NAVAIR

Environmental Program

Zero-VOC Waterborne Polyurethane Topcoat

Non-VOC and Non-HAPs Coating for Aircraft and Support Equipment Demonstrations Underway

Background

The aerospace industry currently uses paint coatings containing a significant quantity of solvents comprised primarily of Volatile Organic Compounds (VOC). Federal, state, and local authorities from the U.S. Environmental Protection Agency (EPA) regulate emission of VOCs and associated Hazardous Air Pollutants (HAP) during painting processes. These regulations affect the VOC and HAP content of aerospace coatings and how these coatings are applied. In addition to EPA restrictions, Occupation, Safety and Health (OSH) regulations are increasingly more concerned with worker exposure to VOCs and HAPs.

Waterborne topcoat technology can significantly reduce the amount of VOC and HAP emissions resulting from aerospace painting processes. Waterborne topcoats can also reduce the hazards associated from exposure to VOCs and HAPs. This reduction of VOCs and HAPs would help relieve immediate and pending environmental compliance regulations and improve worker safety during the painting process. Waterborne topcoats may be disposed of as non-hazardous waste and require smaller volumes of solvents for paint cleanup. This decreases hazardous waste disposal costs and minimizes worker exposure to hazardous chemicals.

Requirements Assessment

VOCs are photo-chemically active substances, primarily organic solvents that result in the formation of ozone in the lower atmosphere. Ozone is a primary air quality standard under the Clean Air Act (CAA) Title I and recent changes in the National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulations have restricted the VOC content of coatings used in the aerospace industry in order to reduce VOC emissions. Although the latest high-solid, solvent-based topcoats and waterborne topcoats meet the NESHAP regulation of 3.5 pounds (lbs)/gallon (gal) (420 grams (g)/liter (L)) of VOCs, stricter NESHAP VOC emission control requirements are anticipated in the efforts to attain compliance with the CAA Title I. Future regulations are likely to require lower VOC level paints or costly control measures. While existing low VOC waterborne topcoats contain 1.75 lbs/gal (210 g/L) VOC, zero-VOC topcoats essentially contain 0.0 lbs/gal VOC. These technologies must achieve challenging adhesion and process requirements met in the past with the properties of organic solvents.

Demonstrations Underway

A joint group of Navy, Air Force, and industry organic-coating specialists are performing zero-VOC waterborne polyurethane topcoat demonstrations. These topcoats are being used on selected aircraft and support equipment at the Naval Air Depots (NADEPs); Sikorsky Aircraft, Stratford, CT; Warner Robins Air Logistics Center; and the Naval Aviation Support Equipment Facility in Solomons, MD.

Items coated for the demonstration will be deployed for at least two years (including two full carrier deployments). Aircraft platforms that

Zero-VOC tow bar before six-month cruise aboard the U.S.S. Harry S. Truman.

Zero-VOC tow bar after six-month cruise aboard board the U.S.S. Harry S. Truman. No significant difference was determined between zero-VOC and standard topcoats.

C-2 outer wing panel painted in May 1999 at NADEP North Island, CA and installed on aircraft (BUNO 162155) in December. The C-2 is attached to VAW-120, Reserve Air Group, NAS Norfolk, VA.

Application of zero-VOC topcoat to tow bars at the Naval Aviation Support Equipment facility in Solomons, MD in April 2000. The tow bars were deployed aboard the U.S.S. Harry S. Truman during a six-month Mediterranean cruise.

participated in the demonstration include the EA-6B, F/A-18, C-2, and H-60 programs. Selected support equipment for painting includes tow tractors, a forklift, cranes, and an electric-powered cart.

Other demonstrations are scheduled to take place throughout 2003. Verification of performance will be monitored by periodic inspections and, if possible, though Navy Maintenance, Material, Management (3M) historical corrosion records, Maintenance Data Reports (MDRs), corrosion prevention and treatment documentation (MDR-11), and local documentation maintained by the squadron corrosion control branch.

Tow bars coated with gloss white (FED-STD-595 color #17925) zero-VOC topcoat were deployed on the U.S.S. Harry S. Truman for a six-month Mediterranean cruise that ended in April 2001. After continuous exposure during the course of the deployment, sailors were not able to determine any significant difference in the durability and performance of the zero-VOC topcoat compared to the standard topcoat.

The mixed coating may be applied by conventional or High-Volume, Low-Pressure (HVLP) spraying techniques. If using HVLP, a high line pressure (about 90 pounds per square inch) should be used to provide the maximum amount of atomization. Smaller droplets coalesce more easily than larger ones, resulting in a more uniform, smoother finish.

It is recommended that before any activity sprays the zero-VOC coating, the artisans receive a day's training to effectively apply the material. Training on the proper application of the zero-VOC topcoat is available from the Naval Air Systems Command (NAVAIR), in Patuxent River, MD through Deft, Inc. NAVAIR is also conducting an ongoing outreach campaign to demonstrate this application to the sailors in the Fleet. All specifics will also be documented in the appropriate military specifications and technical manual updates.

Regulatory Drivers

The Clean Air Act, Clean Water Act, Resource Conservation and Recovery Act (RCRA), local EPA and Air Quality Management Districts (AQMD) rules regulate emissions from zero-VOC topcoats. The EPA has proposed a reduction in low-level ozone non-attainment levels within the National Ambient Air Quality Standards (NAAQS). Because VOCs from topcoats contribute to the generation of low-level ozone, state and local agencies may require VOC reductions beyond those listed in the aerospace NESHAP that were implemented in September 1998.

Applicability

The technology can be implemented at all three levels of Naval Aviation maintenance. It is estimated that virtually all aircraft polyurethane topcoats could be replaced with this technology. The following aircraft types and workload figures were estimated in the impact analysis to apply to the zero-VOC topcoat technology.

Procurement Specifications

Procurement of the zero-VOC topcoat materials will be based on MIL-PRF-85285 Class W Type III.

User Facility Requirements

No additional areas need to be allocated for use of this technology. A work schedule strategy, such as overnight drying, may be needed to allow for the longer drying times. Zero-VOC topcoats are applied with existing conventional or HVLP spray application equipment. Generally, these processes must be performed in designated paint hangars/booths with emissions control devices at user sites. The material is compliant with all existing federal, state, and local emission laws and does not add to existing hazardous waste streams. The Hazardous Materials Authorized Use List (HMAUL) would require update, and the new material will need inventory control per local procedures. No new Personal Protective Equipment (PPE) is needed in addition to the high-solids polyurethane topcoat. PPE includes:

- Protective Rubber Gloves,
- Protective Apron,
- Respirator (if concentration is high), and
- Protective Eyewear.

Eyewash stations and safety showers should be readily available in use and handling areas.

Workplace considerations should include mechanical ventilation whenever the product is used in confined space, atomized, heated or agitated. Engineering controls should limit the exposure time to all topcoats. Artisans should read and understand all cautions, labels and Material Safety Data Sheets (MSDS) before using any chemical product. Personnel should also avoid prolonged or repeated contact with skin. Contaminated clothing should be washed before reuse.

Engineering Controls

Zero-VOC waterborne topcoats may be used when coatings are qualified to MIL-PRF-85285 and the cognizant engineering authority approves the material for use on a weapon system program. Most waterborne equipment will require stainless steel paint cups, tanks, and spray tips. These topcoats must meet the requirements of MIL-PRF-85285 as modified by test results obtained during the ESTCP test program. Training to artisans may be obtained from NAWC-AD Patuxent River and four NADEPs including NADEP Cherry Point, NADEP North Island, Marine Corps Air Station (MCAS) Beaufort and MCAS Camp Pendleton.

Industrial Base Issues

Waterborne coatings are slow drying, especially in high humidity areas like coastal and shipboard environments. Application times are increased due to the tendency of the material to run and the extended drying time required prior to the application of the topcoat. No other significant changes to production, workload, labor, or planning are anticipated.

Publication Support

This technology has required a modification to one military specification. A JTP exists for the technology. No aircraft finishing specifications or technical manuals were affected.

Support of Fielded System

Technical manuals and engineering support will be required for zero-VOC topcoats.

Impact Analysis

The economic and environmental benefits are derived from the implementation of the zero-VOC topcoats at NADEP Jacksonville. The analysis extends the data gathered to a sixty-six site Navy transition and is based on 90 percent implementation of the new topcoat. The resulting impact analysis, (see table), compares the annual economic and environmental considerations of the proposed zero-VOC topcoat to the existing solvent polyurethane topcoat.

The following table shows a summary of the results produced by the impact analysis.

An application of the zero-VOC topcoat on an F-18 aircraft.

The Sikorsky team poses in front of an H-60 that had been coated with the zero-VOC topcoat.

Impact Analysis Metrics: Benefits of Using Zero-VOC Topcoat Versus Solvent Polyurethane Topcoat

Environmental, Safety and Health Benefits	
Metric	**NAVAIR-Wide Summary**
Hazardous Materials Reduction (lbs/year)	31,222
Toxic Release Inventory (TRI) Chemical Reduction (lbs/year)	68,798
VOC Chemical Reduction (lbs/year)	122,270
Hazardous Waste Reduction (lbs/year)	144,950

Economic Benefits	
Payback (years)	Immediate
Annual Savings	$848,019
Net Present Value (NPV) [over 12 years]	$9,450,335

Annual Operating Cost Elements	Current Polyurethane Topcoat	Proposed Zero-VOC Topcoat
MATERIALS	$1,599,193	$1,652,773
LABOR	$936,854	$936,854
MAINTENANCE	$616,667	$61,667
UTILITY	$22,200	$2,220
SERVICES	$303,782	$110,363
FACILITY	$148,000	$14,800
Total Annual Costs	$3,626,696	$2,778,667

Points of Contact

Kevin Kovaleski
NAS Patuxent River, MD
301-342-8049
DSN: 342-8049
KovaleskiKJ@navair.navy.mil

Jim Ambrosino
Support Equipment Team Leader
Naval Air Warfare Center Lakehurst, NJ
732-323-7904
DSN: 624-7904
AmbrosinoJA@navair.navy.mil

Dave Brock
Lead Maintenance Technology Center for the Environment
904-542-0516, x-122
DSN: 942-0516, x-122
BrockDL@navair.navy.mil

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