# Naval Audit Service

## Interim Audit Report

# Consideration of Hazardous Noise and Vibration in the Acquisition of the Expeditionary Fighting Vehicle

**This report contains information exempt from release under the Freedom of Information Act. Exemption (b)(6) applies.**

~~*Releasable outside the Department of the Navy only on approval of the Auditor General of the Navy*~~

**N2009-0002**
**16 October 2008**

## Obtaining Additional Copies

To obtain additional copies of this report, please use the following contact information:

**Phone:** (202) 433-5757
**Fax:** (202) 433-5921
**E-mail:** NAVAUDSVC.FOIA@navy.mil
**Mail:** Naval Audit Service
Attn: FOIA
1006 Beatty Place SE
Washington Navy Yard DC 20374-5005

## Providing Suggestions for Future Audits

To suggest ideas for or to request future audits, please use the following contact information:

**Phone:** (202) 433-5840 (DSN 288)
**Fax:** (202) 433-5921
**E-mail:** NAVAUDSVC.AuditPlan@navy.mil
**Mail:** Naval Audit Service
Attn: Audit Requests
1006 Beatty Place SE
Washington Navy Yard DC 20374-5005

## Naval Audit Service Web Site

To find out more about the Naval Audit Service, including general background, and guidance on what clients can expect when they become involved in research or an audit, visit our Web site at:

http://secnavportal.donhq.navy.mil/navalauditservices

**DEPARTMENT OF THE NAVY**
NAVAL AUDIT SERVICE
1006 BEATTY PLACE SE
WASHINGTON NAVY YARD, DC 20374-5005

7510
N2007-NIA000-0066.001
16 Oct 08

MEMORANDUM FOR PROGRAM MANAGER, EXPEDITIONARY FIGHTING VEHICLE PROGRAM OFFICE

**Subj: CONSIDERATION OF HAZARDOUS NOISE AND VIBRATION IN THE ACQUISITION OF THE EXPEDITIONARY FIGHTING VEHICLE (INTERIM AUDIT REPORT N2009-0002)**

Ref: (a) NAVAUDSVC Memorandum 7510 N2007-NIA000-0066, dated 10 Aug 07
(b) SECNAVINST 7510.7F, "Department of the Navy Internal Audit"

Encl. (1) Status of Recommendations
(2) Scope and Methodology
(3) Pertinent Guidance
(4) Center for Naval Analyses Veterans Hearing Loss Disability Costs
(5) Management Response From Program Manager, Expeditionary Fighting Vehicle

1. **Introduction.** The report provides results of the subject audit announced in reference (a). Section 4 of this report provides our finding and recommendations, summarized management responses, and our comments on the responses. Enclosure 1 provides the status of the recommendations. The full text of management responses is included in Enclosure 5. The Program Manager for the Expeditionary Fighting Vehicle (EFV) Program Office responded to the recommendations, and concurred with Recommendations 1 through 3, which are open pending completion of agreed-to actions. Actions planned by Program Manager, EFV Program Office meet the intent of Recommendations 1 through 3. These recommendations are considered open pending completion of the planned corrective actions, and are subject to monitoring in accordance with reference (b). Management should provide a written status report on the recommendations within 30 days after target completion dates. Summaries of the management responses, with our comments on the responses, are in paragraph 6. The complete text of the responses is in Enclosure 5.

a. This interim report addresses the results of our audit for the EFV. A senior Department of the Navy (DON) official requested that the Naval Audit Service verify that safety and occupational health issues were addressed during the acquisition process

of the EFV, through efforts to mitigate the identified noise and vibration hazards. The EFV Program Office made efforts to mitigate, and told us they are continuing efforts to mitigate, the identified noise and vibration hazards through design selection, which is compliant with the Military Standard 882D (MIL-STD-882D) "System Safety Design Order of Precedence." Mitigating these identified hazards through design selection helped reduce the exposure of Marines to hazardous noise and vibration. In addition, the EFV Program Office established risk categories that complied with required guidance. However, there were opportunities for program management process improvements. Details on our EFV audit results are presented in Paragraph 4, "Summary of Audit Results and Conclusions."

2. **Objective.** Our objective[1] was to verify that safety and occupational health issues were addressed during the acquisition process of the EFV through efforts to mitigate the identified noise and vibration hazards.

3. **Background**

a. **Consideration of Safety and Occupational Health Issues.** The Department of Defense (DoD) MIL-STD-882D, dated 10 February 2000, directs the integration of environmental, safety, and health hazard management into the systems engineering process for acquisition programs. According to the standard, management of mishap risk associated with actual environmental and health hazards is directly addressed by the system safety approach. The standard defines system safety as the application of engineering and management principles, criteria, and techniques to achieve acceptable mishap risk within the constraints of operational effectiveness and suitability, time, and cost, through all phases of the system life cycle. The objective of system safety is to achieve acceptable mishap risk through a systematic approach of hazard analysis, risk assessment, and risk management.

b. **Noise Hazard.** According to Military Handbook 1908B, dated 16 August 1999, steady-state noise is defined as a periodic or random variation in atmospheric pressure at audible frequencies. It may be continuous, intermittent, or fluctuating, with the sound pressure level varying over a wide range, provided such variations have a duration exceeding 1 second. The Handbook further defines impulse noise as a short burst of acoustic energy consisting of either a single impulse or a series of impulses. A single impulse lasts less than 1 second, where a series of impulses may last longer than 1 second. For this audit, we reviewed the identified hazards related to steady-state and impulse noise. According to the Office of the Chief of Naval Operations Instruction (OPNAVINST) 5100.23G, potentially hazardous noise exposure occurs in areas where

[1] The original objective was to verify that safety and occupational health issues are addressed during the acquisition process of the EFV. The objective was changed to specify the issues (noise and vibration hazards) that were assessed.

steady-state noise levels exceed 84 decibels (dBs) or where impulse noise levels exceed 140 dBs. The U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM) EFV Health Hazard Assessment report, dated March 2007, referenced OPNAVINST 5100.23F and Military Standard 1474D and specifically noted in Appendix C, "Health Effects and Medical Criteria," that a steady-state noise level of 84 dBs A-weighted[2] or greater is considered hazardous,[3] and an impulse noise level in excess of 140 dBs pulse is considered hazardous. According to the Naval Safety Center, continuous exposure to these hazardous noise levels reportedly leads to hearing loss. Furthermore, the Center for Naval Analyses reported that from 1996 to 2005, total Navy and Marine Corps veterans disability costs associated with hearing loss have steadily increased. The cost in 2005 was approximately $200.7 million (see Enclosure 4) for DON.

c. **Vibration Hazard.** According to the Naval Safety Center, vibration exposure can be caused by the use of poorly designed equipment and tools. There are two types of vibration exposures: segmental (hand/arm) and whole-body. For this audit, we reviewed the identified hazards related to "Whole-Body Vibration" (WBV). WBV occurs in workers who regularly operate commercial vehicles such as trucks and buses, heavy equipment, helicopters, rotary or fixed wing aircraft, and ships. The International Organization for Standardization (ISO) provides guidance for evaluating the effects of vibration on health. The ISO 2631-1 guidance establishes a "Caution Zone," which identifies the area where there is a potential for health risks. The ISO states that health effects have not been clearly documented or observed for values below the "Caution Zone," while health risks are likely for values above the "Caution Zone." Weighted acceleration vibration values ($m/s^2$) determine the corresponding exposure duration limit of the "Caution Zone" (see Table 1). According to the Naval Safety Center, continuous exposure to excessive levels of vibration can cause irreversible damage to the human body. Workers who are regularly exposed to WBV over time have been reported to suffer from lower back (lumbar) pain, and vertebral disc herniation, distortion, thinning, tearing, buckling, and sliding (prolapse). These conditions occur particularly in workers who are seated during their work shifts.

d. **The EFV.** The EFV is an armored and tracked amphibious vehicle, capable of transporting Marines from Naval ships located beyond the visual horizon to inland locations (see Figure 1). There are two variants of the EFV. The "Personnel Variant" is used to conduct amphibious operations and subsequent ground combat operations ashore. It has a crew of three, can carry 17 Marines ashore, and has a MK46 30 mm weapon station and 7.62 mm coax machine gun. The "Command Variant" is used as a tactical command post, allowing commanders to communicate with senior, adjacent, and

[2] According to OPNAVINST 5100.23G, A-weighted sound level is designated to approximate the response of the human ear to sound.
[3] This limit assumes no more than 8 hours per day of exposure to high noise levels.

subordinate maneuver units. At the time of this report, the EFV Program was in the System Development and Demonstration phase of the acquisition cycle, which began in Fiscal Year 2001, and the program had produced a second generation of prototype vehicles. EFV Program Office representatives stated that the program was restarting the System Development and Demonstration phase and would produce a third generation of prototype vehicles once a new contract is issued, which was awarded on 31 July 2008. According to DoD Instruction (DoDI) 5000.2, System Development and Demonstration has two major efforts: System Integration, and System Demonstration. System Integration is intended to integrate subsystems, complete detailed design, and reduce system-level risk. System Demonstration is intended to demonstrate the ability of the system to operate in a useful way, consistent with approved Key Performance Parameters. The next phase of the cycle is Production and Deployment.

**Figure 1**

Personnel Variant EFV. Picture courtesy of the EFV Program Office

We judgmentally selected and reviewed the following noise and vibration hazards identified by the EFV Program Office:

- Personnel Exposure to Steady-State Noise;
- Impulse Noise Exposure;
- Excessive Whole Body Vibration and Multiple Shock Levels Cause Personnel Injury during Land Mode; and
- Excessive Whole Body Vibration and Multiple Shock Levels Cause Personnel Injury during Water Mode.

e. Representatives from the EFV Program Office Environmental, Safety, and Occupational Health (ESOH) stated that the U.S. Army CHPPM provides findings and recommendations to the EFV Program Office because they are more familiar with tracked vehicles. EFV Program Office representatives provided the CHPPM EFV Health Hazard Assessment report, dated March 2007, which referenced test results conducted

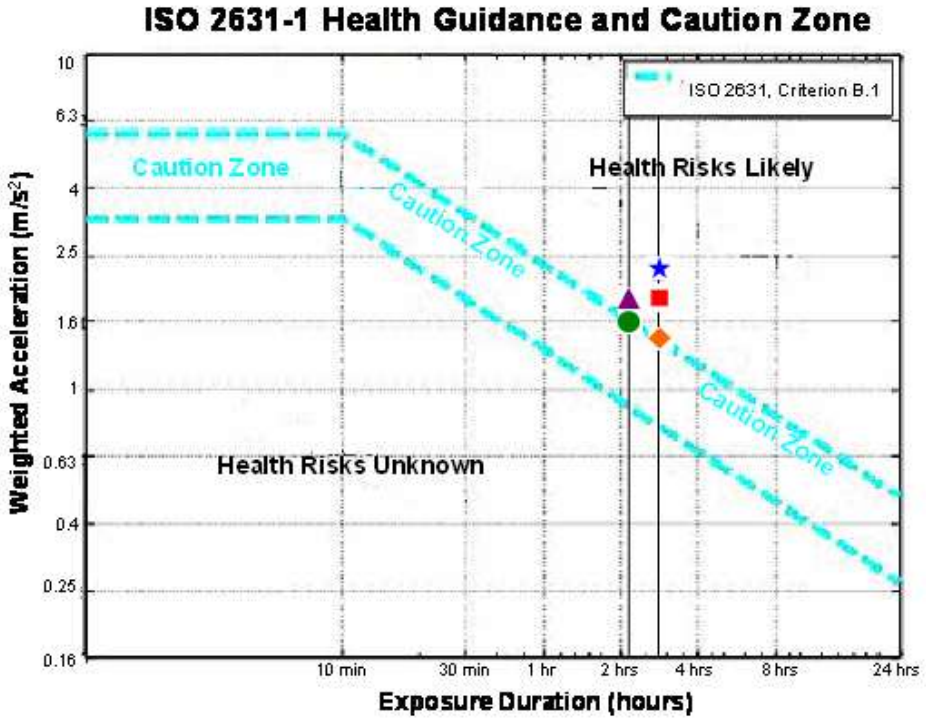
between December 2003 and March 2006, to support the following noise and vibration hazards related to the EFV:

- Steady-state noise levels ranged from 93 to 116.2 dBs (steady-state noise levels exceeding 84 dBs are considered hazardous);
- Impulse noise levels ranged from 134.5 to 176.9 dBs (impulse noise levels exceeding 140 dBs are considered hazardous);
- The land mission profile[4] was 2.12 hours with a vibration upper "Caution Zone" limit of 1.64 $m/s^2$ (see Table 1, green circle ). A driver of the EFV was exposed to vibration measured at 1.73 $m/s^2$ during testing, which placed the driver above the caution limit where health risks were likely to occur (see Table 1, purple triangle );
- The water/land mission profile was 2.85 hours with a vibration upper "Caution Zone" limit of 1.37 $m/s^2$ (see Table 1, orange diamond ). During testing, a driver of the EFV was exposed to vibration measured at 1.81$m/s^2$ and 2.13$m/s^2$, which again placed the driver above the caution limit where health risks were likely to occur (see Table 1, red square and blue star ).

These hazards were the basis of our review for this audit. According to the EFV Program Office, mitigation efforts have continued since the time of the CHPPM report, and noise and vibration levels have been further reduced.

[4] Military Handbook 1908B defines mission profile as a time-phased description of operational events and environments that an item experiences from beginning to end of a specific mission identified by tasks, events, durations, operating conditions, and environment.

**Table 1**




f. **Meetings.** We briefed our audit results to EFV Program Office management on 5 June 2008. In addition, we briefed our audit results to the following customers/stakeholders:

- Deputy Assistant Secretary of the Navy, (Research, Development and Acquisition) for Air Programs representatives - 19 March 2008;
- Deputy Assistant Secretary of the Navy, (Safety) - 8 May 2008; and
- Naval Safety Center representatives - 9 April 2008.

We provided a discussion draft to EFV Program Office representatives on 18 August 2008 and met to discuss the discussion draft report on 27 August 2008.

## 4. Summary of Audit Results and Conclusions

a. The EFV Program Office made efforts to mitigate, and told us they are continuing efforts to mitigate, the identified noise and vibration hazards through design selection, which is compliant with the MIL-STD-882D. Mitigating these identified hazards through design selection has helped reduce the exposure of Marines to hazardous noise and vibration. In addition, the EFV Program Office established risk categories that complied with required guidance. However, we also found that the EFV Program Office:

- Reduced the Risk Assessment Code (RAC)[5] based on exposure limitations in a testing environment, which was not compliant with MIL-STD-882D, Section A.4.4.3.2.2;
- Established risk acceptance authority levels that did not comply with DoDI 5000.2 and Secretary of the Navy Instruction (SECNAVINST) 5000.2C guidance; and
- Lacked sufficient details in their current log of mitigation efforts associated with the identified noise and vibration hazards.

The conditions discussed in this report were present for the period of our review from 18 September 2007 to 5 June 2008.

b. **System Safety Design Order of Precedence.**

(1) To determine if the EFV Program Office followed the system safety design order of precedence requirements, as outlined in MIL-STD-882D, Section 4.4, we conducted meetings with EFV Program Office Environmental, Safety, and Occupational Health (ESOH) representatives. Additionally, we obtained and reviewed the following documentation for each identified noise and vibration hazard:

- Personnel Exposure to Steady-State Noise – an illustration, assembly notes, and material specifications for the engine compartment panel that was installed;
- Impulse Noise Exposure – the Hazard Action Report,[6] which listed the incorporation of soundproofing as a "Selected Corrective Action;"
- Excessive Whole Body Vibration and Multiple Shock Levels Cause Personnel Injury during Land Mode – a chronological list of design efforts and associated test results; and
- Excessive Whole Body Vibration and Multiple Shock Levels Cause Personnel Injury during Water Mode – a chronological list of design efforts and associated test results.

(2) Based on the review of the above documentation and discussions with EFV Program Office representatives, we found that the EFV Program Office followed the MIL-STD-882D, Section 4.4, "System Safety Design Order of Precedence," for mitigating the identified noise and vibration hazards. Specifically, the EFV Program Office sought and implemented design changes, such as incorporating engine noise

[5] Risk Assessment Codes are a combination of severity and probability levels. Severity is defined as an assessment of the consequences of the most reasonable credible mishap that could be caused by a specific hazard. Probability is defined as the aggregate probability of occurrence of the individual events/hazards that might create a specific mishap.

[6] The Hazard Action Report is a "snap-shot" in time of a hazard record, and contains information such as a hazard description, RAC assignments, corrective actions, and a summary of mitigation efforts.

control panels and soundproofing materials to mitigate the identified noise hazards, and seat design changes to mitigate the identified vibration hazards. According to the Hazard Action Reports, Marines operating the EFV will wear hearing protection devices to mitigate the identified noise hazards. Mitigating the identified noise and vibration hazards in accordance with the system safety design order of precedence minimized exposure of these hazards to Marines.

c. **Assignment of RAC.**

(1) We conducted meetings with EFV Program Office ESOH representatives to determine if the EFV Program Office appropriately assigned RACs associated with the identified noise and vibration hazards, and maintained an appropriate process for evaluating the RACs in accordance with MIL-STD-882D, Section A.4.4.3.2.2. We also reviewed Hazard Action Reports for each of the identified noise and vibration hazards.

(2) We found that the EFV Program Office reduced the RAC initially assigned to the identified hazard related to steady-state noise and to both identified vibration hazards, was based on testing limitations imposed by the program office, rather than the life expectancy of the system, as required by MIL-STD-882D, Section A.4.4.3.2.2. Specifically, the rationale for reducing the RACs for these hazards included the implementation of exposure limitations on Marines in a testing environment (testing limitations). Testing limitations are restrictions placed on EFV operators to minimize their exposure to hazards during testing. EFV Program Office representatives stated that the testing limitations were not transferred to a fielded scenario, which we consider to be the planned life expectancy of the system. According to Hazard Action Reports, implementation of exposure limitations was reported as a selected corrective action to mitigate the identified hazard related to steady-state noise and both identified vibration hazards. For example, the testing limitation imposed by the EFV Program Office related to the "Excessive Whole Body Vibration and Multiple Shock Levels Cause Personnel Injury during Water Mode" hazard, was to limit occupant exposure times to calm seas during operational testing, until a solution was identified. According to the Hazard Action Report, this testing limitation was noted as a selected corrective action and was part of the rationale for reducing the RAC. EFV Program Office representatives verified that the exposure limitations were implemented to protect the test community. While this may be an appropriate procedure to protect operators in the testing environment, this does not comply with MIL-STD-882D, Section A.4.4.3.2.2, which defines mishap probability as the probability that a mishap will occur during the planned life expectancy of the system. Assignment and use of the appropriate RAC to manage risk is critical, because it directly impacts the visibility of the risk and its potential consequences, and determines how high in the chain of command the authority to accept the risk is vested.

(3) This condition existed because the EFV Program Office lacked sufficient internal controls related to ensuring that the RAC was based on the life expectancy of the system, as required by MIL-STD-882D, Section A.4.4.3.2.2, rather than the testing environment. EFV Program Office representatives stated that final RACs where testing limitations are imposed by the program office are reestablished prior to the system being fielded and the hazards being closed. However, we found that the EFV Program Office did not reestablish the RAC for another identified hazard[7] (not included in the analysis of the four previously mentioned hazards) prior to closure. The RAC assigned to this hazard was also reduced, in part, based on the implementation of testing limitations, and may have been closed at a RAC lower than appropriate.

(4) As a result of reducing the RAC based on testing limitations imposed by the program office, there may not be an appropriate level of visibility and awareness of the risk at higher command levels. Specifically, it could allow acceptance of the hazard and its residual mishap risk at the program manager level or below, rather than a higher level of the chain of command.

d. **Risk Categories and Risk Acceptance Authority Levels.**

(1) The EFV Program Office established risk categories that complied with required guidance. Risk categories are a combination of severity and probability levels and are classified as "high," "serious," "medium," or "low." While three of the risk categories differed from the requirement, they were more stringent than the categories specified in SECNAVINST 5000.2C, Enclosure 7, Section 7.3. Tables 2 and 3 illustrate the differences between the EFV Program Office's risk categories and those required by SECNAVINST 5000.2C (see Tables 2 and 3, categories IIIA, IIIC, and IID (bolded borders)). Establishing risk categories that were compliant with required guidance increases the potential that similar hazards and residual risks would be properly assessed in a manner that is consistent with like programs. This could enable DON leadership to properly evaluate safety and occupational health risks and make effective risk management decisions.

(2) While the risk categories were compliant, the EFV Program Office established risk acceptance authority levels that did not comply with required guidance. The EFV Hazard Approval/Risk Acceptance Procedures stated that "medium" risks could be accepted by the EFV ESOH Advisory Board while "low" risks could be accepted by ESOH working groups. This does not comply with DoDI 5000.2, Section E7.1.6, which states that the program manager is the authority for "medium" and "low" risks, and SECNAVINST 5000.2C, Enclosure 7, Section 7.3, which further states that risk acceptance authority may not be delegated below the program manager. Three of the

[7] Hazard titled, "Vehicle Plow-In during High Speed Water Operations due to Failure of Bow Flap Over Center Mechanism."

identified noise and vibration hazards (which were rated "medium" at the time of the audit) were categorized at a level of acceptance below the program manager. The remaining identified vibration hazard was rated "serious," and appropriately accepted at the Direct Reporting Program Manager (DRPM) level. Tables 2 and 3 illustrate the differences between the EFV Program Office's risk acceptance authority levels (see bold borders) and those required by SECNAVINST 5000.2C.

**Table 2: EFV Program Office Risk Matrix**

| Severity / Probability | Catastrophic (I) | Critical (II) | Marginal (III) | Negligible (IV) |
|---|---|---|---|---|
| Frequent (A) | IA | IIA | **IIIA**** | IVA |
| Probable (B) | IB | IIB | IIIB | IVB |
| Occasional (C) | IC | IIC* | **IIIC**** | IVC |
| Remote (D) | ID | **IID**** | IIID* | IVD |
| Imporobable (E) | IE | IIE* | IIIE | IVE |

| **Safety Risk** | **Risk Assessment Code** | **Decision Authority For Residual Risk** |
|---|---|---|
| HIGH | IA, IIA, IIA, IB, IIB, and IC | Component Acquisition Executive (ASN (RD&A)) |
| SERIOUS | IIIB, IIC, IIIC, ID, and IID | Direct Reporting Program Manager (DRPM) |
| MEDIUM | IVA, IVB, IIID, IE, IIE, and IIIE | **ESOH Advisory Board** |
| LOW | IVC, IVD, IVE | **ESOH Working Groups** |

*Note 1: Circles indicate the risk categories for each hazard. Purple = Excessive Whole Body Vibration and Multiple Shock Levels Cause Personnel Injury during Water Mode (IIC); Orange = Excessive Whole Body Vibration and Multiple Shock Levels Cause Personnel Injury during Land Mode (IIID); Blue = Personnel Exposure to Steady-State Noise and Impulse Noise Exposure (IIE).
** Note 2: Bolded borders indicate risk categories and authority levels that differed from SECNAVINT 5000.2C.

**Table 3: SECNAVINST 5000.2C Risk Matrix**

| Severity / Probability | Catastrophic (I) | Critical (II) | Marginal (III) | Negligible (IV) |
|---|---|---|---|---|
| Frequent (A) | High | High | **Serious** | Medium |
| Probable (B) | High | High | Serious | Medium |
| Occasional (C) | High | Serious | **Medium** | Low |
| Remote (D) | Serious | **Medium** | Medium | Low |
| Imporobable (E) | Medium | Medium | Medium | Low |

| Risk Level | Risk Acceptance Authority |
|---|---|
| HIGH | ASN (RD&A) |
| SERIOUS | DRPM, PEO/SYSCOM Commanders, or Flag -Level or SES designees |
| MEDIUM | **Program Manager** |
| LOW | **Program Manager** |

*Note: The colors were added and the matrix design was altered for comparison purposes.

(3) The EFV Program Office lacked sufficient internal controls related to ensuring compliance with the DoDI 5000.2, Section E7.1.6 and SECNAVINST 5000.2C, Enclosure 7, Section 7.3. The ESOH Hazard Approval/Risk Acceptance Procedures referred to the ESOH requirements and responsibilities identified in DoDI 5000.2; however, the risk acceptance authority levels noted in the procedures did not comply with DoDI 5000.2. Additionally, the procedures did not reference SECNAVINST 5000.2C, which contains more stringent risk acceptance authority level requirements. The EFV Program Office should comply with the more stringent policy, SECNAVINST 5000.2C. As a result of establishing risk acceptance authority levels that did not comply with required guidance, a hazard and its residual mishap risk may not be visible and accepted at the appropriate risk acceptance authority level.

e. **Tracking of Hazards and Residual Mishap Risk.**

Subj: **CONSIDERATION OF HAZARDOUS NOISE AND VIBRATION IN THE ACQUISITION OF THE EXPEDITIONARY FIGHTING VEHICLE (INTERIM AUDIT REPORT N2009-0002)**

(1) After reviewing the selected Hazard Action Reports from the EFV Program Office hazard database, we concluded that the program maintained a comprehensive database to identify, track, and monitor hazards and their mitigation efforts as required by MIL-STD-882D, Section 4.8 and Section A.4.4.8.1; however, there were opportunities for improvement. The database contained Hazard Action Reports which included:

- Type of hazard (i.e., environmental, safety, or occupational health);
- Activity status (e.g., Open, Closed);
- Brief description of the hazard and the potential effects;
- Initial and current RACs;
- List of suggested and selected corrective actions; and
- Chronological Action Summary that listed actions taken for each hazard.

We found that for the identified noise and vibration hazards reviewed, the database did not have sufficient details, in some cases, to identify the rationale and the supporting documentation used to establish and reestablish the RACs referenced in the Hazard Action Reports. For example, the Impulse Noise Exposure Hazard Action Report only listed the initial RAC and not the documents used to determine the initial RAC level. EFV Program Office representatives stated that they considered engineering reports such as the Bradley Tank Health Hazard Assessment and Safety Assessment when selecting the initial RAC; however, this was not noted in the Hazard Action Report.

(2) The EFV Program Office lacked sufficient internal controls related to ensuring that the actions taken to mitigate the identified noise and vibration hazards were consistently and sufficiently documented in the hazard database. Without sufficient details of actions taken to mitigate the identified hazards, management's ability to efficiently reference past efforts, associated levels of hazard severity and probability, and current initiatives, as well as develop future goals and milestones, may be limited. Basing program decisions on incomplete and inaccurate information could lead to insufficient mitigation of noise, vibration, and other hazards.

(3) EFV Program Office representatives stated that as a result of this audit, they intend to maintain more detailed Hazard Action Reports. Additionally, EFV Program Office representatives stated that they will reference hazard documents, such as meeting minutes, mitigation implementation schedules, and photos or diagrams to explain the hazards and their respective corrective actions from within the database. EFV Program Office representatives stated that they believe this enhancement will provide the detail necessary to maintain an accurate tracking of RACs and their reduction, and also provide a better understanding of the hazards to all hazard database users.

f. **Summary.** During the acquisition process of the EFV, the EFV Program Office followed the system safety design order of precedence when mitigating the identified noise and vibration hazards and established risk categories that complied with required guidance. However, the EFV Program Office incorrectly reduced RACs, did not follow required guidance relating to risk acceptance authority levels, and did not consistently and sufficiently track identified noise and vibration hazards and residual mishap risk. These conditions, if allowed to continue, may contribute to a hazardous environment of high noise exposure and vibration levels that, according to the Naval Safety Center, ensures permanent hearing loss and may cause irreversible damage to the human body. In addition to the personal cost to the Marine, the economic consequences of hearing impairment and bodily injury to the Marine Corps include: lost time and decreased productivity; loss of qualified workers through medical disqualification; military disability settlements; retraining; and expenses related to medical treatment.

5. **Recommendations.** We recommend that the Program Manager for the EFV Program Office:

**Recommendation 1.** Establish controls and provide oversight to ensure that appropriate RAC levels are maintained throughout the life cycle of the system, and RAC levels are not reduced based on testing limitations.

**Management response to Recommendation 1.** Concur. EFV Programmatic Environmental Safety and Occupational Health Integration (PESOHI) plans and procedures will be updated to reflect latest policies. The EFV Program Office will do a thorough review of the Hazard Tracking Database and ensure all RACs reflect the required policy and procedures. Target completion date: May 2009

**Naval Audit Service comment on management response to Recommendation 1.** The management response and planned actions meet the intent of the recommendation. EFV Program Office representatives subsequently communicated that the revised procedures will not allow RACs to be reduced based on test limitations put in place for prototype test vehicles. Because planned actions will take longer than 6 months to complete, they provided an interim status date of March 2009.

**Recommendation 2.** Reestablish risk acceptance authority levels in EFV Program Office policies and procedures and establish controls to ensure compliance with DoDI 5000.2, Section E7.1.6 and SECNAVINST 5000.2C, Enclosure 7, Section 7.3.

**Management response to Recommendation 2.** Concur. The EFV Program Office will review and update internal documents, charters, and guidelines to comply with regulations. Target completion date: March 2009

**Naval Audit Service comment on management response to Recommendation 2.** The management response and planned actions meet the intent of the recommendation.

**Recommendation 3.** Establish controls and provide oversight to ensure that the hazard database includes a full description of the rationale for establishing and reestablishing RACs and the supporting documentation used to make decisions.

**Management response to Recommendation 3.** Concur. The Hazard Tracking Database will be reviewed and rationales will be updated for all closed hazards. Also as part of Action 2, procedures will be revised to ensure open and future hazards are properly documented, including rationales for buying down the risk levels. Target completion date: August 2009

**Naval Audit Service comment on management response to Recommendation 3.** The management response and planned actions meet the intent of the recommendation. Because planned actions will take longer than 6 months to complete, EFV Program Office representatives subsequently provided an interim status date of March 2009.

6. Please provide all correspondence to the Assistant Auditor General for Installations and Environment Audits, XXXXXXXXXXXXXXXXXXX with a copy to the Director, Policy and Oversight, XXXXXXXXXXXXXXXX Please submit correspondence in electronic format (Microsoft Word or Adobe Acrobat file), and ensure that it is on letterhead and includes a scanned signature.

7. Any requests for this report under the Freedom of Information Act must be approved by the Auditor General of the Navy as required by reference (b). This audit report is also subject to followup in accordance with reference (b).

8. We appreciate the cooperation and courtesies extended to our auditors during their visit.

Subj: **CONSIDERATION OF HAZARDOUS NOISE AND VIBRATION IN THE ACQUISITION OF THE EXPEDITIONARY FIGHTING VEHICLE (INTERIM AUDIT REPORT N2009-0002)**

[redacted]

XXXXXXXXXXXXXXXXX
Assistant Auditor General
Installations and Environment Audits

Copy to:
UNSECNAV
OGC
ASSTSECNAV FMC
ASSTSECNAV FMC (FMO)
ASSTSECNAV IE
ASSTSECNAV MRA
ASSTSECNAV RDA
CNO (VCNO, DCNO (N1B), DNS-33, N4B, N41)
CMC (RFR, ACMC)
DON CIO
NAVINSGEN (NAVIG-4)
AFAA/DO
DASN (SAFETY)

**Enclosure 1:**

# Status of Recommendations

| Rec. No. | Page No. | Subject | Status[8] | Action Command | Target Completion Date |
|---|---|---|---|---|---|
| 1 | 12 | Establish controls and provide oversight to ensure that appropriate RAC levels are maintained throughout the life cycle of the system, and RAC levels are not reduced based on testing limitations. | O | EFV Program Office | 3/31/09 |
| 2 | 13 | Reestablish risk acceptance authority levels in EFV Program Office policies and procedures and establish controls to ensure compliance with DoDI 5000.2, Section E7.1.6 and SECNAVINST 5000.2C, Enclosure 7, Section 7.3. | O | EFV Program Office | 3/31/09 |
| 3 | 13 | Establish controls and provide oversight to ensure that the hazard database includes a full description of the rationale for establishing and reestablishing RACs and the supporting documentation used to make decisions. | O | EFV Program Office | 3/31/09 |

[8] / O = Recommendation is open with agreed-to corrective actions; C = Recommendation is closed with all action completed; U = Recommendation is undecided with resolution efforts in progress.

Enclosure 2:

# Scope and Methodology

The broader audit of "Consideration of Safety and Occupational Health Issues in Acquisition of Major Department of Navy (DON) Weapons Systems and Platforms," began on 10 August 2007 and is still ongoing. Separate interim reports will be issued on each system audited, and a summary report summarizing the individual system reviews and identifying systemic issues will be issued upon completion of our audit work. We conducted this audit of the "Consideration of Hazardous Noise and Vibration in the Acquisition of the Expeditionary Fighting Vehicle," (EFV) between 18 September 2007 and 19 September 2008. The period of review, and conditions noted in this report existed between 18 September 2007 and 5 June 2008.

We evaluated internal controls and reviewed compliance with regulations related to consideration of hazardous noise and vibration in the Expeditionary Fighting Vehicle acquisition process. The data quality was adequate for use in this audit.

We verified that the EFV noise and vibration levels posed a hazard to Marines and assessed the EFV Program Office's process of mitigating identified hazards. Specifically, we assessed mitigation efforts related to noise and vibration hazards. We conducted site visits and interviews with EFV Program Office Environmental, Safety, and Occupational Health representatives in Woodbridge, VA, and Camp Pendleton, CA to:

- Determine if the EFV noise and vibration levels posed a hazard; and
- Assess the EFV Program Office's process for mitigating identified noise and vibration hazards.

We judgmentally selected and reviewed the following four noise and vibration hazards identified by the EFV Program Office: (1) Personnel Exposure to Steady-State Noise, (2) Impulse Noise Exposure, (3) Excessive Whole Body Vibration and Multiple Shock Levels Cause Personnel Injury during Land Mode, and (4) Excessive Whole Body Vibration and Multiple Shock Levels Cause Personnel Injury During Water Mode. We also reviewed the Hazard Action Report for the hazard titled, "Vehicle Plow-In during High Speed Water Operations due to Failure of Bow Flap Over Center Mechanism." Additionally, we reviewed the EFV ESOH Hazard Approval/Risk Acceptance Procedures; EFV Safe and Ready letters; the Programmatic Environment, Safety, and Occupational Health Evaluation Summary; the U.S. Army's Center for Health Promotion and Preventative Medicine EFV Health Hazard Assessment report; the Bradley Fighting Vehicle Health Hazard Assessment; and design documentation.

We conducted this performance audit in accordance with Generally Accepted Government Auditing Standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

There were no prior audits relating to this subject, therefore, this report does not include a followup review of past audit recommendations.

Enclosure 3:

# Pertinent Guidance

**Department of Defense Instruction 5000.2, "Operation of the Defense Acquisition System,"** dated 12 May 2003, Section E7.1.6, states that the Component Acquisition Executive is the acceptance authority for high Environmental, Safety, and Occupational Health (ESOH) mishap risks identified by the program. The instruction adds that the Program Executive Office-level is the authority for serious risks, and the Program Manager is the authority for medium and low risks, as defined in the industry standard for system safety.

**Military Standard 882D, "Standard Practice for System Safety,"** dated 10 February 2000, outlines a standard practice for conducting the Department of Defense system safety approach and managing safety and health mishap risks in order to meet the Department of Defense commitment to protecting private and public personnel from accidental death, injury, or occupational illness.

- Section 4.4 states that mishap risk mitigation is an iterative process that culminates when the residual mishap risk has been reduced to a level acceptable to the appropriate authority. The system safety design order of precedence for mitigating identified hazards is:

    1. Eliminate hazards through design selection: If unable to eliminate an identified hazard, reduce the associated mishap risk to an acceptable level through design selection;
    2. Incorporate safety devices: If unable to eliminate the hazard through design selection, reduce the mishap risk to an acceptable level using protective safety features or devices;
    3. Provide warning devices: If safety devices do not adequately lower the mishap risk of the hazard, include a detection and warning system to alert personnel to the particular hazard; and
    4. Develop procedures and training: Where it is impractical to eliminate hazards through design selection or to reduce the associated risk to an acceptable level with safety and warning devices, incorporate special procedures and training. Procedures may include the use of personal protective equipment.

- Section A.4.4.3.2.2 defines mishap probability as the probability that a mishap will occur during the planned life expectancy of the system. It can be described in

terms of potential occurrences per unit of time, events, population, items, or activity.

- Section 4.8 requires a program to track hazards, their closures, and residual mishap risk. A tracking system for this information must be maintained throughout the system life cycle. The program manager must keep the system user apprised of this information. Section A.4.4.8.1 states each system must have a current log of identified hazards and residual mishap risk, including an assessment. As changes are integrated into the system, this log is updated to incorporate additions and/or changes. The Government must formally acknowledge acceptance and keep users informed of hazards and residual mishap risk associated with their systems.

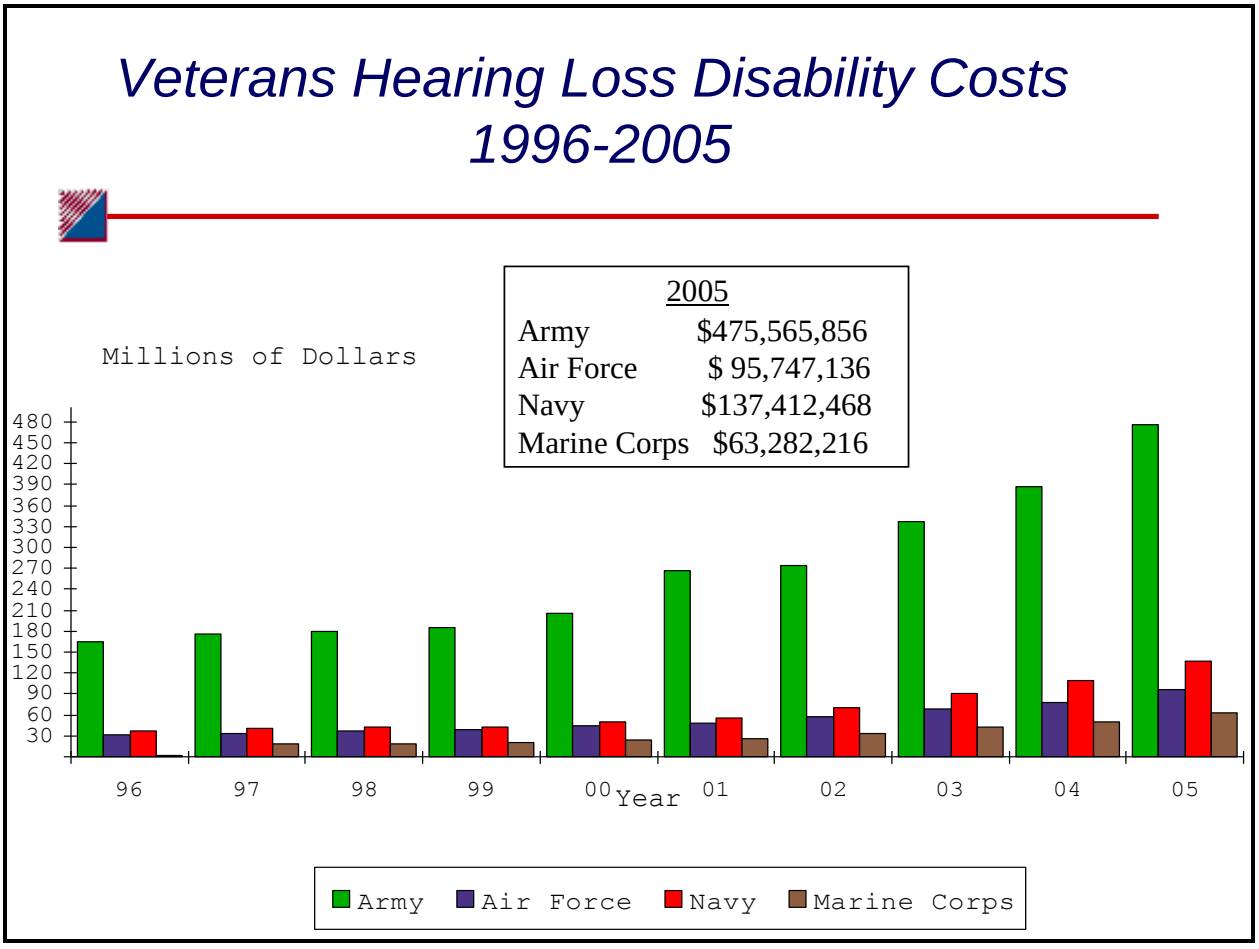
**Secretary of the Navy Instruction 5000.2C, "Implementation and Operation of the Defense Acquisition System and the Joint Capabilities Integration and Development System,"** dated 19 November 2004, Section 7.3, includes the following risk acceptance authority levels:

- High risks: Assistant Secretary of the Navy (Research, Development, and Acquisition) (ASN (RD&A));
- Serious risks: Program Executive Officers/Systems Command Commanders, or Flag-level or senior executive service designees/Direct Reporting Program Managers, Chief of Naval Research; and
- Medium/low risks: program managers. Risk acceptance authority may not be delegated below the program manager.

**Chief of Naval Operations Instruction 5100.23G, "Navy Safety and Occupational Health (SOH) Program Manual,"** dated 30 December 2005, Section 1801a, states that occupational hearing loss resulting from exposure to hazardous noise, the high cost of related compensation claims, and the resulting drop in productivity and efficiency, highlight a significant problem that requires considerable attention. The Instruction defines a potentially hazardous noise area as any work area where the A-weighted sound level (continuous or intermittent) is greater than 84 dBs, or where the peak sound pressure level (impulse or impact noise) exceeds 140 dBs.

**Enclosure 4:**

# Center for Naval Analyses Veterans Hearing Loss Disability Costs




Source: Center for Naval Analyses, "Computing the Return on Noise Reduction Investments in Navy Ships: A Life-Cycle Cost Approach," September 2006.

**Enclosure 5:**

# Management Response from Program Manager, Expeditionary Fighting Vehicle

**DEPARTMENT OF THE NAVY**
UNITED STATES MARINE CORPS
OFFICE OF THE PROGRAM MANAGER,
ADVANCED AMPHIBIOUS ASSAULT
14041 WORTH AVENUE
WOODBRIDGE, VA 22192-4123

IN REPLY REFER TO:
8400
PMAAA/smd
Ser 09.001
6 Oct 08

From: Program Manager
To: Naval Audit Service, 1006 Beatty Place, S.E., Washington Navy Yard, DC 20374-5005

Subj: RESPONSE TO NAVAL AUDIT FINDINGS

Ref: (a) NAVAUDSVC memo N2007-NIA000-0066.001 of 19 Sep 08

1. The following is written in response to the reference. We take one exception to the referenced report and have one recommended change.

a. We non-concur with Paragraph 3.e. which states "Steady-state noise levels ranged from 101.9 to 116.2 dBs…" The 101.9 value should be 93, the CHPPM report describes noise levels ranging from 93 – 116.2 dB(A).

b. Paragraph 3.d. states "EFV program office representatives stated that the program was restarting the SDD phase and would produce a third generation of prototype vehicles once a new contract is issued, which was completed on 31 July 2008." We recommend you revise the last clause to say "which is expected to be awarded by 31 July 2008."

2. Per paragraph 6 of the reference, PM AAA will take the following actions:

a. Recommendation 1. Concur - Establish controls and provide oversight to ensure that appropriate RAC levels are maintained throughout the life cycle of the system, and RAC levels are not reduced based on testing limitations.

PM AAA Action 1: PM AAA Programmatic Environmental Safety and Occupational Health Integration (PESOHI) plans and procedures will be updated to reflect latest policies. PM AAA will do a thorough review of the Hazard Tracking Database and ensure all RACs reflect the required policy and procedures. Target completion date: May 2009

b. Recommendation 2. Concur - Reestablish risk acceptance authority levels in EFV Program Office policies and procedures and establish controls to ensure compliance with DoDI 5000.2, Section E7.1.6 and SECNAVINST 5000.2C, Enclosure 7, Section 7.3.

Subj: RESPONSE TO NAVAL AUDIT FINDINGS

PM AAA Action 2: Review and update internal documents, charters and guidelines to comply with regulations. Target completion date: March 2009

c. Recommendation 3. Concur - Establish controls and provide oversight to ensure that the hazard database includes a full description of the rationale for establishing and reestablishing RACs and the supporting documentation used to make decisions.

PM AAA Action 3: The Hazard Tracking Database will be reviewed and rationales will be updated for all closed hazards. Also as part of Action 2, procedures will be revised to ensure open and future hazards are properly documented, including rationales for buying down the risk levels. Target completion date: August 2009

3. FOIA and FOUO designation of this report is not necessary.

4. PM AAA recommends that prior to publishing the audit report (Consideration of Hazardous Noise and Vibration in the Acquisition of the Expeditionary Fighting Vehicle), that if not already done, it be reviewed by AAG Research, Development Acquisitions & Logistics, Ms. Joan Hughes, since the report is written against an acquisition program.

5. My point of contact for this matter is [redacted], Director Systems Engineering, at [redacted] or [redacted].

FOIA (b)(6)

[redacted]

FOIA (b)(6)

Copy to:
PEO LS

**Use this page as**

# BACK COVER

**for printed copies**

**of this document**