FY 2003 SECRETARY OF DEFENSE ENVIRONMENTAL AWARDS PROGRAM

EXCELLENCE IN WEAPON SYSTEM ACQUISITION

PROJECT MANAGEMENT OFFICE—BRIGADE COMBAT TEAM

WORKING TOGETHER TOWARD A COMMON GOAL

INTRODUCTION

In October 1999, the Department of the Army announced their vision for what is now known as the Stryker Brigade Combat Team, the vanguard for Army transformation. The concept quickly became the Army's first fully-versatile fighting force. For the Project Management Office of the Brigade Combat Team (PMO BCT), merging design specs of the Army's newest family of combat vehicles with environmental responsibilities was not only a challenge, it was their mission. Under the guidance of Colonel David Ogg, Project Manager for the Brigade Combat Team (PM BCT), the Environmental Management Team (PM BCT EMT or Environmental Team), took a comprehensive approach to ensure that environmental issues were being addressed throughout development of the Stryker Family of Vehicles (FoV). Through pollution prevention techniques, waste minimization innovations, the implementation of an Environmental Management System (EMS) as well as environmental compliance strategies, the Stryker FoV program fully incorporated environmental, safety and occupational health regulations.

BACKGROUND

This versatile and fast-paced combat vehicle, which is named after two Medal of Honor winners, PFC. Stewart F. Stryker and SPC Robert F. Stryker, has rugged mobility, lethal firepower, and a full range of combat capabilities.

The Stryker FoV consists of two variants, the Mobile Gun System and the Infantry Carrier Vehicle. The Mobile Gun System serves as the direct fire platform that provides maneuver and infantry fire support for the Stryker Brigade Combat Team. The Infantry Carrier Vehicle serves as an infantry or mission vehicle platform. The remaining eight configurations are based upon the Infantry Carrier Vehicle configuration and include: the Commander's Vehicle; Fire Support Vehicle; Engineer Squad Vehicle; Nuclear, Biological, Chemical Reconnaissance Vehicle; Medical Evacuation Vehicle; Reconnaissance Vehicle; Mortar Carrier Vehicle; and the Anti-Tank Guided Missile Vehicle. The Stryker FoV allow the Army to adapt and maneuver with ease, which are key elements of survival on the battlefield.

▲ 6 Strykers in the National Training Center (NTC) Box.

All of the PMO BCT Divisions[1] worked as a team to ensure that functionality, costs, and scheduling remained a coordinated effort throughout the Stryker FoV's development. The Environmental Team proved to be a valuable asset to the PMO BCT by providing input from their expertise on environmental considerations. Together, they used the knowledge and skill of manufacturers, environmental engineers, soldiers and maintenance crew to identify pollution prevention opportunities. The Environmental Team included representatives from:

- BCT Technical Management, Acquisition Support, and Integrated Logistics Support Divisions
- Program Executive Office—Ground Combat Systems
- Tank Automotive Research, Development and Engineering Center Materials/Environmental Team

> ***"This is a tremendous combat vehicle, and it is totally appropriate that we name it after two great soldiers who gave their last full measure of devotion on the battlefield in defense of our nation."***
>
> ***—Jack L. Tilley, Sergeant Major of the Army***

[1] *The PMO BCT is part of the Program Executive Office – Ground Combat Systems (PEO-GCS), a tenant of U.S. Army Tank-automotive and Armaments Command (TACOM), based in Warren, Michigan.*

- Tank Automotive Research, Development and Engineering Center/Safety Office
- Tank-automotive and Armaments Command—General Law Division
- U.S. Army Acquisition Pollution Prevention Support Office (currently renamed Environmental Support Office)
- U.S. Army Research Laboratory
- U.S. Army Environmental Center
- General Dynamics Land Systems (General Dynamics)
- Anniston Army Depot
- Fort Lewis Environmental Natural Resources Division
- Fort Polk Environmental Natural Resources Management Division
- U.S. Army Forces Command

PROGRAM SUMMARY

The PMO BCT, alongside with the Environmental Team, proactively eliminated hazardous materials and resolved environmental concerns associated with the Stryker FoV. The PMO BCT worked closely with Fort Lewis and Fort Polk, two installations associated with fielding the Stryker FoV. PMO BCT strictly followed the Department of Defense (DoD) 5000.5 guidance to address life cycle environmental requirements for the weapon system while managing program cost and performance. The PMO BCT and Environmental Team proactively implemented innovative pollution prevention techniques and eliminated the use of several types of hazardous material such as hexavalent chromium (Cr^{+6}) and Cadmium (Cd). By PMO BCT and Environmental Team working as a team, every aspect of the Stryker FoV's development and testing remained in compliance with all environmental regulations.

▲ Engineer Squad Vehicle

As a result of PMO BCT efforts, the Stryker FoV is the first fielded United States Army ground combat vehicle system to:

- Eliminate the use of Class I and Class II Ozone Depleting Compounds (ODC) as fire suppression agents in both engine and crew compartment vehicle areas. ODCs were replaced with Fire Master 200 (containing sodium bicarbonate) in the crew area, and FE 25 in the engine compartment
- Eliminate the use of Class I and Class II Ozone Depleting Compound refrigerants
- Prohibit the use of highly toxic chemicals in production and vehicle support
- Require government review and approval prior to use of cadmium, hexavalent chromium, or other highly toxic or carcinogenic materials
- Implement an Environmental Management System (EMS)

> ***"We must provide entry forces that can operate jointly, without access to fixed forward bases, but we still need the power to slug it out and win decisively. Today our heavy forces are too heavy and our light forces lack staying power. We will address these mismatches."***
>
> ***—General Eric Shinseki U.S. Army (retired)***

Incorporating Environmental Analysis into the Acquisition Decision Making Process

The PMO BCT and the Environmental Team integrated environmental analysis throughout the Stryker's development. Through a coordinated effort, the team developed documents that were integral in identifying and

resolving environmental issues. These documents include:

- ***Interim Armored Vehicle Developmental Test and Evaluation Environmental Assessment (EA), March 2002.*** This EA helped identify known and potential impacts the Stryker FoV has on the environment during vehicle testing;
- ***Stryker Family of Vehicles Programmatic Environmental Assessment (EA), February 2003.*** This EA helped identify known and potential environmental impacts associated with the Stryker FoV's manufacture, operational testing, deployment, and demilitarization/ disposal during the Program's Low Rate Initial Production Phase;
- ***Stryker Environmental Quality Life Cycle Cost Estimate (EQLCCE), May 2003.*** Identified for PMO BCT and Department of the Army costs operation and maintenance costs as well as environmental costs throughout the system's life cycle and was integral in helping fielding installations summarize projected environmental costs; and
- ***Final Draft Stryker Programmatic Environmental Safety and Health Evaluation (PESHE), September 2003.*** This document helped PMO BCT gauge its progress in eliminating, mitigating, and resolving environmental, safety, and occupational health issues and provided resource direction in eliminating environmental safety and health risks.

Each of the documents helped PMO BCT reduce the Stryker FoV's impact on the environment. For example, during preparation of the programmatic EA, the team discovered that the vehicle hull could contain water with traces of petroleum, oils or lubricants (POL). The PMO BCT quickly amended technical manuals to include a warning directing that suspected contaminated hull water only be drained into installations' approved containers. This action eliminated contaminated wastewater from entering the environment.

▲ Mobile Gun System

The Environmental Team developed a system engineering methodology to ensure all environmental impacts were resolved and to implement pollution prevention opportunities where feasible. They also provided direct input on environmental issues and pollution prevention alternatives. Based on this input, the PMO BCT made critical decisions, where appropriate, to modify design and handling procedures for the Stryker FoV. This two-way exchange was important in developing a set of lessons learned that was shared across the Army and DoD.

The Stryker Environmental Quality Life Cycle Cost Estimate (EQLCCE) was selected as the EQLCCE model for the Army's Future Combat Systems.

Material Substitution

Contractual Requirements

Eliminating or reducing hazardous material from the Stryker program was a mission requirement. The PMO BCT addressed this requirement up-front during the contracting phase of development. The PMO BCT made certain that their contracts with General Dynamics, their prime contractor and an Environmental Team member, stressed the elimination or reduction

of hazardous materials during the Stryker's development. This action eliminated the need to redesign any vehicle component or implement any after-the-fact pollution prevention fixes. By taking this action, the PMO BCT successfully eliminated hazardous materials that could cause future environmental impacts.

The Stryker Requirements Contract specifically restricted the use of highly toxic materials identified in the Registry of Toxic Effects of Chemical Substances[2]. The PMO BCT allows the use of some materials that are mission critical providing there are no feasible alternatives available and that it does not impact system performance. They ensured that any such materials used strictly followed Occupational Safety and Health Administration Standards preventing personnel from excess exposure[3]. The PMO BCT also prohibited the use of highly toxic or carcinogenic materials such as hexavalent chromium, cadmium, and other hazardous materials without government approval, and restricted the use of radioactive or asbestos materials during manufacture or assembly of the Infantry Carrier Vehicle, excluding pre-approved Government Furnished Equipment. The BCT directed General Dynamics to eliminate ozone-depleting substances from the Infantry Carrier Vehicle as well. Since the Infantry Carrier Vehicle serves as the Stryker FoV's baseline vehicle, any requirements placed on it are automatically applied to the entire Stryker FoV.

Through active contract management and aggressive enforcement of pollution prevention measures, the PMO BCT addressed concerns listed in the Army user requirements for metal pretreatment, painting and fire suppression agents.

Environmental Team's Participation in Stryker FoV's Life Cycle

Stryker FoV Design
- PMO BCT
- TARDEC M/E Team
- TARDEC Safety Office
- TACOM General Law Division
- AAPPSO/ESO
- ARL
- General Dynamics

Stryker FoV Manufacturing
- PMO BCT
- TARDEC M/E Team
- TACOM General Law Division
- General Dynamics
- ANAD
- LATP
- ARL

Stryker FoV Logistics Support
- PMO BCT
- TARDEC M/E Team
- TARDEC Safety Office
- General Dynamics
- USAEC
- ARL
- Fort Lewis
- Fort Polk
- AAPPSO/ESO

Stryker FoV Test and Evaluation
- PMO BCT
- TARDEC M/E Team
- TARDEC Safety Office
- General Dynamics
- USAEC

Stryker FoV Operations
- PMO BCT
- TARDEC M/E Team
- TARDEC Safety Office
- AAPPSO/ESO
- USAEC
- Fort Lewis
- Fort Polk
- AAPPSO/ESO

Stryker FoV Disposal
- PMO BCT
- TARDEC M/E Team
- TARDEC Safety Office
- TACOM General Law Division
- USAEC
- General Dynamics
- ANAD

Stryker Life Cycle Costs
- PMO BCT
- General Dynamics
- ANAD
- USAEC
- Fort Polk
- Fort Lewis

Material Substitutions within the Stryker Family of Vehicles

Since the Stryker FoV is a new vehicle system program, the PMO BCT did not need to revise technical data packages and technical manuals; instead, alternative materials were substituted for commonly used hazardous materials during the technical data packages' and technical manuals'

[2] National Institute for Occupational Safety and Health (NIOSH) registry categorizes these types of materials as substances that will produce toxic effects via inhalation, ingestion, or absorption via the eye or skin.

[3] 29 Congressional Federal Record 1910

initial preparation. Rather than trying to "reinvent the wheel" and develop new alternatives for commonly used hazardous materials, PMO BCT and the Environmental Team used government and commercial information sources such as pollution prevention databases, joint service organizations and equipment manufacturers to identify existing alternative materials. The PMO BCT approved commercially available alternative materials that provide equal-to-superior performance over the hazardous materials they were replacing. Furthermore, every replacement material demonstrated lifecycle cost savings/cost avoidance to the Army and was previously validated, from outside studies, for use in the field.

The PMO BCT's proactive pollution prevention approach resulted in the Stryker FoV Program's continual environmental compliance and military readiness, and is easily transferable to other DoD weapons systems programs yet to be developed.

Actions taken to successfully implement alternative materials into the Stryker Program Technical Data Packages and Technical Manuals include:

- Eliminated use of DoD-P-15328 wash primer application to Stryker hull structures. The wash primer contains hexavalent chromium (Cr^{+6}) as well as high concentrations of volatile organic compounds (VOCs). The wash primer replacement involved the use of a direct-to-metal primer application technology
- Replaced Cr^{+6} containing aluminum pretreatments on non-electrical aluminum vehicle components with alternative aluminum pretreatments that do not contain Cr^{+6}
- Replaced cadmium (Cd) plating on fasteners and hardware with zinc plating
- Replaced Cr^{+6} post rinse treatment on zinc plated hardware with trivalent chromium post treatments
- Replaced Halon 1301, a halogenated fire suppressant, with Fire Master 200 plus sodium bicarbonate in the crew compartment and Fire Extinguisher 25 in the engine compartment. Both of the alternative fire suppressant agents do not contain Class I or II Ozone Depleting Compounds
- Replaced commonly used Class I and II Ozone Depleting Compounds based refrigerants with the R-134a refrigerant in the Commander's Vehicle and Nuclear, Biological Chemical Reconnaissance Vehicle. R-134a is neither a Class 1 nor Class 2 Ozone Depleting Compound
- Replacement of P-D-680 dry cleaning solvents with MIL-PRF-680 solvents in TMs. MIL-PRF-680 solvents have lower concentrations of VOCs and hazardous air pollutants than P-D-680 solvent mixtures

▲ Mortar Carrier Unit

Improved Program Management

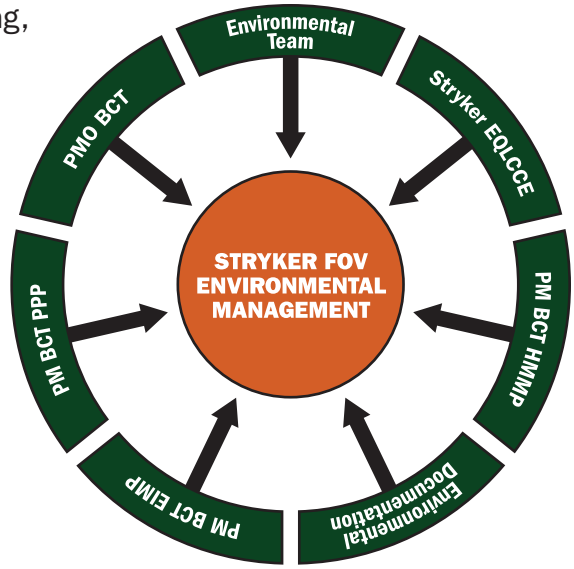
Environmental Management within Project Management Office Brigade Combat Team

In accordance with Executive Order 13148, the PMO BCT adopted an EMS

in fiscal year 2003 that successfully integrated environmental concerns and issues into the entire Stryker Program. The EMS identifies PMO BCT environmental management responsibilities, provides a process to prepare and update environmental documentation, and coordinates DoD 5000.2 requirements. By utilizing the EMS, the PMO BCT can now track environmental issues more efficiently and can resolve those issues while maintaining schedule. The Environmental Team also implemented the EMS within their responsibilities, resulting in a well-maintained and fully coordinated improved management program.

The PMO BCT established the PM BCT Hazardous Materials Management Plan (HMMP) and PM BCT Pollution Prevention Program. The PM BCT HMMP focuses on managing and documenting the use of hazardous materials in the Stryker FoV Program. Functionally, it breaks up the Stryker FoVs' life cycle into three general areas: manufacturing and vehicle integration activities; hazardous material requirements in technical manuals and Depot Maintenance Work Requirements; and Stryker vehicle demilitarization and disposal. This separation of Stryker FoV's life cycle results in a more focused effort for eliminating hazardous materials from the Stryker program. For example, the PMO BCT regularly reviews semi-annual lists of hazardous materials from each life cycle section that cannot be eliminated from the Stryker program. These reviews help correlate how a hazardous material use and elimination in one life cycle phase impacts the remaining cycles.

The PM BCT Pollution Prevention Program provides guidance on prioritizing, evaluating, and implementing pollution prevention opportunities into the Stryker FoV program. PMO BCT and Environmental Team utilize the PM BCT Environmental Impact Management Program to manage, track and resolve potential and real environmental impacts from the Stryker program. For example, the Fort Polk representatives to the Environmental Team notified fellow team members regarding potential improper disposal of contaminated internal vehicle hull water. Through the Environmental Impact Management Program and interaction with the Environmental Team members, PMO BCT has included additional text into the Stryker FoV technical manuals regarding disposal procedures of contaminated hull water.



▲ Contributing elements to the environmental management of the Stryker family of vehicles

Management of Non-hazardous Waste Streams

The Stryker FoV was designed with several features to help reduce and improve the management of non-hazardous waste streams. These design features included:

- Use of remote weapon station catch bags. Catch bags are positioned beneath the Remote Weapon System and function to trap empty shell casings ejected from the Remote Weapon Systems' M2 0.50 caliber machine gun or Mark 19 grenade launcher. Use of these bags eliminates the ejection of the empty

▲ Reconnaissance Vehicle

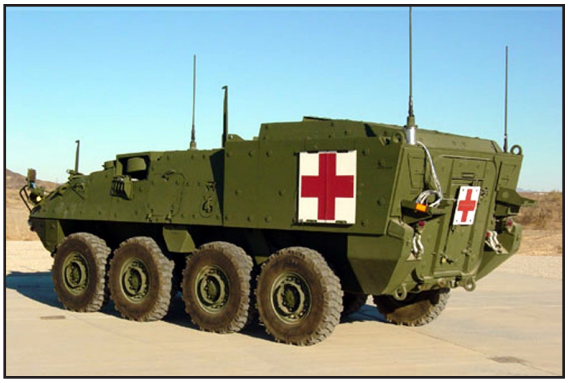
casings to the environment during vehicle weapon firing exercises.

- Use of the Stryker FoV on-board oil exchanger. The exchanger automatically injects used engine oil into the vehicle fuel tank. When this occurs, the fuel and used oil are mixed and burned as a reformulated fuel. Except for unscheduled maintenance activities, the apparatus eliminates the waste stream generated from engine oil draining.

The PMO BCT maintained and used an Integrated Digital Environment and an Internet File System to reduce the volume of office paper generated from making copies of important information and documents. The Integrated Digital Environment is an electronic network of Stryker FoV vehicle information such as presentations, technical and performance reports, meeting minutes, and technical specifications. The BCT created the Internet File System to electronically store this information. The Internet File System facilitates easy retrieval and controlled manipulation of all data in the system. For example, only one paper copy of each BCT environmental document is made with additional copies provided in only electronic format. PMO BCT personnel only used office paper that contained recycled fiber.

Research, Development, and Technology Demonstration/ Validation

Through focused Research, Development and Technology Demonstration/Validation the PMO BCT and Environmental Team successfully eliminated an application of Cr^{+6} and Cd from the Stryker FoV. Due to unavailability of commercial alternatives, some uses of C^{+6} still occur. For example, Cr^{+6} post treatment on fasteners such as bolts could not be replaced. The Environmental Team spearheaded the evaluation of a non-hazardous experimental trivalent chromium process developed by U.S. Naval Air Research Laboratory. Through a collaborative effort between the Naval Air Research Laboratory and Environmental Team members from General Dynamics and the Army Research Laboratory, the trivalent chromium process is being tested for use on the Stryker FoV and other ground combat vehicles. If that evaluation proves successful, the Naval Air Research Laboratory trivalent chromium process will be applied to fasteners, which will undergo further testing to verify performance of the trivalent chromium process. Successful testing will result in changes to technical data packages to incorporate the trivalent chromium process.



▲ Medical Evacuation Vehicle

▲ Fire Support Vehicle

Process Modification and Improvement

The PMO BCT and General Dynamics proactively added several process modifications and improvements into the Stryker FoV designs that help to eliminate potential sources of pollution generating activities. For instance, currently fielded ground vehicle systems have several locations where vehicle fluids such as engine oil and coolant can leak from vehicle components. These contaminants can have adverse affects to the environment. The PMO

BCT and General Dynamics designed the Stryker FoV to have a seamless lower hull that contains any fuel spills or leaks. Drainage holes have also been incorporated into the lower hull. These holes allow personnel to safely remove any spilled or leaked material in a controlled environment. Additionally, the PMO BCT added instructions on the proper draining method to all technical manuals. This design feature had no cost impact to the PMO BCT or to any of the installations fielding Stryker Program components. This seamless hull design feature can be transferred to designs for future ground vehicle systems.

Education and Outreach

The Environmental Team routinely shares its lessons learned in pollution-prevention and health risk mitigation methods throughout the Army and DoD. Initiatives in which the Environmental Team were involved include:

- Assisted the U.S. Army Program Management Office for Combat Systems and the Program Management Office for Future Combat Systems in reviewing coating technologies and metal pretreatments that PMO BCT used in the Stryker program
- Shared valuable information with U.S. Army Installation Management Agency as well as with testing and fielding installations that have not joined the Environmental Team. For example, the PMO BCT participated in the 2002 and 2003 Interim Force/ Stryker National Environmental Policy Act (NEPA) Process Coordination Meetings. At these meetings the PMO BCT gave installation personnel Stryker vehicle information to help in preparing their NEPA documents. PMO BCT presence at these meetings provided direct contact with installation personnel that resulted in a two-way exchange of information on the fielding and impact the Stryker would have to the environment
- The PMO BCT conducted public announcements and corresponded with newspapers local to manufacturing, testing, and fielding installations. Through this correspondence, the PMO BCT notified the public of the availability of Stryker related NEPA documents
- Environmental Team members are representatives of organizations that are spread throughout the nation. In a coordinated effort, this team is in the process of sharing Stryker program successes with state and local agencies, academic institutions, and industrial and civic organizations

▲ Stryker in the field

▲ NBC Reconnaissance Vehicle

ACCOMPLISHMENTS

With assistance from the Environmental Team, the PMO BCT coordinated the environmental efforts for the entire Stryker program. These efforts included:

- Reviewing requirements for hazardous materials and evaluating alternative materials from outside studies for feasibility;
- Evaluating alternative material use impact to vehicle operation and maintenance and potential financial consequences thereof;
- Ensuring that reduction of environmental issues and implementation of pollution prevention methodologies occurred at the earliest possible time in the Stryker FoV's life cycle, reducing cost and schedule conflicts; and

- Verifying that any alternative material did not decrease the Stryker FoV's military readiness nor result in new environmental, safety or occupational health issues.

The PMO BCT successfully coordinated all environmental activities in the Stryker program with federal agencies, contractors and military users. This included the preparation of the Interim Armored Vehicle Developmental Test and Evaluation Environmental Assessment, Stryker Family of Vehicles Programmatic Environmental Assessment, Stryker Environmental Quality Life Cycle Cost Estimate, and the Final Draft Stryker Programmatic Environmental Safety and Health Evaluation. The EMS that the PMO BCT implemented was successful in identifying and resolving potential environmental issues. The following table highlights these successes.

The Stryker FoV is a completely new vehicle program that required engineers to design, manufacture and test the system without the benefit of referencing lessons learned, cost histories or design manuals belonging to predecessors. The entire program was efficiently run to identify and eliminate or reduce potential hazardous materials up-front. These factors contribute to the difficult task of estimating exact cost savings obtained from alternative material trade-offs and process changes for the overall Stryker program. However, the PMO BCT, with the help of its partners, incorporated innovative pollution prevention techniques and eliminated materials from the Stryker that pose a threat to human health and the environment. The Stryker FoV is the fighting combat force of the future that will defend both our nation and our environment.

▲ Infantry Carrier Vehicle

Targeted Hazardous Material/ Pollution Source	Alternative Material/Process	Result
DoD-P-15328 wash primer application to Stryker hull structures	Direct-to-Metal application	Eliminated use of wash primer that contains 6.5 pounds per gallon VOC. Also eliminated approximately 2 pounds of Cr^{+6} pigment per vehicle
Halon 1301 (Class I ODC)	FM200 with sodium bicarbonate in occupied area and FE25 in engine compartment	Eliminated Class I ODC usage in Stryker FoV
Class I and II ODC based refrigerants	R-134a	Eliminated Class II ODC usage in Stryker FoV
Cr^{+6} aluminum pretreatments	Non-Cr^{+6} aluminum pretreatment	Impacted approximately 450 components/ items per vehicle
Cd plating	Zinc plating	Impacted approximately 400 components/ items per vehicle
Cr^{+6} post treatment on zinc plating	Trivalent chromium process	Impacted approximately 400 components/ items per vehicle
Vehicle POL spills	Seamless lower hull	Eliminated POL spills