PMA-231 Nomination for the FY 2012
CNO Environmental Awards:
Sustainability – Team

NAVAIR PMA-231 – Team Narrative

I. PROGRAM MANAGEMENT

Hawkeye, Advanced Hawkeye and Greyhound Program Office (PMA-231) reports to the Program Executive Office Tactical Aircraft Program. PMA-231 is responsible for modifying, maintaining, and upgrading the C-2A Greyhound, E-2C Hawkeye and E-2D Advanced Hawkeye (AHE) aircraft. These aircraft are all-weather, twin engine, carrier-based, Airborne Early Warning aircraft designed to extend task force defense perimeters. The E-2D AHE (Figure 1) is an E-2 upgrade that utilizes the E-2C Hawkeye 2000 configuration as a baseline and is equipped with an AN/APY-9 radar, a replacement for the AN/APS-145. The E-2C was designed to perform its mission over water, while the E-2D AHE expands its mission over land as well as water.

Figure 1: E-2D Advanced Hawkeye

The PMA-231 Environment, Safety, and Occupational Health (ESOH) Team maintains a robust ESOH program to ensure compliance with Department of Defense (DoD) Directive 5000.01; DoD Instruction (DoDI) 5000.02; Military Standard-882E; and other applicable policies, Executive Orders (EOs), and memorandums. The PMA-231 team assures a successful integration of an effective life-cycle ESOH program into the systems engineering process. The PMA-231 ESOH Team strives to resolve any ESOH issues pertaining to the manufacturing, test and evaluation (T&E), maintenance, operations, sustainment, training, and eventual disposal of the E-2D AHE at the end of the aircraft's life-cycle. The PMA-231 ESOH Team operates as an integral part of the PMA-231 programs; and has aligned ESOH management under Air Vehicle Systems. The PMA-231 ESOH Team participates on the PMA-231 Systems Engineering Integration Team Integrated Product Team (IPT). The PMA-231 ESOH Team works closely with stakeholders in the Air Vehicle, Mission Systems, Product Support, T&E, and Human Systems Integration teams. The PMA-231 ESOH Team attends semi-annual System Safety Working Group meetings where the PMA-231 ESOH Team Lead is a voting member. The PMA-231 ESOH Team routinely confers with other organizations within Naval Air Systems Command (NAVAIR) for opinions and guidance, including AIR 1.6-Environmental Programs and AIR 11.0-Legal Counsel.

PMA-231 was responsible for updating environmental acquisition documentation (e.g., Programmatic ESOH Evaluation, with signed approval obtained in July 2012) required by DoDI 5000.02. The E-2D AHE program is approaching full-rate production decision review (FRP DR) in second quarter fiscal year 2013.

Compliance with Executive Order 13514

The partnership between PMA-231 and Northrop Grumman Corporation (NGC) has resulted in measurable improvements towards energy efficiency as PMA-231 and NGC are both committed to protecting the environment. Pursuant to the President's goal expressed in EO 13514 – "It is therefore the policy of the United States that Federal agencies shall increase energy efficiency…" the NGC St. Augustine Manufacturing Center (SAMC), E-2D AHE's final assembly site, is committed to reducing energy and minimizing the environmental footprint related to its products and services.

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The SAMC Lighting Management Program continues to expand. In 2012 411 1,000-watt (W) metal halide lamps and 41 T-12 High Output fixtures were replaced with energy efficient T5 fluorescent lighting. Additionally 263 32 W lamps were replaced with more energy efficient 25W lamps. The program is designed to save an estimated 942,969 kilowatt-hour (kWh) per year (yr.) (Figure 2) and reduce greenhouse gas (GHG) emissions by 595 metric tons of carbon dioxide annually.

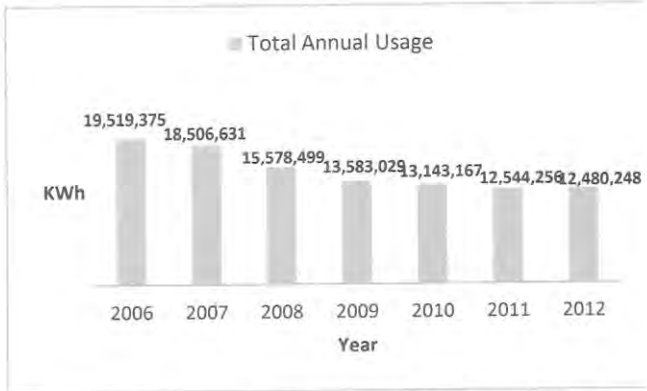

Figure 2: St. Augustine Electricity Reduction 2006-2012

The SAMC Building Automation Systems Program was expanded in 2012 with the addition of three highly efficient infrared radiant heating systems. These new systems replaced antiquated, inefficient systems used to heat manufacturing areas. The combined reduction in electrical and propane usage is designed to reduce GHG emissions by 258 metric tons annually.

The aggressive energy conservation initiatives implemented at SAMC since 2006 have reduced energy consumption by 7 million kWh per yr., or 35 percent, compared to the 2006 baseline.

The SAMC Water Conservation and Quality Program modified plumbing to be compliant with NGC's best management practices for water. In addition, SAMC treated 185,000 gallons (gal.) of groundwater to reuse in their industrial depaint/washing processes. These efforts reduced water usage by 185,000 gal./yr.

II. TECHNICAL MERIT

Material Management

A significant number of sustainable design strategies have been integrated throughout PMA-231 programs. The following material substitution initiatives were employed to help reduce costs, emissions, and hazardous materials (HAZMATs) usage.

NGC Materials and Processes conducted an alternative material investigation for reducing ozone depleting substances and compounds with high global warming potential in aircraft cleaning applications on the E-2. Interior and exterior cleaning products prior to prime, topcoat and final cleaning at SAMC, such as 3M Performance Fluid PF-5070, have an exceptionally high global warming potential (GWP). PF-5070 is perfluoro-based and has a GWP of over 5,000 and atmospheric lifetime of over 1,000 years. Typically 1,560 pounds of cleaner is used annually on E-2 aircraft during production and overhaul activity.

Two new products were successfully evaluated that have significantly lower GWP: 1) 3M Novec 7100 Engineered Fluid; and 2) 3M Novec 72 FL engineered fluid. The new cleaners are methyl and ethyl nonafluoro-based and have a GWP of 280-320 and atmospheric lifetime of four years, three orders of magnitude lower than the legacy cleaner.

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Test materials representative of E-2D AHE production aircraft were exposed to various contaminates that are typically seen during the production process for cleaning, including hydraulic fluid, lubricating fluid and grease. Qualification testing concluded two of the selected cleaning products performed equivalent to or better than the current cleaning product, PF-5070, in all aspects of the testing. In January 2012 the applicable NGC Standard was updated to include Novec 72 FL and Novec 7100 as qualified for aircraft cleaning at the SAMC site, reducing high GWP product usage by 1,560 pounds per year. The cleaners are used for cleaning new E-2D AHE production for Navy as well as legacy E-2 (Figure 3) overhauls for foreign customers. Both Novec 72 FL and Novec 7100 could be substituted in maintenance/overhaul cleaning processes and in production for other Naval Aviation Enterprise (NAE) weapon systems that have similar paint scheme and materials, further reducing GWP product usage.

Figure 3: Personnel Using Cleaning Product to Clean the Aircraft

Diisocyanates are commonly found in many commercial products used by DoD, including "foamed in place" polyurethane plastics. Some diisocyanates are regulated under occupational health rules. Diisocyanate is an allergen and sensitizer with sensitivity to diisocyanates having a dangerous systemic reaction to extremely small exposures. Documented cases of exposure have been found to cause asthma, lung damage and in severe cases fatal allergic reactions.

The E-2D AHE slab fin assembly uses a polymeric diphenylmethane diisocyanate foam material for vibration stabilization, UTC 7007 by Urethane Technology Company, Inc. NGC initiated an alternative material investigation to eliminate the diisocyanate foam from the slab fin assembly design. Candidate materials were included in a producibility study and qualification testing to select less HAZMATs. A mechanical test program, including core shear and flatwise tension, demonstrated strength of the candidate materials compared to the diisocyanate foam. Test coupons were fabricated and tested as representative of the slab fin assembly for the original material and the replacement candidate material for side-by-side equivalency testing. The final candidate replacement product was core splice adhesive AF-3002 by 3M. Drawings were updated in March 2012 and the new adhesive material will be implemented in production starting with E-2D AHE aircraft AA-18. The change will eliminate a total of 174 pounds of diisocyanate from E-2D AHE aircraft.

The E-2 windscreens utilize a gold layer to protect the aircrew from electromagnetic radiation generated by the radar system. The gold layer is located on the interior surface of the windscreen in the legacy design, and is vulnerable to scratching and scuffing especially during cleaning (Figure 4).

Approximately 12 side and 16 hatch windows are replaced annually due to low visibility from scratches, scuffs and crazing.

Figure 4: Personnel Cleaning the Windshield on the E-2C

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The E-2D AHE program initiated a new design that embeds the gold layer between two layers of windscreen material for better durability. In addition in December 2011 NGC qualified a low hazard cleaning procedure that will significantly increase the longevity of the new windscreens. Whiz Aircraft Cleaning Compound by Texstars, Inc., a naphtha/isopropyl-alcohol mix in 80 percent water, was identified for scratches and scuffs that require detailed polishing. The ability to polish out scratches, scuffs and crazing without impacting the protective gold layer will significantly increase the windscreen lifetime and save the E-2D AHE Fleet an estimated $348,000 annually.

Past operations at the SAMC site allowed out-of-station paint spray operations where primers and paints containing target Hazardous Air Pollutants (HAP) were used. Recent changes to federal regulation CFR 40 Part 63 Subpart 6H - National Emissions Standards for HAP, now requires spray applications to be contained in a spray booth or mobile enclosure. To fulfill this requirement and assist SAMC in reducing/preventing pollution, the site has restricted all painting activities to paint booths and preparation stations that have a full roof with at least three complete walls, and that has a filtration system with a 98 percent recovery rate and negative pressure ventilation. SAMC has also purchased and uses high volume, low pressure paint guns, along with enclosed paint gun cleaners that can recycle and reuse cleaning solvent. The addition of this equipment has further helped the SAMC reduce emissions, reduce solvent consumption used for cleaning equipment by 38 percent (400 gals.), and to eliminate 400 gals. of hazardous waste.

III. ORIENTATION TO MISSION SUSTAINABILITY

Hazardous Materials Management and Pollution Prevention

PMA-231 and NGC remain cognizant of HAZMAT management/pollution prevention (P2) responsibilities. In accordance with HAZMAT documentation requirements per DoDI 5000.02, HAZMATs on the E-2D AHE are documented in the E-2D AHE HAZMATs Management Program (HMMP) Database. The database includes the identified HAZMAT, the location and estimated quantities of HAZMAT incorporated into the E-2D AHE system, and the HAZMAT used in manufacturing the E-2D AHE. The database was initially designed to capture NGC and major supplier HAZMAT data. However, the weapon system contains components produced by many lower tier suppliers as well.

Table 1: HMMP Database Sample HAZMAT E-2D AHE Data

Supplier Safety and HMMP Submittals						
System and Supplier:	Contract No.	System Safety Rpt: 123-SAFT-001/001A	Safety Assess. Rpt: DI-SAFT-80102B	Health Haz Assess. Rpt: DI-SAFT-80106B	HMMP Rpt: DI-MISC-81397	HMMP Plan: DI-MGMT-81398
3253 Model K Voice and Data Recorder (KVADR) - GE Aviation	123U-SRD-153	3253K11-001	3253K11-001	N/A	N/A	N/A
ADS-18 Rotodome Antenna Assy - L-3 Randtron	123U-SRD-010	R1384-7969B	R1384-7836A	R1384-7936	DI-MISC-81397	DI-MGMT-81398
Aircraft Transmission Lines - Cobham Sensor Systems, CDES - M/A-COM	123U-SRD-032	N/A	AR-3152	N/A	N/A	N/A

In January 2011, the E-2D HMMP database (Table 1) was expanded to include system safety reports, safety assessment reports, health hazard assessments, HMMP reports and HMMP plans for 48 aircraft subsystems. Collecting copies of these documents and centralizing them into one location greatly simplifies the review and identification of program HAZMAT risks.

Additionally, in July 2012, several macros were added to the database to streamline future revisions of the database. The new macros identify aircraft components both new and modified since the prior revision, as well as new process and finish codes.

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Process and finish codes define the HAZMATs associated with the individual components and assemblies. The macros then invoke the numerous previously written database "update" queries to add or update the HAZMATs information associated with the individual parts in the database. The macros "automate" much of the update operations which had previously been performed manually.

As a new aircraft, the E-2D AHE program had the opportunity to scrutinize maintenance processes for less HAZMATs. Efforts were undertaken in the E-2D AHE maintenance manual review to eliminate organic solvents that are generally toxic and flammable. Cleaning agents were evaluated for less or non-hazardous substitutes. One example is the replacement of Methyl Ethyl Ketone (MEK) with Methyl Propyl Ketone (MPK). MEK is flammable, considered both a HAP [pollutants that are known or suspected to cause cancer or other serious health effects], and Superfund Amendments and Reauthorization Act (SARA) by USEPA. MPK is less flammable, non-HAP, and non-SARA. MPK has been qualified for use alone and in combination with other solvents to provide a balance of solvent cleaning and evaporation rate. This will avoid the use of approximately 623 pounds annually of MEK during operational and intermediate level maintenance, and potentially avoid another 620 pounds annually if adopted for depot level maintenance. NGC is aware of both the environmental and financial impacts of hazardous chemical waste generated during aircraft maintenance and takes every opportunity to substitute more sustainable alternative materials.

IV. TRANSFERABILITY

Compliance with EO 13423

Products and processes using hexavalent chromium (Cr6+) continue to be a critical part of materials and processing for Navy weapon systems. Cr6+ is used in 10 major metal finishing and corrosion-protection processes, including paint primers. Corrosion related costs are estimated to be $3billion per year, resulting in a tremendous readiness degrader for naval aviation. Assessments also show that the cost impact of continued use of Cr6+ is highest for compliance with environmental, safety and health regulations when removing Cr6+-containing coatings.

PMA-231 is engaged with the NAVAIR Material Engineering Department to investigate viable alternatives to Cr6+ and proceed in addressing the requirements reflected in the DoD Memorandum for Secretaries of the Military Departments, *Minimizing the Use of Hexavalent Chromium (Cr6+)*, of April 2009. In addition, EOs 12856, 13148, 13423 and 13514 direct P2 and exposure reduction tasking.

E-2 maintenance activities use roughly 600 pounds of chromate primer, and generate almost 31,000 pounds of paint-related waste annually. The Navy supports replacing chromate-based technologies as acceptable alternatives are developed. Improper selection and use of non-chromate alternatives, however, pose negative risks, including safety of flight, increased maintenance costs, and reduced fleet-wide readiness.

Figure 5: E-2C in Non-Chromate Primer

The E-2C is the first carrier-based aircraft on which non-chromate primer is being tested on the entire exterior of the aircraft. Over the 2011/2012 time period several non-chromate primed E-2Cs (Figure 5) successfully completed carrier deployments. One E-2C completed two deployments, and two E-2Cs completed one deployment each. General conclusions from post-cruise inspections and maintainer input

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indicate extremely robust performance of the non-chromate primer with equivalent or better performance compared to standard chromate primer on co-deployed E-2Cs. In response to the good field test results NAVAIR Materials Engineering concurred with expanding the demo to include four additional E-2Cs. The effort was initiated in 2009 by Fleet Readiness Center-Southwest Fleet Support Team in a proactive effort to substantially reduce exposure to chromates during de-painting operations. The aircraft are painted with Deft 02-GN-084 non-chromate primer qualified to MIL-PRF-23377 Type I, Class N Epoxy, High Solids Paint Primer.

A key element of implementation feasibility, proven over the past two years during deployments, is the Deft non-chromate primer is a drop-in replacement for standard chromate primer as de-painting and touch-up processes are the same as for standard chromate primer. No additional equipment, materials or processes are required to maintain the non-chromate primer in-service. The second E-2C to complete two carrier deployments is due to return in mid-fiscal year 2013, at which time a decision to implement non-chromate primer fleet-wide for E-2/C-2 is anticipated. The transition to non-chromate primer on the E-2/C-2 will avoid the use of over 20,000 pounds of chromate primer over fleet lifetime.

If the in-service performance of the non-chromate primer on E-2C continues favorably as expected, then NAVAIR will likely pursue transition of the non-chromate primer technology across all gloss paint weapon systems type/model/series, as well as flat and specialty paint systems, dramatically reducing chromate primer usage in the Navy.

V. STAKEHOLDER INTERACTION

Education, Outreach, and Partnering

In support of the Navy's Tactical Training Theater Assessment and Planning Program (TAP), the PMA-231 ESOH Team works closely with various stakeholders to ensure that all PMA-231 testing requirements for 2014 to 2020 are appropriately embedded in TAP Phase II National Environmental Policy Act (NEPA)/EO 12114 documents. This effort was initiated with an extensive data call from production and T&E to identify all testing activities, including new aircraft capabilities that will be required to support intelligence reconnaissance and airborne early warning missions. Data was collected for numerous test events that are expected to occur within Navy Range Complexes/Operating Areas both within and outside of the U.S. during the seven year timeframe.

Ensuring that NAVAIR testing requirements are adequately and accurately captured in these documents streamlines the NEPA/EO 12114 process and eliminates the need for duplicative and additional documentation in the future. This will ultimately mitigate categorical exclusions/memorandums for the record development and save the program an estimated $350,000 over the seven-year period. This also ensures that the program continues to balance protecting the environment from the potential effects of testing while also meeting NAVAIR mission requirements.

STAKEHOLDERS

- NAVAIR IPT structures (production, T&E, foreign military sales, Defense Contract Management Agency).
- Competencies within NAVAIR (Patuxent River Range Sustainability Office, Environmental Programs, and Legal Counsel).
- Fleet Forces Command Atlantic and Pacific.
- Chief of Naval Operations N45.
- Naval Facilities Engineering Command.
- Naval Undersea Warfare Center.

In addition to the TAP effort, PMA-231 is taking other steps to eliminate redundancy in NEPA/EO 12114 requirements for the program. As a result of NEPA/EO 12114 scoping for various test phases, the PMA-231 ESOH Team initiated a gap analysis to assess upcoming flight test requirements through 2014

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in the event that TAP Phase II NEPA/EO 12114 documents are delayed. In support of the gap analysis, the PMA-231 ESOH Team reviewed existing Navy NEPA/EO 12114 documents (including TAP Phase I) for applicability to planned testing of PMA-231 platforms being proposed at various locations inside and outside 12 nautical miles of the U.S. and its territories. The PMA-231 ESOH Team found the assessments within the documents were applicable to proposed testing activities and adequately address the respective affected environments and potential environmental consequences. Additionally, this gap analysis ensured that all test requirements for PMA-231 platforms have been proactively addressed and that existing environmental documentation has been identified, in addition to identifying any potential planning deficiencies.

The PMA-231 ESOH Team also routinely coordinates with test engineers, planners, and the Range Sustainability Office to ensure that appropriate mitigation measures and standard operating procedures are taken into consideration and implemented during testing activities to ensure compliance with NEPA/EO 12114.

VI. PROJECT IMPACT

Material Enhancement

In April 2009, the DoD documented its policy to minimize Cr6+ usage, which bolstered the development of non-chromate materials and processes alternatives. PMA-231 has been actively leading the demonstration of non-chromate primer that can be used on the E-2/C-2 aircraft, as well as other Navy weapon systems. Currently the E-2C non-chromate primer demonstration aircraft are maintained with chromated primer for paint related touch-up and repair activity. Non-chromate primer for repair and touch-up is currently only authorized on chromate primed NAE aircraft. A natural progression of this effort would be evaluation of non-chromate primer for repair on non-chromate primed aircraft, significantly reducing HAZMAT usage/exposure and waste during maintenance.

The current E-2C non-chromate primer demonstration is only for the exterior of the aircraft, where inspection areas are easily accessible. Continued demonstration efforts could potentially include application of non-chromate primer to the interior of the aircraft. Interior areas are typically difficult to inspect, inspected less frequently and can be subjected to humidity or standing water if drainage is not ideal. Once non-chromate primer performance is proven in-service on exterior areas a next step is to demonstrate its performance on interior areas. This would almost double the reduction of chromate primer usage on the aircraft.

The current E-2C non-chromate primer demonstration was conducted with chromate conversion coating, the coating preparation directly applied to the aircraft bare metal prior to primer application. Non-chromated conversion coating is currently only authorized for use under chromate primers on NAE aircraft. A natural progression of the efforts would be to demonstrate non-chromate conversion coating paired with non-chromate primer. Pending completion of the second E-2C's second carrier deployment in mid-2013 the program is likely to pursue a non-chromate conversion coating/non-chromate primer demonstration on C-2 aircraft. Over 100 pounds of chromate conversion coating are used annually for E-2 overhaul and maintenance activities.

Finally, although the current E-2C non-chromate primer demonstration is with a gloss paint system, NAVAIR will likely pursue transition of the non-chromate primer technology across all NAE gloss paint weapon systems, as well as flat and specialty paint systems, dramatically reducing chromate primer usage in the Navy.

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