

Considerations on Defense Force Personnel Survivability in Vehicle Incidents Under Urban Warfare Conditions

A Report by



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US Defense Secretary Dr Robert Gates pointedly focused Defense Department concern on the reduction of US ground force casualties in Iraq and Afghanistan when he said on May 2, 2007, that the new Mine Resistant Ambush Protected (MRAP) family of vehicles had the “highest priority” in Pentagon planning.¹

Some media criticism indicated that the US Marine Corps and Army had been derelict in failing to deploy, as much as two years earlier, better protected vehicles for troops in Iraq.

The reality, however, is that the rush to deploy as many as 22,000 MRAP vehicles, and to upgrade thousands of M1114 HMMWV soft-skinned vehicles in the Iraq War theater may still overlook some fundamental, and yet easily-remediable, safety issues. Moreover, premature deployment of new MRAP and up-armored M1114s (and other variants of the HMMWV), had it occurred — as demanded by media reports — would have added enormous cost to the Iraq operational deployment without the commensurate increases in safety which are now possible.

It is not too late, if corrective measures are taken immediately, to ensure that these new, low-cost safety systems could serve as the fundamental rationale for the priority MRAP procurement and planned interim upgrades of M1114s and other HMMWVs and the range of soft-skinned and armored vehicles in use by the Coalition forces.

The priority of the new MRAP family of three different vehicles, and the interim upgrades on the M1114s which currently bear the brunt of the battle, has been on armor protection. Research by the International Strategic

¹ “In a May 2 internal letter to top Pentagon officials, Defense Secretary Robert Gates called upon service leaders to make acquisition of the MRAP their ‘highest priority.’” *Army Times*, May 12, 2007: Army to request 17,000 MRAPs, by Gina Cavallaro.

Studies Association (ISSA), however, finds that up-armorings alone does not provide the crew safety and survivability required in the operational setting.

A variety of US Defense Department Joint Service policy papers in 2007 have identified the urgent need for a protected vehicle capability which would increase the survivability and mobility of forces operating in a hazardous fire area against threats including mines, improvised explosive devices (IEDs) and small arms fire.

Significantly, previously undisclosed studies by private sector organizations have indicated that the solution lay only partially in increasing the quantity and design of armor protection of vehicles, but also in ensuring survivability of vehicle occupants through other means.

At present, the bulk of the injuries and deaths from IED and other blast incidents result not so much from the initial blast itself, but from secondary factors resulting from the blast. Moreover, the armoring concerns have been geared more to deal with vehicle survivability than occupant survivability.

Significantly, issues such as inertial compression of the body due to acceleration and, in particular, “slam down” — the effect of the vehicle being lifted by blast and then slammed down after it — cause the an unduly high proportion of spinal injuries, head trauma and other injuries, and poor restraint systems, including those still specified (unchanged from earlier vehicles) for the new MRAPS and upgraded M1114s, create death and injury among vehicle occupants.

Clinically, the problem is defined as “dynamic amplification”. Dynamic amplification (DA) is where the seating system actually lets the occupant see more accelerative loading than the seat would otherwise experience. This occurs because the occupant stays in motion as he compresses the soft seated surface and eventually bottoms out on the understructure. This motion creates excessive dynamic amplification, which produces a known and predictable spike in the accelerative loads to the occupant. Should such loads exceed the limits of human tolerance, then serious injury or death is an expected outcome. The human tolerance limits for these vertical accelerative loads have been long studied by the US military for ejection seats and helicopter seating and tolerance values have been established. In essence, this amplification causes the body to exceed the limits of human tolerance even though the blast itself falls within the otherwise acceptable realm of human tolerance.

The regular seating in existing HMMWVs and the new MRAPS vehicles is a traditional soft automobile or truck seat and this is what naturally creates dynamic amplification, which, in a blast situation, can be three to five times the magnitude of the blast input. While the new armoring — particularly the new V-shaped MRAP chassis — will protect from the direct effects of blast, the occupants may nonetheless suffer serious injury or death as a result of the slam-down and the resulting overshoot from interaction with their seated surface. New seating technology is available which will reduce the dynamic amplification to 1.6 times the normal load, which gives occupants survivability.² Further, the seating ensures proper body and spinal alignment during blast, crash, and other dynamic events. Improper posture after these dynamic events, caused by vehicle-attached restraints and/or poorly designed seats, further reduces injury thresholds.

To compound the issue, energy attenuators (EA), are being installed in at least some of the MRAP and are already installed in some of the HMMWV vehicles. These EA devices, while well intended, can, in fact, be dangerous in blast situations because the current state-of-the-art is designed for a single phase EA, whereas blast is, by definition, a double phase (lift-up and slam down). These attenuators are set to protect only the average size occupant in one blast profile. The problem is that if the blast exceeds the designed profile or the occupant is too heavy, then the occupant ends up seeing more amplification in the blast than would be the case without the EA (due to a larger bottoming-out pulse). Also, in coming down (slam down), the occupant is essentially uncoupled from the seat (due to the seat belt harness configuration), and then the bottoming-out now can become lethal, well beyond all survivable injury thresholds.

Moreover, although the specifications for MRAP seating specify four-point, aircraft-type harness attachments, the reality is that four-point aircraft-type harnesses are not capable of functioning properly in the myriad of crash and blast events which the MRAP is expected to encounter. The US Marine Corps, although it has yet to re-write its specification for MRAP, is, as a result, telling some vehicle manufacturers that it would be wise to consider moving to a new five-point seat-mounted harness system matched to appropriate seating systems, which would ensure that body trauma is reduced or eliminated. Because of the slight additional cost involved,

² ISSA has studied, in particular, the CCOPS seat and the laboratory testing of the seat with the demonstrable improvement in survivability of the occupant.

however, most vehicle manufacturers are treating the verbal “advice” given by some Marine Corps officials as just that: advice, rather than instruction.

According to the unclassified Test and Evaluation Master Plan (TEMP) produced for MRAP by the Department of the Navy, the Marine Corps, and the Department of the Army on March 2, 2007, “MRAP vehicles must be inherently offensive in character, built to survive a combination of mines, Improvised Explosive Devices (IEDs) Explosively Formed Projectiles (EFPs), Rocket Propelled Grenades (RPGs), and Small Arms Fire (SAF), to better support the expected operational environment. MRAP vehicles must facilitate the rapid and efficient projection of combat power, to maintain the initiative of the maneuver element.”

The vehicles, in other words, must not only survive attack but be able to “maintain the initiative of the maneuver element”, meaning that the crew must be able to survive in condition to continue its mission. ISSA analysis indicates that this is not likely to be feasible under most conditions of normally-survivable IED attack against the new vehicles because the appropriate restraint and seating systems are not being employed in them.

Moreover, the lack of such restraint and seating systems in existing vehicles in combat operations in Iraq and Afghanistan means that the US forces — and other Coalition partners using other vehicles — have been subject to unnecessarily high casualty and injury rates. Indeed, it is argued that the installation of appropriate seating and restraint systems, which could have been instituted at the onset of combat operations in Iraq in 2003, would have made the 2007 priority production demand for new vehicles at this stage of Iraq operations less urgent and more measured in the consideration of all aspects of personnel safety.

This becomes significant when considering the fact that media and political pressure on the US Government and other Coalition governments with regard to the Iraq War has been largely spurred by casualty reporting. It is an inescapable conclusion that had proper personnel survivability precautions been taken in HMMWVs and other vehicles engaged in the war, then the numbers of deaths and injuries resulting from ambushes, blasts, and accidents could have been significantly reduced, and therefore the political pressures on Coalition governments regarding the conduct of the conflict would have been likewise reduced.

The MRAP family of vehicles is now being rushed into production, with production priorities which will skew the overall program of defense

systems production as a whole. The US trade newspaper, *Defense News*, said on May 28, 2007:

“The fast-growing, \$25-billion Mine Resistant Ambush Protected (MRAP) vehicles program may soon receive the Pentagon’s top-priority DX rating, reserved for acquisition efforts of the highest national urgency. But even that may not be sufficient to get the vehicles as fast as officials want them. A DX designation would put the planned procurement of some 22,000 MRAP vehicles in a select category with 16 other military programs, and make their production needs a discussion topic by a special joint group run by the deputy defense undersecretary for industrial policy. But the Defense Contract Management Agency has said that US firms will be able to handle a monthly production rate of no more than 900 vehicles, well short of the 1,200 requested by the Marine Corps, whose Systems Command (SysCom) runs the joint procurement effort.”

However, unless the new vehicles, and the M1114s being refitted as an interim measure, are fitted with appropriate seating, then the massive cost and resultant distortion to the defense procurement process through the diversion of priority materials, will be lost, and there will be an insufficient reduction in casualty levels as well as insufficient improvement in operational capability.

Sources within the five major vehicle manufacturers in the US associated with the new MRAP programs all indicated that they had complied, essentially, only with the written basic minimum requirement of the MRAP and M1114 up-armoring specifications because, given the finite budget allocations for the programs, any unilateral improvement in seating/safety would make their programs uncompetitive in the bids for USMC or Army contracts. As a result, crew survivability will not become an issue until the USMC and US Army mandate the appropriate specifications for seating and restraints.

It is known that both the USMC and US Army have been fully briefed on the available technologies to remediate the safety hazard by recognized authorities on crash/blast survivability, but have yet to translate the advice into the MRAP and M1114 upgrade specifications.

The US experience in developing doctrine to counter IED warfare — which is itself a constantly evolving phenomenon in the Iraq conflict (in particular) — has provided sufficient statistical data to enable the new family of

vehicles to be more effective and safe. However, the focus of almost the entire R&D and vehicle development effort has been directed toward deflecting blast, instead of coping with the impact of blast on crew survivability and warfighting sustainability.

The one particular seating and restraint system which was developed specifically to address the threat was the CCOPS (Common Crashworthy Occupant Protection System).³ CCOPS was originally developed under contract with the US Army to provide crash and blast protection to troops in all military ground vehicles. CCOPS addresses blast, slam down, rollover, rear impact (convoys), side impact and frontal impact. The Army contract tested the system in each of these crash modes and it performed in an exemplary fashion in all of the conditions while maintaining crew comfort and convenience. A follow-on version of CCOPS, known as the Cobra Soldier survivability system allows troops to comfortably use the seat-mounted belt restraints even when encumbered by gear such as body armor, *Camelbaks*, canteens, and other body-mounted equipment.

Transforming Threat Environment:

Significantly, new threat intelligence as of mid-June 2007 indicated that the Iranian Revolutionary Guard Corps (IRGC: *Pasdaran*) and Iranian-backed and independent *jihadi* groups operating in Iraq have been actively preparing new doctrine and IEDs to meet and defeat the new range of MRAP vehicles preparing for deployment to the Iraq combat theater.

Sources within the US Department of Defense (DoD) confirmed the reports. Several *jihadi* websites, in fact, had shown imagery of successful IED and other attacks against the early MRAP-type vehicles already deployed in EOD (explosive ordnance disposal) missions by the US forces in Iraq. Some 100 or so early MRAP-type vehicles have already been deployed to Iraq.

Sources confirmed that the insurgents were looking at ways to use underbelly or side blast weapons against the vehicles, and noted that the average attack to this point involved the use of around 100 lb. of explosive.

One DoD source at the Pentagon noted: “The reality is that, whatever we do, we are going to lose vehicles, even with the MRAP family of vehicles. Our main priority is to ensure that we safeguard personnel. Moreover, the DoD

³ CCOPS was developed under contract with the US Army National Automotive Center at the Detroit Arsenal and is currently produced by Global Seating Systems LLC, of Pennsylvania.

has recently made it clear — and spelled out for the first time — that personnel safety had primacy over platform safety.”

Despite the growing body of intelligence becoming available to the US Defense Department with regard to the scope and nature of the IED threat, many suppliers of components — and particularly seating — for the new MRAP vehicles have been designing and building their solutions not to meet the realistic threat environment, but rather to meet the testing criteria of the US Army and US Marine Corps. With blast tests in the 8-12 lb. range, versus average field experience in the 100 lb. range, it is clear that designing seating systems to meet test criteria alone courts operational disaster for US personnel.

Indeed, some of the US Army testing capabilities for the new vehicles have themselves been limited, with only sufficient test dummies to test the two front seats in the vehicles. The changing threat environment, then, has taken both industry and the military by surprise, to some degree.

Since the issuance of the original version of this document, the US Army and Marine Corps have worked toward redressing the areas of vehicle specifications which focus on energy attenuation and the two stages of blast with which the vehicles and occupants must contend. The Marine Corps, in particular, is taking advantage of the vast experience gained in aircraft (and particularly helicopter) seat design, while acknowledging the different requirements between the crashworthiness of aviation seats and the blast protection required for ground vehicles.⁴

However, failure of the US Defense Department to adopt this readily-available and low-cost solution in the production of MRAP and M1114 vehicles — and other vehicles — will result in unnecessary injury and casualty levels which could otherwise be avoided. Moreover, the benefit of this new technology for all military vehicles, not just those of the US, and, indeed, for civilian applications worldwide, would be profound.

Further Information:

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⁴ It is understood that the USMC and Army have worked closely with the key organization with undisputed expertise on aviation (including military aviation) seating crashworthiness, and which also designed and developed the CCOPS seating system, ARCCA, Incorporated, of Penns Park, Pennsylvania.