

Department of Navy and California Innovation Partnership – CO2 Washing System Demonstration

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Technology Innovation

The U.S. Navy, the California Energy Commission (CEC) and TERSUS Solutions are conducting a year-long demonstration of a water-free and dryer-free cleaning process for textile-based battle gear worn by Seabees.

The demonstration, conducted at Naval Base Ventura County, Port Hueneme, California will examine the effectiveness of liquid carbon dioxide (CO2) to clean operational clothing and industrial textile articles worn or utilized by Navy personnel on deployment overseas. Typically, on return to homeport, these items are cleaned by traditional commercial laundry services, but, water cannot be used to clean Kevlar battle vests because it degrades the integrity of the ballistic fabric.

The demonstration comes from an ongoing partnership between the Navy and the state of California on issues of energy efficiency, renewable energy, water conservation and clean transportation.

The CEC is focused on a wide range of technologies and programs that support the State's ambitious energy, transportation and greenhouse gas reduction goals. Each year, it awards millions of dollars for innovative energy saving research and development projects, such as the TERSUS® system.

The Technology

The TERSUS® system was developed by Tersus Solutions, a commercial company based in Denver, Colorado. The technology is a waterless, closed-loop textile cleaning processing system which uses recycled CO2 to clean & decontaminate textiles & garments. The process restores technical performance and coatings, extends garment life, and decreases life-cycle costs.

Since the cleaning process uses CO₂, which is a gas until put under pressure, it requires none of the traditional water-based infrastructure such as sewer connections, wastewater treatment, hot/cold water tanks, or industrial boilers.

Partnership Arrangements and Objectives

The Navy entered into a Cooperative Research & Development Agreement (CRADA) with TERSUS Solutions and funded the necessary improvements to install the system, and the CEC awarded a \$900,000 grant for the demonstration.

This arrangement provides the State an opportunity to evaluate an emerging technology that reduces water consumption and allows the Navy to evaluate the technology's potential application to multiple deployment scenarios.

The initial evaluation will be for the Seabee battle gear, but a wide variety of operational fabrics and garments used by troops will be tested and evaluated. They include Nomex and other fire retardant materials, Kevlar, wool uniforms, special coated or treated fabrics, and oily rags.

The system will also be evaluated on its environmental impact such as water and energy use, volume of waste produced and amount of chemicals used. The cost of running and maintaining the system will be assessed as well as the logistics of using the system on a Navy installation.

Technical Criteria – What is Clean and Are There Impacts?

Measures of cleanliness for apparel and technical personal protective equipment (PPE) typically relate to garment functionality, and only some are explicitly outlined in regulations. For many pieces of apparel, cleanliness is a subjective matter, measured by means of visual, hand, and smell inspection. During the demonstration, TERSUS personnel will attempt to quantify cleanliness by technical parameters, including residual contaminants, technical functional, color retention, and more. Subjective variables, particularly as it impacts user comfort and usability, will also be evaluated.

HP White Laboratory, a ballistic and PPE testing facility, will assist with the evaluation of technical functionality, color retention, and more. They are certified to measure PPE functionality according to various required standards.

They will, for example, evaluate the ballistic properties of the vests and certify the properties have not been degraded through cleaning. The company will also perform tear, flammability, and water repellency tests on all relevant garments as well.

The usability of the pieces will also be reviewed by the Seabee Personal Gear Issue office at Port Hueneme, California. These post-processing features will be measured through primary research by TERSUS Solutions.

Additional Deployment Scenarios

There are additional applications and deployment scenarios within the Navy and DOD driven by some combination of favorable environmental, operational, or infrastructure variables.

Applications under consideration include:

- a. Ballistic vests
- b. Chem-Bio suits
- c. Oily/hazardous industrial rags & gloves
- d. Fire Fighting Gear & PPE (eg. Nomex flight suits, work uniforms, etc)
- e. Sleep systems & back packs
- f. High visibility/reflective apparel
- g. Cleanroom specific garments & apparel
- h. Apparel & gear related to incident response
- i. Other specialty apparel and gear (subject to a survey of Navy wide installations)
- j. Personnel uniform laundry and dry cleaning

The Navy is actively seeking additional garments, gear, or washable items to evaluate during this demonstration to determine the potential for application of this technology in various scenarios.

Deployment scenarios for the above could include:

- a. Regional facilities to process these and other identified applications.
- b. Isolated or remote installations: targeting locations without ready access to water.
- c. Installations with critical wastewater restrictions: targeting installations and facilities where stringent wastewater or waste disposal regulations apply. Target installations will be located where these regulations overlap with a need for laundering items with a potential hazardous waste component (e.g. oily rags).
- d. Shipboard uniform laundry and dry cleaning.

The technology demonstration is being conducted through the end of 2017. Once the testing phase of the demonstration is concluded 4th Quarter of 2016, the project will go into operating phase whereby day-to-day items will be processed, and additional parties within Navy and DOD will be invited to participate through item testing or data sharing.