# *Report of the Defense Science Board Task Force*

on

# Patriot System Performance

# Report Summary


***January 2005***

***Office of the Under Secretary of Defense***
***For Acquisition, Technology, and Logistics***
***Washington, D.C. 20301-3140***

# Report Documentation Page

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This report summary is **UNCLASSIFIED.**

## Introduction

The Defense Science Board Task Force on Patriot System Performance began in August 2003 and concluded in June 2004. The Terms of Reference for the Task Force are given in Appendix A, the Task Force Membership is in Appendix B, and the briefings given to the Task Force are listed in Appendix C. This is the Report Summary. The complete Final Report is classified.

The Task Force investigated the lessons learned from the Patriot system performance in Operation Iraqi Freedom (OIF) and assessed if these lessons could be incorporated into the continuing development of Patriot and its follow-on system, the Medium Extended Air Defense System (MEADS). The Task Force concluded that the lessons can be incorporated into Patriot-MEADS. Two of the main shortfalls seen in OIF performance transcend just the Patriot system; they involve combat identification and situational awareness.

## Patriot Missile Defense

The Patriot role in OIF was defense against tactical ballistic missiles; it had no assigned air defense role, but it did have a self-defense role against anti-radiation missiles. The Patriot deployment was substantial, involving up to 40 U.S. fire units and 22 fire units from four coalition nations. Two types of Patriot interceptor missiles were used: the improved PAC-2 missile, which is the traditional Patriot interceptor; and a new hit-to-kill missile, the PAC-3. Both were used with success in OIF, with the bulk of the engagements falling to the PAC-2. All nine enemy tactical ballistic missiles that threatened areas designated for Patriot defense were engaged. Eight of these engagements were observed by enough other sensors to conservatively declare them successes; the ninth engagement is judged to be a probable success. None of the attacking tactical ballistic missiles caused any damage or loss of life to the coalition forces.

The Patriot battalions operated reliably, and the two variants of the interceptor missile worked well against these Iraqi tactical ballistic missiles. One can argue that these relatively slow missiles which did not break up in flight like the Scuds of Desert Storm, were not stressing targets; however, their short range and the coalition's goal of large defended footprints and high-altitude intercepts due to chemical warhead concerns made them somewhat stressing targets for the Patriot and their crews.

In an overall sense, the Task Force assessed the Patriot missile defense in OIF to be a substantial success.

## Fratricide Incidents

The Patriot system was involved in three regrettable fratricide incidents. Two of these incidents involved Patriot firings at coalition aircraft that in one case was classified as an attacking anti-radiation missile and an attacking tactical ballistic missile. Three aircraft crew members were lost in these two incidents. The third incident involved a U.S. aircraft firing on a Patriot battery believed to be an enemy surface-to-air missile system.

These incidents generally involved a complex chain of events and failures, and there is often insufficient data to pin down the exact causes of failure. However, a number of shortfalls can be identified.

First, our combat identification capability embodied in the Mode IV IFF system performed very poorly. This is not exactly a surprise; this poor performance has been seen in many training exercises. The Task Force remains puzzled as to why this deficiency never garners enough resolve and support to result in a robust fix. The number of coalition aircraft flights in OIF was enormous, 41,000, and the Patriot deployment was large, 60 fire units, so the possible Patriot-friendly aircraft observations were in the millions and even very-low-probability failures could result in regrettable fratricide incidents. We have to fix Mode IV and institute additional protection measures such as safe return corridors for our aircraft.

A second shortfall was the lack of significant situational awareness in our combined air defense system, which involved major systems such as Patriot, AWACS, and AEGIS. We tend to assume that data are routinely communicated from one system to the other, that targets are correlated, and target information is shared and assimilated by all. The Task Force believes that we are a long way from that vision. The communication links, the ability to correlate target tracks by disparate sensors, and the overall information architecture are simply not there. Thus, a Patriot battery on the battlefield can be very much alone. Its closest connection is its Patriot battalion headquarters unit, and in some cases in OIF even that connection was weak.

The third shortfall was the Patriot system operating philosophy, protocols, displays, and software, which seemed to be a poor match to the conditions of OIF. The operating protocol was largely automatic, and the operators were trained to trust the system's software; a design that would be needed for heavy missile attacks. The 30 days of OIF involved 9 engagements of tactical ballistic missiles which were immersed in an environment of some 41,000 coalition aircraft sorties; a 4,000-to-1 friendly-to-enemy ratio.

The solution here will be more operator involvement and control in the functioning of a Patriot battery, which will necessitate changes in software, displays, and training.

## Patriot-MEADS Development

The Task Force was asked to comment on the ongoing Patriot and MEADS programs, which recently were combined into a single program. The main question was – could the planned program assimilate the lessons learned in OIF?

The basic architecture of MEADS calls for a high degree of connectivity to other air and missile defense systems. This, plus the MEADS battery design with three radars with 360 degree coverage capability, should provide a high degree of situational awareness.

The recently combined Patriot-MEADS program plans a gradual infusion of MEADS software and components, so that in the 2015 era the Patriot system will have fully migrated to MEADS. The interceptor missile will be an improved version of the PAC-3. The Task Force believes this multi-year migration from Patriot to MEADS will be a challenging task. Adding to the challenge will be the relatively unique acquisition program that involves several European firms developing and producing major components of the MEADS system, in addition to U.S. firms.

During this long development-acquisition period, we need to upgrade and maintain our Patriot batteries, since they will be our main air and missile defense well into the future.

## Recommendations

The Task Force had recommendations in three areas. With regard to the fratricide incidents, we must find and fix the Mode IV IFF problem(s) and we must improve the situational awareness of our air defense systems. With regard to the Patriot system itself, we need to shift its operation and control philosophy to deal with the complex environments of today's and future conflicts. These future conflicts will likely be more stressing than OIF and involve Patriot in simultaneous missile and air defense engagements. A protocol that allows more operator oversight and control of major system actions will be needed.

With regard to the Patriot migration to become MEADS, the Task Force recommends a conservative course where we maintain a robust Patriot system as MEADS components are developed, proven, and integrated into Patriot battalions.

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# Appendix A

# Terms of Reference

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# Appendix A

## Terms of Reference

THE UNDER SECRETARY OF DEFENSE

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WASHINGTON, DC 20301-3010

ACQUISITION,
TECHNOLOGY
AND LOGISTICS

JUN 3 2003

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Terms of Reference - Defense Science Board Task Force on Patriot System Performance

You are requested to form a Defense Science Board (DSB) Task Force on Patriot System Performance.

The Task Force is to assess the recent performance of the Patriot System in OPERATION IRAQI FREEDOM from deployment through use across the threat spectrum. The Task Force should assess logistical, doctrine, training, personnel management, operational and material performance. The Task Force should also understand the causes of all fratricide incidents during OPERATION IRAQI FREEDOM.

The Task Force should identify those lessons learned which are applicable to the development of the Medium Extended Air Defense System (MEADS). The Task Force should also assess the current planned spiral development of the Patriot to ensure early incorporation of fixes discovered in the lessons learned process. The Task Force should provide a final report by December 2003 if possible.

The study will be co-sponsored by me as the USD(AT&L) and the Director, Defense Systems. Mr. William Delaney and GEN Michael Williams, USMC (Ret) will serve as Co-Chairmen of the Task Force. Dr. Kent Stansberry, Deputy Director, Defense Systems (Missile Warfare), will serve as Executive Secretary; and CDR Dave Waugh, USN, will serve as the DSB Secretariat Representative.

The Task Force shall have access to classified information needed to develop its assessment and recommendations.

The Task Force will be operated in accordance with the provisions of P.L. 92-463, the "Federal Advisory Committee Act," and DoD Directive 5105.4, "The DoD Federal Advisory Committee Management Program." It is not anticipated that this Task Force will need to go into any "particular matters" within the meaning of Section 208 of Title 18, U.S. Code, nor will it cause any member to be placed in the position of acting as a procurement official.

Michael W. Wynne
Acting

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# Appendix B

# Task Force Membership

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# Task Force Membership

**Task Force Co-Chairs**

**GEN Michael Williams, USMC (Ret.)**
*Logistics Management Institute*

**Mr. William Delaney**
*MIT Lincoln Laboratory*

**Task Force Members**

**Mr. Julian Davidson**
*Davidson Technology Inc*

**Dr. David Ebel**
*MIT Lincoln Laboratory*

**Mr. Robert Everett**
*Consultant*

**Mr. Charles Fowler**
*Consultant*

**LTG David Heebner, USA (Ret.)**
*General Dynamics Corp.*

**Mr. Cliff McLain**
*ARES Corp.*

**Dr. Dennis Murray**
*SAIC*

**Dr. George Schneiter**
*Consultant*

**Government Advisor**

**Mr. Mike Eison**
*Army PEO-ASMD*

**Executive Secretary**

**Dr. Kent Stansberry**
*OSD-ATL*

**DSB Secretariat**

**CDR David Waugh**
*United States Navy*

**Task Force Support**

**Mr. Mike Osborn**
*SAIC*

**Mr. Chester Kurys**
*MIT Lincoln Laboratory*

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# Appendix C

# List of Briefings

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# Appendix C

# List of Briefings

### August 26-27, 2003

Overview of Use of Patriot in Operation Iraqi Freedom – Mr. Michael Eison, Army Air, Space & Missile Defense Program Executive Office

Data Sources from OIF to Assess Patriot Performance (against threat targets and in friendly fire incidents) – Mr. Michael Eison, Army ASMD PE

Overview of DoD Plans for Integrated Air and Missile Defense – Mr. David Crim, OSD/AT&L

Army Development Plans for Combined Patriot/MEADS Program – Mr. Stan Sherrod, Army PEO ASMD

Patriot Performance in OIF Against Threat Targets – Mr. Michael Eison, Army PEO ASMD

Status of Investigation of Patriot Friendly Fire Incidents – Mr. Michael Eison, Army PEO ASMD

Patriot “Lessons Learned” to Date – Mr. Michael Eison, Army PEO ASMD

### October 2-3, 2003

Iraqi TBM threat review – Mr. Scott Stanfield

Performance of Patriot and Patriot Development Program Plan to Include Response to OIF Lessons Learned – COL Newberry

Overview of Patriot Volleys 2-15 – Mr. Don Adams, PEO ASMD Consultant

Friendly Fire Brief and Patriot Operational LessonsLearned – COL Jassey

Patriot logistics during OIF – Gifford Lee, LPTO

Detailed Comparison of MEADS and Patriot Requirements – MAJ Robertson and Bob Clune, LTPO

MEADS Risk Reduction Effort to include MEADS Architecture – MAJ Robertson, LTPO

**October 29-30, 2003**

Army Inspector General Investigation – COL Michael Rhoden

Air Force Friendly Fire Investigation – LtCol Bob Schwarze

Perspective of U.S. Central Command – LtCol John Miller

Work of Joint Air and Missile Defense Organization – JTAMDO

Perspective of 32d Army Air and Missile Defense Command – LTC David Mantiply

Work of Single Integrated Air Picture System Engineer (SIAP SE) – CAPT Jeff Wilson

Work of Joint Combat Identification Evaluation Team – Dr. Jeff Lutz

**December 11-12, 2003**

DoD Integrated Architectures – Dr. V. Garber, OSD/AT&L

SIAP/FIOP Industry Blue Ribbon Panel – Mr. George Smith

Patriot Performance in OIF – Raytheon

MEADS System Design – Lockheed Martin

OIF Major Combat Operations – Joint Forces Command

Patriot Performance in OIF – Mr. Larry Lewis, Center for Naval Analysis

**February 11, 2004**

Introduction and agenda for IFF discussion – CAPT Peter Riester, Naval Air Systems Command

Mode 4 Security – Mr. Don Crossman, National Security Agency

IFF Tutorial – Mr. Mark Cianflone, Naval Air Warfare Center

Center for Naval Analyses Briefing – Mr. Larry Lewis, CAN

Mode 5 Development & Performance – Mr. Mark Cianflone, Naval Air Warfare Center

**March 3-4, 2004**

JTAMDO on Near Term Possible Improvements in SIAP/Combat Identification – Dr. Barry Fridling, JTAMDO

Ban on Data In and Out of Theater & Limits in DoD Regulations on Track Correlation – Mr. Larry Lewis, CNA

Additional Assessment of F/A-18 Friendly Fire Incident – Mr. Don Adams, PEO ASMD

Training Issues for Evolution from Patriot to MEADS – COL Rob Jassey, TRADOC System Manager, Lower Tier

Joint SIAP System Engineering Organization on Near Term Possible Improvements in SIAP/Combat Identification – CAPT Jeff Wilson, USN

**April 7, 2004**

Patriot/MEADS Program Overview – Army

Discussion of Patriot Battle Management (software tabs, etc.) – Cliff McLain

Review of Lessons Learned by Others (JFCOM report on OIF, JCIET brief to Task Force, Army Center for Lessons Learned briefing on OIF) – OSD/AT&L

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