	84	83	82	79	73	63	62
N	1800	0	98	101	105	107	102	102	91	97	97	93	88	77	69

HATCH OPEN/FAN ON

N	800	0	93	94	96	98	93	90	84	89	84	84	87	88	80
N	1800	0	99	101	105	106	101	100	92	96	97	94	90	89	80

HATCH CLOSED/FAN OFF

N	800	0	85	92	102	106	105	93	89	86	83	81	75	67	67
N	1800	0	99	103	110	113	111	102	97	100	98	93	87	79	72

HATCH CLOSED/FAN ON

N	800	0	98	99	102	104	102	92	89	94	88	93	92	92	87
N	1800	0	101*	104	110	112	110	103	99	99	98	95	91	92	86

MAXIMUM ALLOWABLE LIMITS OF MIL-STD-1474B(MI), TABLE 2, CATEGORY B

100

121

111

103

102

100

100

100

100

100

*LEVELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY B

ACOUSTICAL TEST DATA

TIME: 1100		DATE: 27 APR 89		TEST ITEM: M9 ACE	
TEST CONDUCTED BY: K. DICKHOFF			TEST ITEM OPERATOR: ROBERT PARKER		REG./MODEL NO:
SERIAL NO. A038		ODOMETER: 589		HOUR METER: 273.9	
TEMPERATURE: 66 DEG F		HUMIDITY: 42%		TEST SITE: PERRYMAN	
TERRAIN: FLAT		BAROMETRIC PRESSURE: 1011.7 mb		SKY COVER: CLEAR	
WIND SPEED: 3 km/hr		TAPE RECORDER: 7006		OCTAVE ANALYZER: 2131	
MICROPHONE: 4155		STATIONARY OPERATION (X)		HIGHWAY DRIVING (X)	
INTERIOR (X)		EXTERIOR ()		MICROPHONE LOCATION: DRIVER	

OCTAVE BAND CENTER FREQUENCIES (HZ)					
GEAR	RPM	SPEED KM/HR	dBA	dBB	dBC
			ALL PASS	31.5	63
				125	250
				500	1000
				2000	4000
				8000	

HATCH OPEN/FAN ON

1	1800	3.9	99	102	105	106	101	100	92	97	98	94	91	86	81
2	1800	6.1	99	102	104	106	100	98	93	97	97	94	90	86	80
3	1800	9.7	99	102	104	106	100	98	94	97	97	94	91	86	80
4	1800	14.4	100	103	106	107	102	100	95	98	96	95	91	87	80
5	1800	21.4	102*	105	108	110	104	103	99	101	100	98	92	87	80
6	1800	24.8	104*	107	110	111	104	105	100	102	100	100	94	87	80

HATCH OPEN/FAN OFF

1	1800	3.9	98	102	105	107	102	102	91	98	96	93	89	74	70
2	1800	6.2	98	102	104	107	100	100	92	98	97	93	88	74	69
3	1800	9.5	98	102	104	107	101	100	93	98	97	93	89	74	69
4	1800	14.3	99	103	106	108	103	102	94	95	98	94	89	75	69
5	1800	21.5	101*	105	108	111	105	105	98	102	100	97	90	75	69
6	1800	24.7	103*	107	110	112	105	107	99	103	100	99	92	75	69

MAXIMUM ALLOWABLE LIMITS OF MIL-STD-1474B(MI), TABLE 2, CATEGORY B

100 121 111 103 102 100 100 100 100 100

*LEVELS EXCEEDING MAXIMUM ALLOWABLE LIMITS OF CATEGORY B

ACOUSTICAL TEST DATA										TIME: 1300	DATE: 7 SEPT 1982				
TEST ITEM: MULTIPLE LAUNCH ROCKET SYSTEM										TEST CONDUCTED BY: W.M. H. DIEGEL	TEST ITEM OPERATOR: F. BALDWIN				
REG./MODEL NO:		SERIAL NO: 9	ODOMETER: HOUR METER		TEST ITEM CONDITION: WINDOWS OPEN/FAN OFF/ESC NORMAL			TERRAIN: FLAT		DRIVE-BY					
TEMPERATURE: 77°F		HUMIDITY: 68%		TEST SITE: PERRYMAN A.P.G.		SURFACE: PAVED									
BAROMETRIC PRESSURE: 1029.5		SKY COVER: OVERCAST		STATIONARY OPERATION		HIWAY DRIVING									
WIND DIRECTION: W.S.W		WIND VELOCITY: 3-6 mph		MICROPHONE: GR-1551-PI-150		SOUND LEVEL METER: GR-1551-C		OCTAVE ANALYZER: HP-5451-B							
INTERIOR		EXTERIOR		MICROPHONE LOCATION: 15 SHOWN BELOW		TAPE RECORDER: NAGRA IV SJ		TAPE NO: 1-MLRS							
GEAR	APPROX SPEED	dB A	dB B	dB C	ALL PASS	31.5	63	125	250	500	1,000	2,000	4,000	8,000	REMARKS
								DRIVER							RUN # 1
D	10	106	112	119	120		113	113	105	102	100	95	89	85	
D	20	107	115	120	121		117	117	107	104	102	97	91	87	WINDOWS - OPEN
D	30	107	115	120	121		117	116	108	103	102	96	88	82	FAN OFF
D	40	108	117	121	122		117	121	111	105	101	97	92	85	ESC - NORMAL
D	1750	103	118	124	125		174	116	108	104	102	98	90	86	
								GUNNER							
D	10	105	110	115	116		108	110	106	102	102	98	90	89	
D	20	108	114	116	117		107	115	108	105	103	99	93	90	
D	30	107	115	118	120		117	116	108	104	102	98	89	83	
D	40	109	118	121	121		106	118	114	107	103	100	93	88	
D	1750	107	114	119	120		117	112	108	103	101	98	92	90	
								COMMANDER							
D	10	106	114	120	121		117	113	107	101	100	96	92	88	
D	20	107	115	120	121		117	117	109	102	100	97	90	87	
D	30	108	117	122	123		123	114	110	100	100	97	87	82	
D	40	110	120	124	125		116	123	113	102	102	98	90	84	
D	1750	110	124	131	132		131	116	109	101	100	97	92	90	

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ACOUSTICAL TEST DATA										TIME: 1300	DATE: 7 SEPT 1982					
TEST ITEM: MULTIPLE LAUNCH ROCKET SYSTEM																
REG./MODEL NO: 77° F		SERIAL NO: 9		ODOMETER: HOUR METER		TEST ITEM CONDITION: WINDOWS OPEN/FAN LOW/ESC NORMAL		TEST CONDUCTED BY: WM. H. DIEGEL		TEST ITEM OPERATOR: F. BALDWIN						
TEMPERATURE: 77° F		HUMIDITY: 68%		TEST SITE: PERRYMAN A.P.G.		SURFACE: PAVED		TERRAIN: FLAT								
BAROMETRIC PRESSURE: 1024.5		SKY COVER: OVERCAST		STATIONARY OPERATION		HIWAY DRIVING		CIVIL-DY								
WIND DIRECTION: W.S.W.		WIND VELOCITY: 3-6 mph		MICROPHONE: GR-1551-P1-150		SOUND LEVEL METER: GR-1551-C		OCTAVE ANALYZER: HP 5451-B								
INTERIOR		EXTERIOR		MICROPHONE LOCATION: AS SHOWN BELOW		TAPE RECORDER: NAGRA IV SJ		TAPE NO: 1 MLRS								
☒		☐														
GEAR	APPROX SPEED	dB A	dB B	dB C	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000	REMARKS	
								DRIVER						RUN #2		
D	10	106	113	120	122		113	114	104	103	101	95	90	87		
D	20	107	115	120	121		115	117	106	104	102	97	91	86		WINDOWS - OPEN
D	30	106	115	120	120		115	118	108	102	100	95	88	81		FAN - LOW
D	40	100	117	121	121		109	120	112	105	101	97	92	84		ESC - NORMAL
D	1750	108	118	124	124		123	117	108	103	102	97	70	86		
							GUNNER									
D	10	105	110	116	117		109	110	106	101	101	97	89	89		
D	20	105	112	115	116		109	114	106	102	100	96	92	89		
D	30	106	113	117	118		111	116	107	102	101	97	89	82		
D	40	109	116	120	120		104	118	113	106	103	99	93	87		
D	1750	105	112	118	118		116	111	107	101	100	97	91	89		
							COMMANDER									
D	10	106	113	120	121		117	112	106	101	101	96	91	88		
D	20	107	115	120	121		117	118	110	102	101	98	91	87		
D	30	108	119	124	125		123	118	110	103	100	97	85	81		
D	40	110	119	124	124		115	123	113	104	102	97	87	83		
D	1750	111	123	131	132		130	117	108	102	101	98	93	90		

ACOUSTICAL TEST DATA										TIME: 1300	DATE: 7 SEPT 1982						
TEST ITEM: MULTIPLE LAUNCH ROCKET SYSTEM																	
REG./MODEL NO:		SERIAL NO: 9		ODOMETER: HOUR METER		TEST SITE: PERRYMAN A.P.G.		TEST CONDUCTED BY: WM H. DIEGEL		TEST ITEM OPERATOR: F. BALDWIN							
TEMPERATURE: 77° F		HUMIDITY: 68%		TEST SITE: PERRYMAN A.P.G.		SURFACE: PAVED		TEST ITEM CONDITION: WINDOWS OPEN/FAN MEDIUM/ESC NORMAL		TERRAIN: FLAT							
BAROMETRIC PRESSURE: 1024.5		SKY COVER: OVERCAST		STATIONARY OPERATION		HIVAY DRIVING		DRIVE-BY									
WIND DIRECTION: W. S. W.		WIND VELOCITY: 3-6 mph		MICROPHONE: GR-1551-P1-150		SOUND LEVEL METER: GR-1551-C		OCTAVE ANALYZER: HP-5451-B									
INTERIOR		EXTERIOR		MICROPHONE LOCATION: 15' SHOWN BELOW		TAPE RECORDER: NAGRA IV SJ		TAPE NO: 1 MLRS									
GEAR	RPM	APPROX SPEED	dbA	dbB	dbC	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000	REMARKS	
									DRIVER								
D		10	106	112	118	120		112	113	104	103	100	96	89	84		
D		20	108	116	121	122		118	118	108	105	103	98	91	88		WINDOWS OPEN
D		30	106	115	120	120		117	116	108	104	100	96	85	81		FAN MEDIUM
D		40	109	118	122	123		110	122	113	106	102	98	90	84		ESC NORMAL
D	1750		108	117	123	124		173	115	107	105	102	98	87	86		
									GUNNER								
D		10	106	110	115	116		109	110	105	102	103	98	92	88		
D		20	108	114	117	118		107	116	108	106	103	100	94	91		
D		30	107	115	119	120		116	115	110	104	101	98	88	84		
D		40	109	117	120	120		106	118	114	107	103	101	93	88		
D	1750		108	114	119	120		117	113	110	105	101	99	93	90		
									COMMANDER								
D		10	105	113	119	120		116	113	106	101	99	95	92	88		
D		20	106	115	119	120		116	117	108	101	99	97	89	86		
D		30	109	119	124	125		122	121	111	103	101	98	87	81		
D		40	110	120	124	125		116	123	112	104	103	98	90	85		
D	1750		111	125	132	133		132	115	110	102	101	97	88	87		

ACOUSTICAL TEST DATA										TIME: 1300	DATE: 7 SEPT 1982						
TEST ITEM: MULTIPLE LAUNCH ROCKET SYSTEM																	
REG./MODEL NO:		SERIAL NO: 9		ODOMETER: HOUR METER		TEST CONDUCTED BY: W.M. H. DIEGEL		TEST ITEM OPERATOR: F. BALDWIN									
TEMPERATURE: 77°F		HUMIDITY: 68%		TEST SITE: PERRYMAN A.R.G.		SURFACE: PAVED		TERRAIN: FLAT									
BAROMETRIC PRESSURE: 1025.4		SKY COVER: OVERCAST		STATIONARY OPERATION		HIWAY DRIVING		DRIVE-UY									
WIND DIRECTION: W.S.W		WIND VELOCITY: 3-6 mph		MICROPHONE: GR-1551-P1-150		SOUND LEVEL METER: GR-1551-C		OCTAVE ANALYZER: HP-5451-B									
INTERIOR		EXTERIOR		MICROPHONE LOCATION: AS SHOWN BELOW		TAPE RECORDER: NAGRA IV SJ		TAPE NO: 1 MLRS									
GEAR	RPM	APPROX SPEED	dbA	dbB	dbC	ALL PASS	31.5	63	125	250	500	1,000	2,000	4,000	8,000	REMARKS	
									DRIVER								
D		10	106	112	119	121			113	112	106	104	101	96	91	87	
D		20	108	115	120	121			117	117	106	105	103	97	87	87	WINDOWS CLOSED
D		30	107	116	121	122			113	117	108	104	100	96	88	83	FAN - OFF
D		40	110	119	123	123			110	122	110	106	102	98	91	85	ESC - FIRING
D	1750		107	119	121	127			126	117	107	105	104	99	92	89	
									GUNNER								
D		10	106	111	116	117			108	110	107	103	102	97	93	90	
D		20	107	113	117	117			108	115	108	105	101	99	93	90	
D		30	108	115	120	120			118	116	108	106	103	98	92	86	
D		40	110	117	120	121			106	119	113	106	104	100	94	89	
D	1750		109	115	120	120			117	115	111	105	103	100	95	92	
									COMMANDER								
D		10	108	114	121	123			116	115	108	104	103	98	91	89	
D		20	106	115	121	122			111	117	107	102	100	97	89	89	
D		30	109	120	124	125			121	121	112	103	101	97	87	82	
D		40	110	119	124	124			116	123	113	105	102	98	90	82	
D	1750		110	115	122	123			120	116	111	103	101	99	90	85	

ACOUSTICAL TEST DATA										TIME: 1300	DATE: 7 SEPT 1982						
TEST ITEM: MULTIPLE LAUNCH ROCKET SYSTEM										TEST CONDUCTED BY: W.M. H. DIEGEL	TEST ITEM OPERATOR: F. BALDWIN						
REG./MODEL NO: SERIAL NO: 9										TEST ITEM CONDITION: WINDOWS CLOSED/FAN-LOW/ESC FIRING							
TEMPERATURE: 77°F HUMIDITY: 68%										SURFACE: PAVED	TERRAIN: FLAT						
BAROMETRIC PRESSURE: 1024.5 SKY COVER: OVERCAST										STATIONARY OPERATION HIWAY DRIVING DRIVE-UY							
WIND DIRECTION: W. S.W WIND VELOCITY: 3-6 mph										SOUND LEVEL METER: GR-1551-C							
INTERIOR EXTERIOR ☒ ☐										TAPE RECORDER: NAGRA IV SJ							
MICROPHONE LOCATION: AS SHOWN BELOW										TAPE NO: 1-MLRS							
GEAR	RPM	APPROX SPEED	dbA	dbB	dbC	ALL PASS	31.5	63	125	250	500	1000	2000	4000	8000	REMARKS	
									DRIVER								RUN # 6
D		10	104	111	117	118			114	113	104	101	98	94	87	82	
D		20	110	116	125	125			124	116	108	107	105	100	92	90	WINDOWS - CLOSED
D		30	107	116	121	121			118	117	107	103	102	97	89	84	FAN - LOW
D		40	110	120	125	125			112	125	111	105	101	97	91	86	ESC - FIRING
D	1750		108	119	126	127			126	116	108	104	102	99	89	87	
									GUNNER								
D		10	104	109	113	114			108	109	105	100	100	95	91	92	
D		20	108	115	119	119			112	117	108	105	103	100	93	92	
D		30	107	113	118	118			114	115	106	104	102	98	90	86	
D		40	108	116	120	120			103	119	109	105	101	99	93	86	
D	1750		105	112	116	117			114	112	106	103	100	97	91	90	
									COMMANDER								
D		10	105	114	120	121			119	113	107	101	98	93	88	86	
D		20	108	119	127	128			126	119	110	102	100	97	91	89	
D		30	110	120	124	125			122	120	116	105	99	96	89	82	
D		40	110	121	126	126			119	124	112	105	100	99	89	83	
D	1750		108	119	126	127			126	116	109	102	99	96	88	84	

ACOUSTICAL TEST DATA										TIME: 1300	DATE: 7 SEPT 1982						
TEST ITEM: MULTIPLE LAUNCH ROCKET SYSTEM										TEST CONDUCTED BY: WM. H. DIEGEL	TEST ITEM OPERATOR: F. BALDWIN						
REG./MODEL NO: SERIAL NO: 9										ODOMETER: HOUR METER	TEST ITEM CONDITION: WINDOWS CLOSED/FAN HIGH/ESC FIRING						
TEMPERATURE: 77°F										TEST SITE: PERRYMAN A.F.G.	SURFACE: PAVED						
HUMIDITY: 68%										STATIONARY OPERATION	HIWAY DRIVING						
BAROMETRIC PRESSURE: 1024.5										SKY COVER: OVERCAST	DRIVE-BY						
WIND DIRECTION: W. S.W.										WIND VELOCITY: 3-6 mph	SOUND LEVEL METER: HP 5451-B						
INTERIOR EXTERIOR										MICROPHONE LOCATION: AS SHOWN BELOW	TAPE RECORDER: NAGRA IV SJ						
										TAPE NO: 1-MLRS							
GEAR	RPM	APPROX SPEED	dB A	dB B	dB C	ALL PASS	31.5	63	125	250	500	1,000	2,000	4,000	8,000	REMARKS	
									DRIVER								RUN # 8
D		10	105	113	120	120		117	113	106	101	99	94	88	86		
D		20	108	119	125	126		125	117	107	104	101	99	90	89		WINDMILL SPEED
D		30	106	116	120	121		117	118	107	103	98	97	90	85		FAN HIGH
D		40	108	117	122	122		115	120	110	105	101	97	91	85		ESC FIRING
D	1750		108	119	124	127		124	114	109	103	103	95	90	88		
									GUNNER								
D		10	105	109	114	115		107	108	105	103	100	96	91	87		
D		20	108	114	118	118		110	116	109	105	103	99	95	94		
D		30	107	115	118	119		112	116	109	106	101	98	91	87		
D		40	108	114	117	117		104	115	112	106	102	99	92	87		
D	1750		108	113	116	117		109	114	109	105	102	100	92	94		
									COMMANDER								
D		10	106	116	123	124		123	113	108	102	96	93	89	87		
D		20	109	119	127	128		127	119	110	103	103	99	93	92		
D		30	110	121	126	127		125	121	113	104	101	100	87	83		
D		40	111	121	126	126		121	124	114	106	101	97	89	84		
D	1750		110	122	129	130		129	117	113	103	101	98	92	92		

2. IMPULSE NOISE TEST OF M901A2 (ITV)

2. .1 Objective

The objective was to evaluate the sound pressure levels to which crew members of the M901A1 (ITV) and personnel operating around the vehicles will be exposed to while firing the TOW 2 missile.

2. .2 Criteria

None were supplied; therefore, MIL-STD-1474B(MI) (Noise Limits for Army Materiel) was used to evaluate hearing protection requirements.

2. .3 Data Acquisition Procedure

This impulse noise test was conducted in accordance with TECOM TOP 1-2-608 (Sound Level Measurements) and MIL-STD-1474B(MI) (Noise Limits for Army Materiel) at a site free of all sound-reflecting surfaces within a 50-meter radius around the vehicle. A list of test instrumentation is presented in Table B-1 of the Appendix.

Impulse noise measurements of five TOW 2 rocket motors (slug warheads) were made at all interior crew stations and at four positions outside the vehicle.

Microphones were mounted with the sensing elements up, along a plane parallel to the ground at a height of 0.8m above the seats of each crew station. Tripod-mounted sound level meters were mounted at the exterior positions with the sensing elements facing up, along a plane parallel to the ground, 1.5m above ground.

System alignment and individual data channel (microphone-preamplifier) pistonphone calibrations were conducted both prior to testing and upon test completion. Sound pressure levels were recorded for five single TOW 2 missiles (rocket motors and slug).

2. .4 Results

Peak sound pressure levels for each position are presented in Table 2. .-1 and Table 2. .-2. Microphone accuracy is ± 2 decibels(dB).

TABLE 2. .-1. IMPULSE NOISE LEVELS (INTERIOR)

Round No.:	1		2		3		4		5	
	"B"		"B"		"B"		"B"		"B"	
Position	Peak (dB)	Duration (msec)	Peak (dB)	Duration (msec)	Peak (dB)	Duration (msec)	Peak (dB)	Duration (msec)	Peak (dB)	Duration (msec)
Driver	--	----	--	----	151	>200	150	>200	156	196
Squad Leader	--	----	136	>200	137	194	138	196	140	>200
Gunner	--	----	153	181	159	134	158	>200	159	>200
Loader 1	--	----	152	>200	154	>200	153	>200	154	>200
Loader 2	--	----	152	>200	155	>200	155	>200	154	>200

2.4 RESULTS

Impulse noise levels at each position are presented in Table 2.4. Microphone accuracy is ± 2 decibels (dB).

TABLE 2.4. FAASV IMPULSE NOISE (INTERIOR)

Crew Position:	<u>1</u>		<u>2</u>		<u>3</u>		<u>4</u>		<u>5</u>	
Round No.	<u>Peak</u> ^a	<u>Mode</u>	<u>Peak</u>	<u>Mode</u>	<u>Peak</u>	<u>Mode</u>	<u>Peak</u>	<u>Mode</u>	<u>Peak</u>	<u>Mode</u>
1	151	1	164	1	158	1	148	1	147	1
2	151	2	^b —	2	149	2	146	2	146	2
3	155	1	—	1	163	1	156	1	156	1
4	159	1	159	1	153	1	154	1	—	1

^a Peak values are in dB; "B"-Duration for all rounds exceeded 200 msec.

^b Data lost in acquisition.

Environmental Conditions: Temp- 22 ° C
 Humidity- 54%
 Pressure- 1016.4 mb
 Wind Speed- 6 km/hr

2.5 ANALYSIS

Analysis of this impulse noise data is difficult because only four FAASV AFES activations were measured. This is in variance with MIL-STD-1474B(MI), para 5.4.2.1.3, which states not only that a minimum of three samples be measured, but also that the spread of peak pressure levels (PPL's) in decibels (dB) not exceed the number of samples.

The worst-case PPL was 164 dB and was measured at crew position 2; the lowest PPL was 146 dB and was measured at crew position 5.

Despite the limited sample size, the impulse noise levels generated by FAASV AFES activations were above 140 dB (the minimum level for single hearing protection).

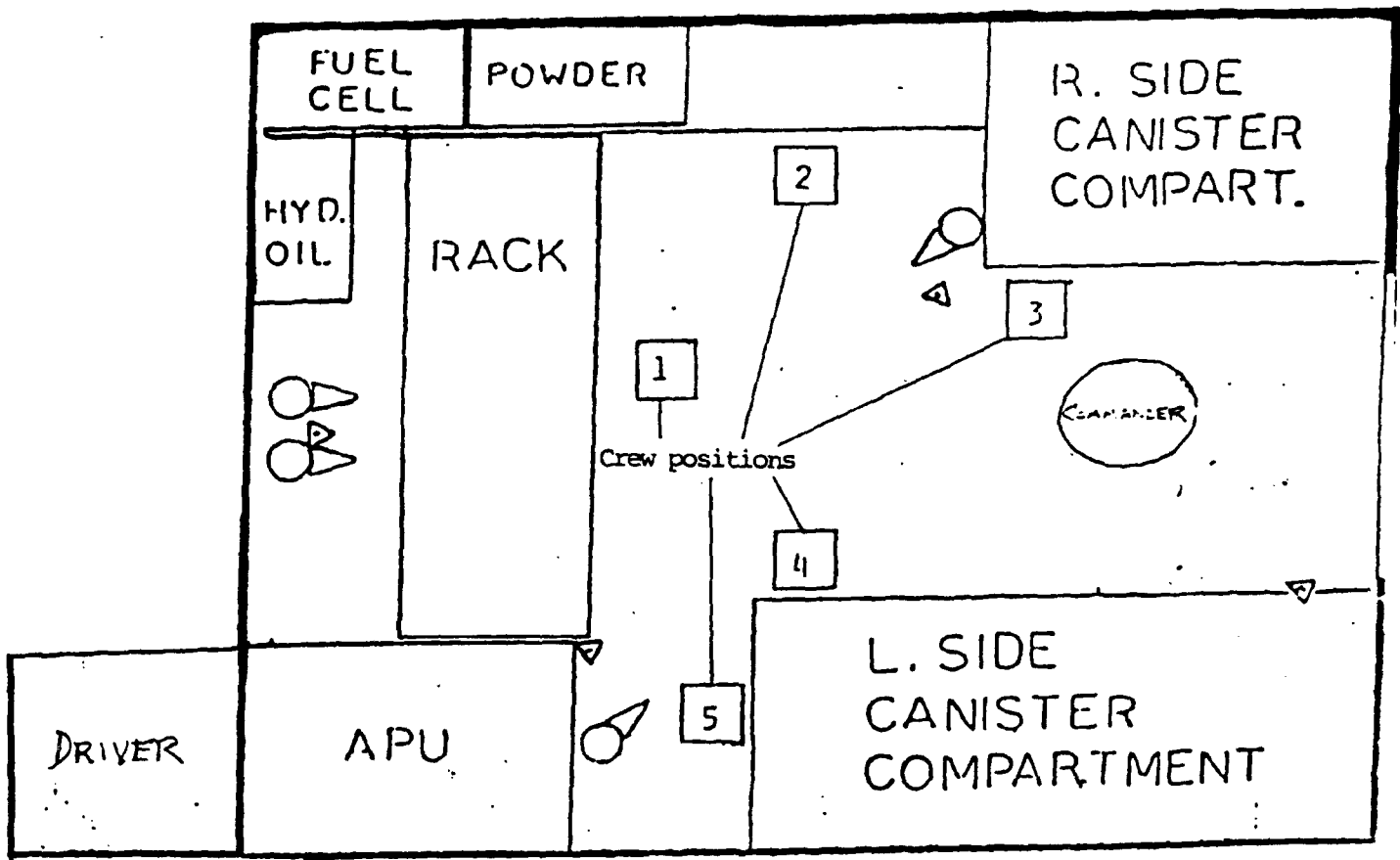
SECTION 3. CONCLUSIONS

Peak pressure levels produced during FAASV AFES activations indicate that single hearing protection must be worn by FAASV operators. No conclusions can be drawn as to whether double hearing protection is also required by the FAASV

APPENDIX

Table B-1

Crew Positions



APPENDIX D

HEAD INJURY INFORMATION FOR COMBAT VEHICLES CREWMAN FROM
THE U.S. ARMY AEROMEDICAL RESEARCH LABORATORY

HEAD INJURY INFORMATION FOR COMBAT VEHICLES CREWMAN FROM
THE U.S. ARMY AEROMEDICAL RESEARCH LABORATORY



DEPARTMENT OF THE ARMY
U.S. ARMY AEROMEDICAL RESEARCH LABORATORY
FORT RUCKER, ALABAMA 36362-5292



REPLY TO
ATTENTION ON

SGRD-UAD-IE (70-45a)

14 August 1992

MEMORANDUM FOR Acting Director, U.S. Army Human Engineering
Laboratory, ATTN: SLCHE-CC-LHD (CPT Oblak),
Aberdeen Proving Ground, MD 21005-5001

SUBJECT: Head Injury Information for Combat Vehicle Crewman
(CVC) Helmet

1. Reference memorandum, U.S. Army Aeromedical Research Laboratory, SGRD-UAD-IE, 26 May 92, SUBJECT: Request for Assistance in Collecting Head Injury Information.
2. As requested in referenced memorandum, this division has completed a study detailing injuries from the U.S. Army Safety Center (USASC) Database for head injury in vehicles where a CVC may be considered. The study was conducted by our staff epidemiologist, head injury specialists, and a student contractor.
3. As suspected, the injuries in the USASC database represent only severe mishaps and few cases involve injuries that involve little equipment damage or lost work days. I suggest that a survey of representative units be conducted to learn the incidence of injuries that may not appear in the USASC data. This may provide additional information on facial injury prevention and ballistic requirements.
4. Our study did indicate that some of these severe head injuries may have been prevented by providing additional impact protection as suggested in the summary report (Encl 1). Limitations in the information available from the USASC database did not allow us to predict the exact number of head injuries that could be prevented by helmet design changes.
5. We expect to publish a USAARL report detailing all of the procedures and details studied in this effort. This should be ready in the next 60 days and will be forwarded upon receipt from the printer. USAARL point of contact is Mr. Licina, DSN 558-6893 or Commercial (205) 255-6893.

Encl

JOHN V. BARSON
LTC, MC, SFS
Director, Biodynamics
Research Division

Injury Analysis: Head and Facial Injuries When Wearing the DH-132A Combat Vehicle Crewman Helmet

**Troy A. Bowman
S.G. Shannon, Dr. Ph.**

Introduction

On 11 May 1992, the U.S. Army Aeromedical Research Laboratory (USAARL) was tasked by the Human Engineering Laboratory (HEL) to conduct a study of head and facial injuries experienced by combat vehicle crewmen. The results of this study will be used to prepare design requirements for a new Combat Vehicle Crewman (CVC) helmet. The study included a search of the Army Safety Management Information System (ASMIS) database of the U.S. Army Safety Center, a review of several mishap reports, a survey of armored vehicles, and a search of the USAARL Aviation Life Support Retrieval Program (ALSERP) database.

Background

The ASMIS database contains information from Army ground mishaps reported in accordance with Army Regulation 385-40. The Commander of the mishap unit submits a DA Form 285 (U.S. Army Mishap Report) or a shaded DA Form 285 to report the mishap circumstances. The Aviation Life Support Equipment Retrieval Program at USAARL retrieves life support equipment from aviation mishaps to study the performance of the equipment in the crash environment. Equipment from ground mishaps is also provided to USAARL for further analysis. This information is used to detect performance problems, improper use of the equipment, and to guide design requirements for new life support equipment.

Impact standards for the current CVC helmet, as outlined in MIL-H-44117A (1990), requires that the helmet assembly shall not transmit an impact acceleration to a standard headform accelerometer in excess of 75 G when dropped from a height of 18 inches. These limits were obtained as a result of approximated human thresholds to concussion. In contrast, current aviation helmets such as the SPH-4B transmits less than 250 G acceleration with a 6 foot drop and newer flight helmets are expected to limit this to less than 175 G. In addition, the current CVC helmet's V_{50} ballistic requirement provides shrapnel protection for a standard simulated fragment projectile at 1400 feet per second. The PASGT helmet requires V_{50} ballistic protection for the standard fragment simulator at 2000 fps.

Materials and Methods

ASMIS Ground Database Information

A total of 20,818 vehicle mishap case records were extracted from the ASMIS ground database for the fiscal years 1984-1991. These records included injury data on 26,328 U.S. Army personnel and Department of the Army civilians. Among these database records were 2,902 records which represented all armored vehicle mishaps. Armored vehicle crewmembers injured in other vehicle mishaps (such as automobile, truck, or van accidents) were not included in this analysis.

A list of vehicles which employ the DH-132A was compiled from Janes Armor and Artillery (1984), and contacts in several armored units. In addition, a list of Military Occupational Specialty (MOS) titles of armored vehicle crewmembers was compiled from Army Regulation 611-201. (Department of the Army, 1987) These titles were cross-referenced with ASMIS data fields to verify consistency. A complete list of vehicles and MOS titles used in this report can be found in Appendix A.

For the purpose of this study an armored vehicle crewman was defined by the MOS of the soldier. All other persons were listed as passengers (MOS not reflecting armored vehicle duties). For each soldier we abstracted information from the ASMIS record about age, MOS, factors contributing to the mishap, and the reported injury (type, body location, and severity).

Only one injury is reported on the DA Form 285. This limits the amount of information available when multiple injuries are present. Information on the operating hours and/or miles driven by each type of armored vehicle was not available to determine mishap incidence.

Mishap Report Review

Due to the limited injury information in the ASMIS database, we performed a confirmation study to verify the number and severity of injuries to each soldier in a typical armored vehicle mishap. Records for 30 mishaps were randomly selected. Among this group, 17 mishaps included a completed DA Form 285 was present, we compared the information from Form 285 with the investigation report, and autopsy or emergency treatment records.

Vehicle Surveys

Vehicle surveys were conducted at the Unit Training Equipment Site at Fort Rucker and at the 1/29th Infantry Battalion at Fort Benning. The surveys included photographs of likely injury areas and informal interviews with combat vehicle crewmembers to learn about vehicle operations and procedures.

Results

ASMIS Database Study

In reported mishaps, 74 percent of the occupants in an armored vehicle were injured, and at least 20 percent of the occupants suffered head injuries. Among 2902 armored vehicle mishaps over an 8-year period, head injuries resulted in 31 deaths, and 643 non-fatal injuries. A comparison of head injuries among armored vehicle crewmembers wearing the CVC helmet and passengers is presented in figure 1.

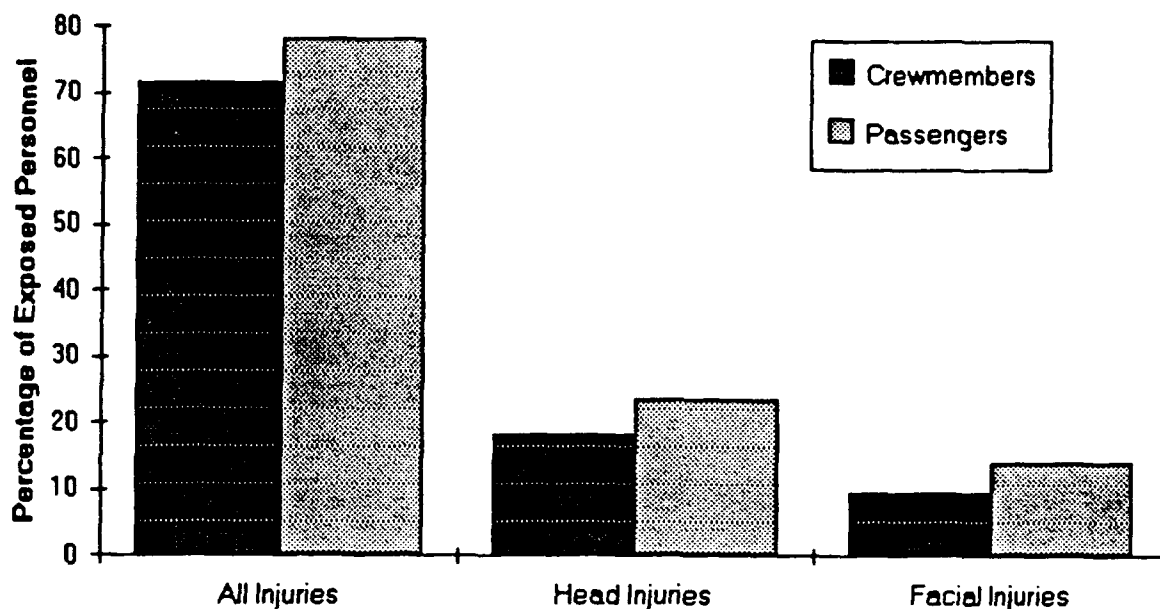


Figure 1. Injuries in armored vehicles for crewmembers wearing the CVC helmet and passengers wearing the PASGT helmet or no head protection.

Head and facial injuries were predominantly lacerations, fractures, concussions, burns or other injuries. These were evenly distributed among persons wearing the CVC helmet and passengers as detailed in Table 1. These mishaps resulted in more than 60,000 lost workdays, 15,000 for head and facial injuries, over the eight-year study period.

Table 1.

Comparison of number head and face injuries among crewmembers wearing the CVC helmet and passengers in armored vehicle mishaps.

Injury Type	Crewmembers (N=598)	Passengers (N=450)
Laceration	245 (41%)	217 (48%)
Fracture	122 (20%)	100 (22%)
Concussion	83 (14%)	45 (10%)
Burn	33 (6%)	18 (4%)
Other	115 (19%)	70 (16%)

Complete Mishap Report Review

Review of the 17 complete mishap reports showed at least two injuries were sustained by each individual involved in the mishap. The most severe injury is the injury reported to the USASC database.

Discussion

This retrospective review of information from the U.S. Army Safety Center Database provides an insight into the serious and sometimes fatal mishaps that occur with armored vehicles. Approximately 20% of the injuries among crew involved head injuries despite the use of a protective helmet. This result is not unexpected considering the impact protection specification for the current helmet. The ability to limit head acceleration to less than 75 G for an 18 inch fall would be expected to protect the wearer from the "bumps" expected in operating an armored vehicle, but is insufficient to protect the wearer from a significant impact. Impact protection for roll-over mishaps or falls to the ground would require a helmet that provides less than 175 G head acceleration for a 6 foot drop height (19.7 fps impact velocity). A new crew helmet should continue the specification for the repetitive "bump" protection, but also should include the ability to protect the wearer from a single significant impact similar to flight or motorcycle protective

helmets. No specific information on ballistic protection requirements was suggested by the data in the US Army Safety Center database.

The data portion of the current USASC mishap report could be improved by providing additional detail on more than one injury and the type of protective equipment worn. Failure to record this information in the current database and not reporting less serious mishaps leads to under reporting of head and facial injuries. The information in this study is limited to the most serious injuries and underestimates the head and facial injury problem. In addition, facial lacerations and broken teeth resulting from head and face strikes that do not result in lost workdays are probably not reported. A prospective or survey study of armored vehicle crewmembers is needed to clearly define the population at risk, the incidence of all types of injuries, and the mechanism of injury for each cause.

Other methods are available to reduce the number of head and facial injuries in combat vehicles. These include the use of restraint systems to reduce the individual strike envelope and the use of padded or frangible structures within the strike envelope. In the case of roll over accidents and sudden vehicle decelerations, proper restraint and improved padding of selected contact surfaces could greatly reduce the incidence and severity of injuries.

Conclusions

Approximately 20% of the 2902 serious armored vehicle mishaps resulted in head or facial injuries. Over the 8-year study period, this resulted in 31 deaths, 643 non-fatal injuries, and over 15,000 lost workdays for the U.S. Army. The types of head and facial injuries included lacerations, skull and facial fractures, concussions, and burns. Information sources used for this study would be expected to underestimate the magnitude of this problem. A prospective study of this problem could accurately define the head and face injury risk for armored vehicle crewmembers.

Head and face protection would be improved by maintaining the current "bump" protection in a new CVC helmet, but also including true impact protection for falls or roll-over mishaps. A recommended standard would be to limit head acceleration to less than 175 G for a 6-foot drop height.

In conjunction with an effort to improve protection with a new CVC helmet, other methods to reduce head injuries should be considered. For example, a careful study of each crew position strike envelope to determine if improved restraint, padding, or frangible structures could reduce injury.

References

Department of the Army. 1987. Army Regulation 385-40. Accident Reporting and Records. Issue No. 1. Washington, D.C.

Department of the Army. 1987. Army Regulation 611-201. Enlisted Career Management Fields and Military Occupations. Washington, D.C.

Department of the Army. Military Specification, Helmet, Combat Vehicle Crewman, Ballistic Shell. DH-132A; MIL-H-44117A Amendment 1. March 1990.

Janes' Armor and Artillery. 1983-1984. New York, NY. Janes' Publishing Inc.

Appendix A.

Vehicles evaluated for use of the Combat Vehicle Crewman Helmet

<u>Vehicle Designator</u>	<u>Vehicle Nomenclature</u>
M1/A1	Tank, Main Battle
M2/3	Bradley Fighting Vehicle
M60/A1,3	Tank, Medium
M113/A1,2,3	Armored Personnel Carrier
M551	Armored Reconnaissance
M557/A1,2	Armored Personnel Carrier
M901/A1	TOW Armored Carrier
M106	Carrier
M981 (FISTV)	Carrier
M973	SUSV LW Track
M163/A1	Vulcan Tracked Vehicle
M109/A1,2,3	Howitzer
M110/A2	Howitzer
M88/A1	Medium Recovery Vehicle
M578	Light Recovery Vehicle
M47	Tank
M48/A5	Tank
M103/A2	Tank

MOS Titles for Crewmembers in Armored Vehicles (list may not be inclusive)

<u>MOS Classification</u>	<u>MOS Title</u>
12A	Track Commander
12B	Combat Engineer
12C	Bridge Crewmember
12F	Engineer Tracked Vehicle Crewman
12Z	Combat Engineer
13A	Cannon Crewmember
13B	Cannon Crewmember
13E	Cannon Fire Detection Spec.
13F	Fire Supp. Spec.
15J	LANCE Crew
16P	CHAPARRAL Crew
16R	Vulcan Crew
17K	Radar Crew
19D	Cavalry Scout
19E	M48/60 Crewman
19K	M1 Crewman
19Z	Armor Sr. Sgt.
24M	Vulcan Mech.
27E	Dragon Repairer

27F	Vulcan Repairer
31G	Tact. Comm.
31V	Comm. Maint.
45D	Turret Mech.
45E	M1 Turret Mech.
45K	Tank Turret Repairer
45N	M60 Tank Turret Mech.
45T	Bradley Turret Mech.
63D	Artillery Syst. Mech.
63E	Heavy Constr. Oper.
63H	Track Veh. Repairer
63N	M60 Syst. Mech
63T	Bradley Syst. Mech.
63Y	Track Veh. Mech.
91A	Medical Spec.
91B	Medical NCO.