NESDI & ONR Sponsor Technology to Control Paint Overspray

MAEE Helps to Prevent Contaminants from Reaching the Air & Water

ENGINEERS FROM THE Naval Surface Warfare Center, Carderock Division (NSWCCD) have introduced a new prototype device—the Motion Assisted Environmental Enclosure (MAEE)—to mitigate the release of contaminants into the environment during ship hull painting operations.

The hull coating process is critical to the preservation of the ship's hull. The more efficient the hull coating is, the greater the fuel economy of the vessel, and the less future maintenance will be required—resulting in less time in dry dock and reduced ownership costs. For these reasons, anti-fouling coatings containing copper and zinc are utilized.

Unfortunately, some of these heavy metals are released during the painting process through overspray and paint waste. Current commercial painting methods can result in greater than 30 percent (by weight) of the applied paint going to waste through overspray. This overspray can settle onto the dry dock floor and surrounding areas, where it has the potential to be incorporated in dry dock industrial operations or discharges associated with flooding or storm water runoff into nearby waterways.

In an effort to address these challenge, NSWCCD in conjunction with Concurrent Technologies Corporation (CTC) and NORX, LLC, has developed the MAEE prototype to capture paint overspray.

MAEE's Predecessor

In some regards, the MAEE concept is the second generation solution developed by the Navy for overspray containment. In 1997, NSWCCD personnel began the development of an Automated Paint Application, Containment and Treatment System (APACTS). The technology was designed to apply paint robotically to hull surfaces and to capture and retain the overspray emissions.

APACTS, a predecessor of the MAEE, was designed to be an automated system using an integrated dome-covered nozzle and vacuum technology to help minimize overspray at its source.

The MAEE control system's micro-computer converts the operator's instructions into precise commands that follow along the ship's hull.

APACTS was designed to be an automated system utilizing an integrated dome-covered nozzle and vacuum technology to help minimize overspray at its source. The system, while technically innovative, particularly in its ability to increase paint transfer efficiency and mitigate the release of overspray, was costly due to hardware and software complexities associated with the robotic control platform and treatment system components of the system. A subset of the motion control technology developed for APACTS has been incorporated into the overall MAEE system development. MAEE technology is designed to be a much simpler, significantly lower cost adaptation of APACTS that retains a painter in the operating loop.

MAEE technology is a portable, light weight, inexpensive enclosure that allows a painter to manually or semi-autonomously apply coatings with conventional spray equipment, on a boomlift or man lift with little or no overspray. The containment unit, or shroud, covers a small portion of the hull, allows operator access to the surface to be painted, draws and circulates air from within the enclosure to contain the overspray, and generates a positive, contact-free seal with the hull to prevent the overspray from escaping. The seal around the shroud is a pressurized zone created by a flow of air similar to an air curtain. Blowers on each side of the operator window clear paint overspray and fumes away from the painter and deposit them into the enclosure's filters.

The operator commands a desired direction (up, down or steady) and a speed based on their particular expertise and coating application capability. A system of sensors and computers on the work platform detect the position of the hull as well as the positions of the aerial work platforms' joints. The control system's micro-computer converts the operator's instructions into precise commands that follow the hull's surface at a fixed standoff distance of four to six inches. As the paint is applied, the shroud constantly moves along the surface, exposing more of the surface to be painted. The painter simultaneously paints and relocates the basket, thereby eliminating a platform operator from the process.

MAEE Development

MAEE was designed to be used on submarines and the hulls of surface ships.

The maturing MAEE enclosure technology has been tested and evaluated in a series of four, progressive shipyard operational assessments conducted by shipyard and research and development personnel under representative production conditions. The evaluations began in March of 2009 at Atlantic Marine Shipyard (now BAE Systems Southeast) in Jacksonville, Florida.

Following each test, prototype modifications and refinements were made based upon recommendations from operators trained on the system and shipyard process management personnel. Blotter tests and high definition video were used to determine capture efficiency as well as overall system performance. Capture efficiency assessments conducted to date indicate that efficiencies

The MAEE can be assembled on a conventional boom lift in about an hour.

on the order of 90 percent can be achieved. The targeted goal is to capture more than 95 percent of the paint overspray.

The most recent full scale test and evaluation of the MAEE unit was conducted on an active ship hull in August 2010 at the BAE Southeast Shipyard. This evaluation exercised four new integrated component technologies: a flat faced high efficiency filter, a bottom-mount basket mechanism, a cable driven tilt mechanism, and a modified blower distribution. The current unit mounts to the bottom of the boom-lift basket in order to enhance safety and to comply with lift manufacturer restrictions.

Results to date indicate that a peripheral air seal, light enough to be carried on a standard aerial work platform, can be successfully configured and operated to block the discharge of overspray into the environment during representative hull coating application on relatively flat hull surfaces.

Advanced prototype development is ongoing and must trade off goals for increased performance with requirements for expanded system functionality on curved surfaces while continuing to address safety requirements, limits on overall enclosure weight, and requirements for structural sturdiness.

MAEE technology will require more extensive shipyard testing on actual hull surfaces to further refine and harden the system by exposing it to the rigors and full breadth of production level operations needed for full demonstration, validation and integration.

The ultimate goal is to demonstrate a production-ready MAEE that is available to all Navy and commercial shipyards by either purchase or lease agreement.

Benefits

The primary benefits of MAEE are:

- Virtually eliminates paint overspray and associated contaminants such as heavy metals into the atmosphere and waterways
- Enhances environmental compliance and reduces associated risk and liability associated with potential permit requirements and burden associated with by-product waste generation and management
- Increases productivity and reduces total ownership cost as a simple, sustainable, inexpensive and versatile production enhancement that is interchangeable and synergistic with existing coatings application systems and processes
- Maximizes use of existing shipyard assets, expertise and work flow characteristics to increase industrial productivity and enhance compliance with existing environmental requirements
- Enables expanded capability and use within the greater shipbuilding and repair industry

The MAEE's modular design also supports alternative tool development. The enclosure concept has the potential to be modified and used for hull hydro-washing operations as well

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as capturing smoke emissions during hull cutting and welding operations.

The MAEE system consists of three subsystems:

1. Integrated sensors and control software to semi-autonomously coordinate and control the motions of a boomlift
2. A portable, light weight air curtain frame or enclosure carried by the man lift that redirects and captures un-adhered paint spray from the painter
3. A means of communication between the enclosure and the boomlift controller.

To reduce system costs and improve safety, the controller does not require any significant or permanent modifications to the boomlift. Modifications are easily assembled and can be completed in approximately one hour. The boomlift is then readily deployable for other shipyard activities or it may be returned to a rental company without incurring any additional charges. The boomlift's intrinsic safety systems remain fully intact and functional.

Project Support

Primary funding for this project is provided by the Chief of Naval Operations Energy and Environmental Readiness Division's (N45) Navy Environmental Sustainability Development to Integration (NESDI) program to address mature system configuration, demonstration, validation and initial integration efforts.

The Office of Naval Research is funding research to better understand and optimize enclosure characteristics and to develop technology for achieving efficient operations over the breadth of curved surfaces likely to be encountered within the shipyard dry dock environment.

Initial interest and support for development of MAEE technology has been provided by Navy and commercial sources including the Naval Sea Systems Command 04XP and 04RE offices, as well as the National Shipbuilding Research Program via their Surface Preparation and Coating Panel and their Environmental Technologies Panel.

Photos by Naval Surface Warfare Center, Carderock Division

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The Basics About the NESDI Program

THE MISSION OF the NESDI program is to provide solutions by demonstrating, validating and integrating innovative technologies, processes, and materials, and filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Fleet readiness. The program seeks to accomplish this mission through the evaluation of cost-effective technologies, processes, materials and knowledge that enhance environmental readiness of naval shore activities.

The NESDI program just released a manual which contains all of the documents essential to the timely and successful execution of demonstration/validation (Dem/Val) projects sponsored by the program and/or other projects leveraged with funding from other Dem/Val programs. This manual is intended to provide Principal Investigators and other program personnel with the necessary guidance and templates for completing the documentation required for each program project. For a hardcopy of the NESDI Program Manual, contact Barbara Sugiyama at barbara.sugiyama@navy.mil and 805-982-1668.

For more information, visit the program's web site at www.nesdi.navy.mil.