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United States Government Accountability Office
Washington, DC 20548

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Congressional Committees

Subject: Warfighter Support: Information on Army and Marine Corps Ground Combat Helmet Pads

Combat soldiers operate in diverse environments and face injury threats that place demands on the protective equipment systems they use to provide consistent protection throughout a range of temperatures and threat magnitudes. Protective helmets are one of those systems. In addition to protecting against ballistic threats, Army and Marine Corps ground combat helmets are now designed to absorb energy in order to reduce head injury risk from blunt impacts; previous combat helmets, such as the Personnel Armor System for Ground Troops helmet in use until 2002, were not designed to provide any tested levels of blunt impact protection.¹ The currently used Army Advanced Combat Helmet and Marine Corps Light Weight Helmet are outfitted with a pad suspension system to protect against these threats. These pad suspension systems have been found to offer superior blunt impact protection over the older sling suspension systems.

The Explanatory Statement accompanying the Consolidated Security, Disaster Assistance, and Continuing Appropriations Act of 2009 directed GAO to review ground combat helmet pads. In response, this report focuses on two objectives: (1) Who currently provides the pads used in Army and Marine Corps ground combat helmets, and how were they chosen? and (2) What efforts and research have been undertaken by the Army and Marine Corps to improve helmet pad performance and helmet technology? In addition, we have included information on servicemembers' use of helmet pads that are not approved. A timeline of events regarding helmet technology is included in the attached enclosure.

In April 2009, we provided congressional staff with a preliminary overview of our work, including our scope and methodology. This report summarizes that briefing and includes additional information subsequently obtained from Department of Defense officials. To conduct our review, we interviewed officials from the Army, Marines, and Defense Logistics Agency, as well as representatives from National Industries for the Blind, which packages and supplies helmet pads to the Army and Marines. We also met with representatives from two helmet pad manufacturers at their request. Further, we reviewed and analyzed test reports and other documentation related to helmet pad performance, although we did not evaluate the reliability or validity of the testing or test results. A detailed scope and

¹Examples of blunt impacts include trips and falls while maneuvering by foot, airborne (parachutist) operations, and motor vehicle or aircraft accidents where body flail and vehicle structural deformation could produce a head impact.

methodology is included at the end of this report. We conducted this review from December 2008 through July 2009.

Results in Brief

Both the Army and the Marine Corps currently use pads that are manufactured by Team Wendy, a company based in Cleveland, Ohio, and are supplied through National Industries for the Blind, an organization that packages and supplies helmet pads to the Army and Marines through the AbilityOne program. These pads were selected based on the results of prior Army testing, as well as value. Helmet systems, including helmet pads, have undergone a variety of tests, including tests to judge their relative protection in comparison with the sling suspension system and tests to judge comfort and ease of use.

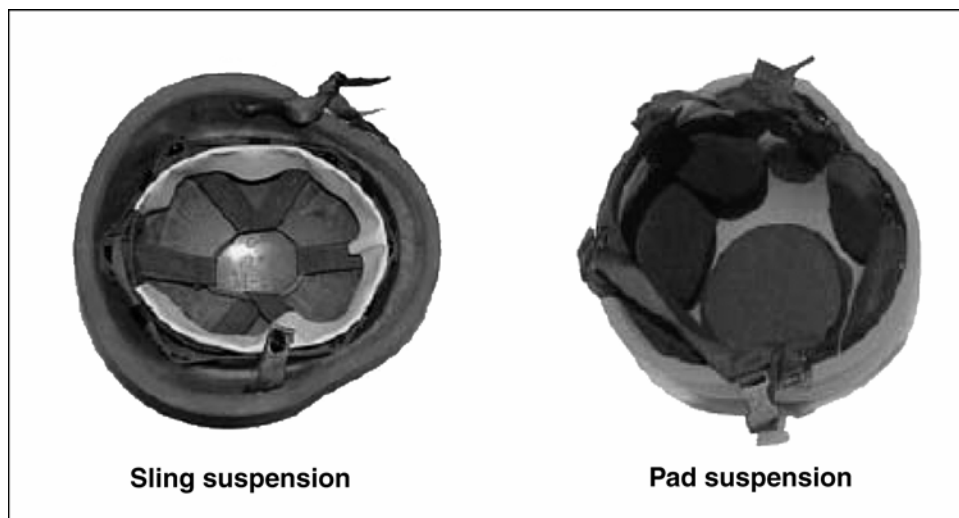
The Army and Marine Corps are actively seeking new options to improve helmet technology. In 2007, in an effort to spur industry to design a more effective pad system, the Army issued a request for information seeking an off-the-shelf technology solution that could increase blunt impact protection over the current performance standard. The current testing standard for blunt impact protection requires that a helmet dropped at a speed of 10 feet per second be able to diminish the force to which the wearer's head accelerates to under 150 g.² According to Army officials, the request for information called for the same degree of protection at a drop speed of 14.1 feet per second, with the ultimate objective of increasing this drop speed to 17.3 feet per second. To date, no manufacturer has submitted a pad system that passes the testing at 14.1 feet per second, but the Army believes that this call for an improved technological solution will motivate industry to develop better performing pads. Additionally, the services are looking for new alternatives for protecting against blunt impact injury. This effort includes outreach to other countries and sports organizations, and research into the causes of traumatic brain injury.

Background

Prior to 2002, both the Army and the Marine Corps used the Personnel Armor System for Ground Troops helmet that was equipped with a sling suspension system consisting of an adjustable leather band fastened around the head, as well as other supporting straps. Starting in 2002, however, the Army began evaluating new helmets and eventually fielded the Advanced Combat Helmet. The Advanced Combat Helmet uses a seven-pad suspension system affixed to the inside of the helmet using hook pile tape and was modeled after a similar helmet, the Modular Integrated Communications Helmet, then in use by Special Operations Command soldiers. Figure 1 shows the differences between the sling suspension and pad suspension systems.

² The notation of g or G denotes an acceleration equal to the acceleration of gravity, 980 centimeter per second squared, or approximately 32.2 feet per second per second at sea level. It is used as a unit of stress measurement for bodies undergoing acceleration.

Figure 1: Sling and Pad Suspension Systems



Source: U.S. Army Aeromedical Research Laboratory.

Concurrently, the Marine Corps also adopted a new helmet—called the Light Weight Helmet—to replace its Personnel Armor System for Ground Troops helmets. Although the Light Weight Helmet has a shell shape similar to that of the Personnel Armor System for Ground Troops helmet and provides the same coverage, it is constructed with lighter weight ballistic material that provides equivalent ballistic protection. When initially fielded, the Light Weight Helmet also used a sling suspension system, albeit somewhat modified. In 2006, however, the Marine Corps replaced this modified sling suspension system with the same pad suspension system used in the Army’s Advanced Combat Helmet.

The Army and the Marines Currently Use Team Wendy Pads Supplied by National Industries for the Blind on the Basis of Army Testing, Approval, and Value

Both the Army and the Marine Corps currently use pads that are manufactured by Team Wendy, a pad manufacturing company based in Cleveland, Ohio, and are supplied to them through National Industries for the Blind on the basis of Army testing, approval, and value. Helmet systems, including helmet pads, underwent a variety of tests, including tests to judge their relative protection in comparison with the sling suspension system. In 2005, the U.S. Army Aeromedical Research Laboratory reported on its evaluation of the blunt impact protection offered by pad suspension systems versus sling suspension systems. In that evaluation, the U.S. Army Aeromedical Research Laboratory tested the Advanced Combat Helmet with its standard pad configuration against two types of Personnel Armor System for Ground Troops helmet sling suspension systems: that of the infantry and that of the paratrooper, of which the latter includes some padding in addition to the sling. The U.S. Army Aeromedical Research Laboratory found that the pad suspension system offered superior blunt impact protection to either of the sling suspension systems. Again in 2006, the U.S. Army Aeromedical Research Laboratory tested pad suspension systems against sling suspension systems, this time assessing six different pad systems from five different manufacturers against the sling suspension system then used in the Marine Corps Light Weight Helmet. The U.S. Army Aeromedical Research Laboratory found that while all but

one of the pad systems passed the Army's blunt impact protection requirements, the Marine Corps Light Weight Helmet sling suspension system did not pass. Furthermore, while the test did not explicitly state which pad system performed the best, the data presented in the report indicate that Team Wendy pads were the all-around best performing pad system.

In addition to the blunt impact protection performance of helmet pads, the services also consider the comfort and ease of use of helmets, and they conducted user evaluations to assess the form, fit, and function of helmets. In March 2009, the Department of Defense reported on the most recent user evaluation of helmets. This limited user evaluation tested four helmet pad sets from four different manufacturers in both the Army Advanced Combat Helmet and the Marine Corps Light Weight Helmet. The evaluation found there was no significant difference in the form, fit, or function of the helmet pads tested.

To date, based on the results of the testing performed, the Army has approved pad systems made by two manufacturers—Team Wendy and Mine Safety Appliances—for use in its Advanced Combat Helmet, while the Marine Corps has chosen to limit its approval to one pad, and has approved only Team Wendy pads for use in its Light Weight Helmet. The approved pads used by the Army and the Marine Corps are consistent with the 2006 U.S. Army Aeromedical Research Laboratory testing results in that they showed the best performance relative to the other pads tested.

Administrators of the AbilityOne Program have identified helmet pads as appropriate for production by blind or severely disabled individuals and placed them on the Procurement List.³ Pursuant to the Javits Wagner O'Day Act, ordering offices are required to purchase supplies on the Procurement List from participating nonprofit agencies if they are available within the period required.⁴ The AbilityOne Program negotiated a contract for the National Industries of the Blind to be the nonprofit agency to produce helmet pads. National Industries of the Blind chose Team Wendy as its subcontractor, on the basis of value and the potential added value that it could contribute, to produce the pad components from among the Army-approved pad manufacturers.

Once National Industries for the Blind employees receive the pad components from Team Wendy, they cut and assemble pad sets, stamp required identification information on the individual pads, and assemble the pad systems in preparation for distribution. The completed pads sets are then sent to one of three places: Defense Logistics Agency depots, for Army and Marine sustainment stocks; the Army's Natick Soldier Research, Development, and Engineering center, for further testing and evaluation; or the helmet shell manufacturers, for insertion into helmets before distribution.

³The Committee for Purchase from People Who Are Blind or Severely Disabled administers the AbilityOne Program and selects for the Procurement List goods that can be produced according to the customer's quality and quantity standards, with at least 75 percent of direct labor being performed by blind or severely disabled individuals.

⁴41 U.S.C. 46-48c (2008). According to officials with the National Industries for the Blind, within 30 days after a good is added to the Procurement List, a contract is negotiated with a nonprofit agency to manage production of the good.

The Army and Marine Corps Are Actively Seeking More Effective Pad Systems

The Army and Marine Corps are actively working to improve helmet technology. In an effort to spur industry to design a more effective pad system, in November 2007 the Army issued a request for information seeking an off-the-shelf technology solution that would increase blunt impact protection over the current performance standard. The current testing standard for blunt impact protection requires that a helmet dropped at a speed of 10 feet per second be able to diminish the force to which the wearer's head accelerates to under 150 g. The request for information called for the same degree of protection at a drop speed of 14.1 feet per second, with the ultimate objective of increasing this drop speed to 17.3 feet per second. To date, no manufacturer has developed a pad system passing the 14.1 feet per second test, but the Army believes that this call for an improved technological solution will motivate industry to develop better performing pads.

In addition to improving helmet pads, the services are also looking into new alternatives for protecting against blunt impact injury, including a one-piece helmet liner currently used in some North Atlantic Treaty Organization countries, as well as a fluidic helmet liner. They have also reached out to sports and motor sports organizations that use protective helmets, although with the understanding that there are important differences between military helmets and sports helmets.⁵ Moreover, the services' efforts to develop new blunt impact protection mechanisms are performed in conjunction with research to better understand the causes of traumatic brain injury and how blast overpressure experienced during an explosion affects servicemembers. To this end, both the Army and Marine Corps recently deployed units to Iraq and Afghanistan with sensor-equipped helmets in order to gather useful data toward developing better protection against blunt impact. Additionally, the services are presently engaged in efforts to improve the ballistic protection of helmets, working to design helmets that can withstand impacts from higher-caliber weapon rounds.

Army and Marine Corps Are Aware of Use of Unapproved Pads and Have Taken Steps to Rectify This Practice

During the course of our engagement we became aware of the use of unapproved pads by soldiers and Marines, although the extent and impact of unapproved pad use is unknown. According to our limited work, such unapproved use occurs primarily in two ways. The first is through the purchase of pads by military personnel from the General Services Administration catalogue, which lists an assortment of pads intended for use by a variety of federal agencies. The second is through the procurement of pads by individuals or their family members or friends from commercial sources. Both the Army and the Marine Corps are aware of this problem and have issued directives specifically precluding the use of unapproved pads or other personal protective equipment.⁶

⁵Two important differences are that unlike sports helmets, combat helmets are designed to provide ballistic protection and may have to accommodate peripheral equipment such as night vision and communication devices.

⁶The Army and Marines have each issued directives that preclude the use of unapproved pads or other personal protective equipment and/or provide guidance on obtaining approved pads, including a 2004 Army Maintenance Advisory, a 2005 Army Safety of Use Message, a 2007 Marine MARADMIN notice, and a 2009 Army memo warning against the use of unapproved protective equipment.

Scope and Methodology

During this engagement, we gathered information on which pads were currently used by the Army and the Marine Corps and how they were tested and selected by reviewing documents and speaking with officials from the U.S. Army, Program Executive Office—Soldier; the U.S. Army Natick Soldier Research, Development, and Engineering Center; the U.S. Marine Corps, Program Manager Infantry Combat Equipment; the Defense Logistics Agency; National Industries for the Blind; and two helmet pad manufacturing companies, at their request. Additionally, we analyzed documents related to the selection and testing of helmet pads in use by the Army and the Marine Corps, including reports from the U.S. Army Aeromedical Research Laboratory. We gained an understanding of the testing and evaluation efforts by conducting extensive interviews with agency officials who either conducted or had expertise on the tests and evaluations. We did not, however, observe testing or evaluate test results, given the considerable lapse in time since such tests had occurred. We also did not evaluate the validity of the military specifications.

To gain a greater understanding of blunt impact protection mechanisms for future use in ground combat helmets, we spoke with the U.S. Army, Program Executive Office—Soldier; U.S. Army Medical Research and Materiel Command; and the U.S. Marine Corps Program Manager Infantry Combat Equipment. We also analyzed documents related to future methods for blunt impact protection, including materials supplied by helmet pad manufacturers, as well as presentation slides prepared for GAO by the services. We conducted our work from December 2008 through July 2009 in accordance with all sections of GAO's Quality Assurance Framework that are relevant to our objectives. The framework requires that we plan and perform the engagement to obtain sufficient and appropriate evidence to meet our stated objectives and to discuss any limitations in our work. We believe that the information and data obtained, and the analysis conducted, provide a reasonable basis for any findings and conclusions.

Agency Comments

DOD was given an opportunity to review and comment on a written draft of this report, and it provided only technical comments. We incorporated these into the body of the report as appropriate.

We are sending copies of this report to other interested congressional committees; the Secretary of Defense; the Secretary of the Army; and the Commandant of the Marine Corps. In addition, this report will be available at no charge on GAO's Web site at <http://www.gao.gov>.

If you or your staffs have any questions regarding this report, please contact me at (202) 512-8365 or solisw@gao.gov. GAO staff who made major contributions to this report include

Cary Russell, Assistant Director; Guy LoFaro; Emily Norman; Maria Storts; Karen Thornton; Cheryl Weissman; and Gerald Winterlin.

A handwritten signature in black ink, appearing to read 'W. Solis', with a long horizontal flourish extending to the right.

William M. Solis
Director, Defense Capabilities and Management

Enclosure

Congressional Committees

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Ranking Member
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United States Senate

The Honorable Daniel Inouye
Chairman
The Honorable Thad Cochran
Ranking Member
Subcommittee on Defense
Committee on Appropriations
United States Senate

The Honorable Ike Skelton
Chairman
The Honorable Howard McKeon
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable John P. Murtha
Chairman
The Honorable C.W. Bill Young
Ranking Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

Enclosure: Timeline of Events Regarding Helmet Technology

2001

- U.S. Army Special Operations Command approves Modular Integrated Communications Helmet; Army study reports that soldiers notice benefits.

2002

- Program Executive Office—Soldier surveys field and directs Advanced Combat Helmet testing. (March)

- Program Executive Office—Soldier conducts a limited user test of the Advanced Combat Helmet with Oregon Aero pads. (December)

2003

- Advanced Combat Helmet tested and approved to meet Army standards. (January)

2004

- Neurosurgeon in theater estimates there could be more head wounds due to limited coverage provided by Advanced Combat Helmet as compared with Personnel Armor System for Ground Troops helmet. (January – September)

- The Vice Chief Staff of the Army orders holistic review of Advanced Combat Helmet based on neurosurgeon's estimate. (October)

2005

- Combat Helmet Study released demonstrating Advanced Combat Helmet with pads to be superior to Personnel Armor System for Ground Troops helmet with sling suspension. (May)

- Army adopts Team Wendy pads.

2006

- House Armed Services Subcommittees write to Kenneth Krieg, Under Secretary of Defense Acquisition, Technology, and Logistics, about helmets, citing that pads are being supplied by non-military sources and request independent testing of helmets. (June)

- Advanced Combat Helmet non-ballistic impact requirement raised from 150g average and 300g maximum at 10 feet per second to 150g maximum. (November)

- U.S. Army Aeromedical Research Laboratory technical memorandum issued showing that pads provide better protection than suspension system. (December)

2007

- Undersecretary Krieg replies to House Armed Services subcommittees, and includes results of non-ballistic impact testing. (February)

- Ballistic neck protection introduced for Advanced Combat Helmet. (March)

- Testing of pads under new standard proposed in Army Request for Information for non-ballistic impact protection for Advanced Combat Helmet to maximum 150g at 17.3 feet per second (objective) and 14.1 feet per second (threshold). (November)

Enclosure

2008

- Army conducts a multi-organizational Criteria Review Board and subjects pad systems from five vendors to additional evaluation. (April)
- Army conducts congressionally directed ACH pad assessment on several manufacturers' pads, as well as a Limited Soldier Evaluation. (July-August)

2009

- Army continues to test for viability of a commercial pad system to provide increased non-ballistic protection to 150g maximum at an impact velocity of 17.3 feet per second (objective) or 14.1 feet per second (threshold). (February)
- DOD's Director of Operational Testing and Evaluation compiles a Limited Field User Evaluation to assess the relative form, fit, and function of four helmet pad systems. (March)

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