

# Improved Safety and System Integration: Advances in Aircraft Maintainers Head Protection

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## PROBLEM STATEMENT

The Navy flight deck is one of the most hazardous and demanding work locations on Earth. The close proximity of man and machine during flight and maintenance operations produces a working environment in which advanced personal protective equipment is required to ensure the continued safety of the maintainer workforce. In addition, the challenges of integrating new technologies like Night Vision Devices (NVD) into the current flight deck helmet (cranial), and protecting personnel from the higher noise levels of modern air platforms such as VSTOL aircraft, have shown the inadequacy of this legacy capability as safe, integrated personal protection equipment.

Existing solutions for head protection, hearing protection, and system integration are becoming less effective in the face of ever-increasing aircraft noise, power, and complexity.

### **Head Protection**

Head protection is worn on the flight deck and flight line during launch and recovery operations for up to 16 hours at a time and the current 50 year-old flight deck cranial (FDC) was not intended to meet the rigors of current fleet maintainer use. The legacy system also does not meet NAVOSH (Naval Occupational Safety and Health) requirements. At the time of its development, the current cranial was not held to any specific performance requirements, as it was viewed as "better than nothing." Adaptive Technologies' advanced

FDC meets ANSI Z89.1-2003 Type II head protection requirements. In keeping with new industrial standards, the helmet also meets requirements for electrical protection in accordance with MIL-PRF-81735C(AS).

### **Human Factors**

Problems with human factors typically rank among the highest in complaints about the currently fielded system. Poor heat management, substandard hygiene, and lack of proper fit result in making it uncomfortable for extended wear. The FDC which Adaptive Technologies developed under this program has taken a bottom-up approach to the problem, starting with basic anthropometric requirements and building a suitable architecture around the war fighter to address the most frequent and serious complaints in human integration. The attention to detail in fit and comfort, combined with an understanding of the operational environment, has driven the design into an open, reconfigurable, easily-maintained system capable of meeting all Navy requirements.

### **Systems Integration**

Since the introduction of the current system some fifty years ago, technology to address hearing protection, communications, biological protection, night vision, and other needs have made significant strides. Unfortunately, the legacy cranial design remained stagnant, proving inadequate for integrating these currently available systems with the maintainer and the demands of his environment. The new FDC system addresses all known and projected technology for maintainer use, providing a stable, reliable platform around which systems can be built and integrated. Stable NVD use is now a viable option on the flight deck. In addition, CBR gear, legacy hearing protection, and advanced hearing protection systems can be used with this new design. Circumaural hearing protection has also been improved by decoupling head and hearing protection, ensuring proper fit and function every time.

### **WHO CAN BENEFIT?**

Adaptive Technologies, Inc. (ATI), in collaboration with its affiliated manufacturing company, Aegisound, is preparing to launch a new product line developed to meet the Navy needs for breakthrough improvements in head and hearing protection and communication functions in flight deck noise environments. The advanced flight deck cranial uses state of the art materials and manufacturing techniques to provide the highest levels of head protection ever used on the flight deck. This helmet, coupled with the digital active noise reduction (ANR) earplug and digital noise canceling (DNC) microphone products, leverage DSP technologies being delivered by the ATI/Aegisound design and manufacturing team, allowing the maintainer to reach unprecedented levels of performance. The improved head protection provides a new level of security for aircraft maintainers and other personnel on CVN, LHD, and LPD flight decks, and at USN and USAF flight lines.

Commercial opportunities are also available in any industries that require hard hat level protection. The system's ability to seamlessly integrate hearing protection and communications uniquely lends itself to industrial markets requiring simultaneous head and hearing protection.

## **BASELINE TECHNOLOGY**

The legacy cranial system designs are now more than 50 years old. The operational environments have dramatically changed, and legacy head and hearing protection systems inadequately address the new risks to maintainer health and well-being and do not provide the flexibility for incorporating new capabilities, such as NVD. Highlighted here are a few key areas in which legacy systems fail to meet the needs of today's USN maintainers.

**Fit Rate:** Today's Navy has a demographic considerably different than that of 50 years ago. Improvements in personal protective equipment (head and hearing) have been outpaced by the increasing proportion of women on the flight deck. As such, most head and hearing protection devices fail to properly fit as much as 30% of the flight deck population. It is imperative that the full range of the maintainer population from 5<sup>th</sup> percentile females to 95<sup>th</sup> percentile males be offered the same level of head and hearing protection as those for whom "one size fits all" actually works. The reality is that most "one size fits all" solutions really fit no one well.

**Integration with Advanced Technology:** As with the flight deck demographic, legacy head and hearing protection systems have been rendered all but obsolete by advancements in aircraft power and noise on the flight deck. Current flight deck cranials and hearing protection devices are also unable to cope with the introduction of night vision devices (NVD). The currently-fielded systems were designed at a time before NVD and therefore, only hearing protection was considered. As such, the ability to properly adjust NVDs for use during night operations adversely affects the user's ability to properly adjust the Hearing Protection Devices (HPDs) for proper hearing protection and vice versa. These technologies are currently being forced to work together even though neither was designed with the other in mind.

**Poor Hygiene and Comfort:** Navy maintainers have complained that the legacy cranial system is hot and uncomfortable, producing hot spots around the user's head. With more and more operations being conducted in hotter environments, the inability of the existing equipment to manage heat and stay clean is getting worse and worse. The current procedure to deal with soiled cranial liners is to discard and replace. Washing is possible, but causes more discomfort and lack of fit due to material shrink. The advent of new textiles and foams makes this a solvable problem.

**Impact Protection Standards:** The flight deck cranials being used today do not and have never met any form of industry or military standard for head protection. It is now commonplace that personal protection systems should be held accountable to traceable specifications for performance and protection. As such, the Navy is borrowing direction from industry ANSI specifications and imposing vertical and side impact requirements on all future cranials. This will greatly improve the level of protection and provide a better basis from which to design future systems.

## TECHNOLOGY DESCRIPTION

The advanced flight deck cranial helmet is being developed to address all known operational and usability problems associated with currently fielded head protection systems. Current solution deficiencies were identified through user surveys, specification reviews, safety center data analysis, and Navy engineering interviews. A head protection specification was adopted to allow as many system upgrades and performance enhancements as possible.



The new system architecture is taking advantage of state-of-the-art energy-absorbing materials and low-density foams to improve protection and comfort. Heat management, hygiene, safety, usability, and suitability have all played important roles in determining the product form and system architecture. The resulting system provides a level of comfort and fit unlike any system currently available to the flight deck maintainer. This new technology will allow full ANSI Z89.1-2003 Type II Class G protection when worn with or without hearing protection, providing the modularity when and where it is needed without compromising performance. The table below summarizes the most significant improvements being offered by the new technology.



**Features, Advantages, and Benefit of the Advanced Flight Deck Cranial**

<b>Feature</b>	<b>Advantage</b>	<b>Benefit to Customer</b>
<b>ANSI Z89.1 2003 spec compliance</b>	<b>Provides a known level of head impact protection</b>	<ul style="list-style-type: none"> <li>• Provides both vertical and side impact protection</li> <li>• Provides electrical protection in excess of 2200 VAC</li> <li>• Provides functional traceability to industry standards</li> </ul>
<b>Integration with NVD</b>	<b>Unlike current systems, this head protection system is specifically designed to interface with NVD</b>	<ul style="list-style-type: none"> <li>• More reliable eye-centric placement of NVD</li> <li>• Reduced fatigue (proper placement and balancing)</li> <li>• Reduced maintenance</li> </ul>
<b>Anthropometric fit</b>	<b>Provides proper fit from 5<sup>th</sup> % female to 95<sup>th</sup> % male</b>	<ul style="list-style-type: none"> <li>• Better fitment</li> <li>• Better comfort</li> </ul>
<b>Integration with current HPD</b>	<b>The system will be backward compatible with all hearing protection systems</b>	<ul style="list-style-type: none"> <li>• Increased usability</li> <li>• Use with legacy and new HPD systems</li> </ul>
<b>Modular design</b>	<b>Allows fast and cost-effective replacement of parts</b>	<ul style="list-style-type: none"> <li>• Better hygiene</li> <li>• Less costly to repair/replace</li> <li>• Less time for assembly and maintenance operations</li> </ul>

## CURRENT STATE OF DEVELOPMENT

The head protection system is currently at TRL 6 and is on an accelerated development track to meet the Navy's desired low rate production in 2010. Due to efforts and activities in the FDC System Development and Demonstration program, the TRL is expected to jump to TRL9 by July 2010.

## TECHNOLOGY AVAILABILITY

The helmet system has been prototyped and is being prepared for verification testing and T&E field-testing. A System Design and Development phase is supporting early technology transition costs for the APC-2G and full production is expected in FY11. The current development goals include:



- Finalize the production representative model of the APC-2G cranial system for testing in flight line and flight deck environments using USN fleet assessments (January 2010).
- Extensive qualification testing, including environmental and impact, is scheduled for CY 2009 and CY2010.
- Identify production process tradeoffs that impact ISO 9001:2000 quality control and production unit cost drivers.
- The entire FDC system, including head and hearing protection, is scheduled to begin Navy procurement in October 2010.
- The FDC system, either in whole or as piece part, will be available for procurement by all DoD agencies by July 2010.
- All FDC components will be ready for commercial sales by March 2010. Aegisound and Adaptive Technologies welcome inquiries into product sales and availability now.

## REFERENCE

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## ABOUT THE COMPANY

Adaptive Technologies, Inc. is a small business located in Blacksburg, Va. Since 1997, the engineering staff has completed numerous consulting contracts and has been awarded Phase II SBIR contracts by all of the various DOD agencies. Adaptive Technologies, Inc. provides R&D, design and engineering, and consultation on products and problems associated with noise control, hearing protection, signal processing, and control theory. World-class expertise and patented products are providing communication solutions for

military and commercial applications involving dangerous noise levels. ATI is dedicated to advancing the state of the art in hearing protection and improved communication for the war fighter and civilian. ATI holds key patent rights to the digital earplug and microphone technologies and is licensing manufacturing rights for all new products. Aegisound is an affiliated HubZone manufacturing company, also located in Blacksburg, VA, which has exclusive rights to ATI products. Aegisound plans to complete its ISO9001:2008 certification by February, 2010.