

Enhanced Combat Helmet (ECH)

Executive Summary

- The Enhanced Combat Helmet (ECH) successfully met its ballistic and non-ballistic requirements during its First Article Test (FAT). However, while the ECH protects against perforation by the specified small arms threat, it does not provide a significant overall improvement in operational capability over currently fielded helmets against that threat. The ECH provides improved fragmentation protection compared to the fielded Advanced Combat Helmet and the Light Weight Helmet (LWH).
- Subsequent to FAT, during Engineering Change Proposal (ECP) testing of helmets manufactured using new machinery and tooling intended to provide increased helmet production capacity, the ECH experienced unexpected ballistic failures.
- Ceradyne (the manufacturer) indicated it had identified the reasons for these ballistic failures and implemented corrective actions. The ECH Program Office conducted additional testing to verify the effectiveness of Ceradyne's corrective actions. The ECH continued to experience unexpected ballistic failures during this testing.
- The ECH Program Office and Ceradyne continue to investigate the reasons for the ballistic failures.
- The ECH Program Office has delayed production and fielding of the ECH pending identification and correction of the reasons for the ballistic failures. The ECH Program Office projects testing to determine the effectiveness of corrective actions will begin in early 2013.

System

- The Marine Corps developed the ECH in response to a 2009 Urgent Statement of Need to produce a helmet that provides ballistic protection from energetic fragments and selected small arms ammunition, yet maintains all other characteristics of the Marine Corps' LWH and the Army's Advanced Combat Helmet (ACH).
- The ECH is compatible with and is typically worn in conjunction with other components of infantry combat equipment such as body armor systems, protective goggles, night vision equipment, and a camouflage fabric helmet cover. This new helmet is intended to provide Marines and Soldiers improved protection compared to the currently fielded LWH and ACH.



- The ECH consists of a ballistic protective shell, a pad suspension system, and a 4-point chin strap/nape strap retention system. Unlike the ACH and LWH helmets, which are constructed with aramid fibers, the ECH is constructed using ultra-high-molecular-weight polyethylene fibers.

Mission

Forces equipped with the ECH will rely on the helmet to provide ballistic protection from selected small arms ammunition and fragmentation when engaged with enemy combatants during tactical operations in accordance with applicable tactics, techniques, and procedures.

Major Contractor

Ceradyne, Inc. – Costa Mesa, California

Activity

- The Marine Corps conducted FAT II during November and December 2011 in accordance with the DOT&E-approved test plan. Following successful completion of this FAT, the Marine Corps conducted Full-Up System-Level live fire

tests against both direct and indirect fire threats between December 2011 and February 2012.

- In April 2012, the ECH Program Office began testing ECPs to assess if helmets produced using new machinery, tooling,

or hardware (necessary to expand ECH production capability) continued to meet performance requirements prior to incorporating these new items into the production process.

- Due to unexpected ballistic failures during ECP testing, Ceradyne began an analysis of the causes for the failures, as well as actions required to correct the reasons for the failures. Ceradyne implemented corrective actions it thought would be effective and submitted newly-manufactured helmets for testing that began in late June 2012. The ECH Program Office designed the testing to verify that the corrective actions addressed the reasons for the ballistic failures, and that the helmets met ballistic requirements. However, the helmet continued to experience ballistic failures during this verification testing.
- In July 2012, the ECH Program Office assembled a team to assist Ceradyne with the subsequent failure analysis. Both the ECH Program Office and Ceradyne continue to conduct root cause analysis to determine the reasons for the ballistic failures.
- The ECH Program Office currently projects testing will begin in early 2013 to verify Ceradyne has corrected the reasons for the ballistic failures and that the helmets continue to meet requirements.

Assessment

- Although the ECH protects against perforation by the specified small arms threat, it does not provide a significant overall improvement in operational capability over currently fielded helmets against that threat. It is unlikely to provide meaningful protection against this small arms threat over a significant portion of the threat's effective range. However, the ECH does provide improved penetration protection against fragments relative to currently fielded helmets. The ECH met all ballistic performance requirements.
- In stopping high-energy threats, the helmet absorbs the projectile energy by deforming inward toward the skull. It is unknown, definitively, whether the ECH provides protection against injury when the deforming helmet impacts the head. There is, however, reason to be concerned because the deformation induced by the impact of a non-perforating small arms threat exceeds accepted deformation standards across most of the threat's effective range.
- There are no definitive medical criteria or analytic methods to correlate the extent of helmet deformation to injury. However, according to the Armed Forces Medical Examiner's Office, even absent medical studies definitively correlating helmet

deformation with specific injury, the deformation observed during testing represents significant blunt force and/or penetrating trauma to the head that could be lethal.

- While the ECH met the stated resistance to the perforation requirement against the specified small arms threat, one helmet shot location was more prone to small arms perforations than others. The ECH Program Office plans to implement an ECP to address this problem.
- Structural degradation as a result of prolonged temperature and humidity exposure may be a concern for the ECH. Published data document the degradation of ballistic performance in ultra-high-molecular-weight polyethylene materials, but the long-term performance of the ECH's specific ballistic material is unknown.
- The ECH Program Office has contracted to procure ECHs in production lots of mixed helmet sizes. There is no assurance that testing of these mixed lots will include sufficient numbers of the individual sizes produced within a lot to draw valid conclusions from the test results.

Recommendations

- Status of Previous Recommendations. There were no previous recommendations for this program.
- FY12 Recommendations. The ECH Program Office should:
 1. Conduct adequate testing to ensure the failures observed during ECP testing are identified and corrected. In addition, they should test and implement the planned ECP to address small arms perforation concerns at the one shot location. Until the ECP addressing the small arms perforation concern is implemented, the ECH Program Office should conduct adequate lot acceptance testing to ensure the helmet provides adequate protection from small arms perforation at all impact locations.
 2. Carefully monitor the results of lot acceptance testing when ECH production begins for indications of variations in the manufacturing process that could affect the ECH's ballistic protection.
 3. Improve ECH protection by reducing the amount of helmet deformation caused by non-perforating small arms impacts, as improvements in materials and manufacturing processes permit.
 4. Conduct testing to determine whether long-term exposure to elevated temperatures and humidity degrades ECH ballistic performance.
 5. Procure ECH in production lots of a single helmet size to ensure adequate lot acceptance testing.