STATEMENT
OF
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TECHNICAL DIRECTOR, PROGRAM MANAGER, NUCLEAR, BIOLOGICAL AND CHEMICAL DEFENSE SYSTEMS
MARINE CORPS SYSTEMS COMMAND
BEFORE THE
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CONCERNING
TECHNOLOGIES AVAILABLE FOR REMEDIATING BUILDINGS CONTAMINATED BY BIOLOGICAL CONTAMINANTS

Mr. Chairman and members of the committee, **I am Mr. Mike Grosser, the Technical Director for the Program Manager, Nuclear, Biological and Chemical Defense Systems, Marine Corps Systems Command, Quantico, Virginia.** I am pleased to appear before you today to discuss several decontamination technologies that the Marine Corps and the Joint Chemical and Biological Defense community have been developing and supporting. I am responsible to the Program Manager for the oversight of these programs and I have knowledge of the origin, progress and current status of each.

The Marine Corps has pursued these technologies as possible solutions to the requirement for an environmentally benign, patient-friendly and effective personnel and equipment decontaminant. We did not set out to identify a specific decontaminant for anthrax-contaminated buildings. The technologies that I will talk about are by and large still in research and development. They have been, and in fact still are considered as candidates for the Joint Service Family of Decontaminating Systems Program and may be designated as more appropriate for use by the first or secondary responders, that is, a municipal firefighter or a unit such as the Marine Corps Chemical-Biological Incident Response Force (CBIRF), than the traditional warfighter. While it is possible that one or two of them may be made available quickly, each has some facet that still requires funding, research, testing or evaluation. I will describe four decontamination technologies.

The first technology, Electrochemical Activated Solution, or ECASOL, was developed in 1972 in Russia to control oil well biofilms. It is now used commercially in Russia, Japan, South Africa and the U.K. where it is used for home drinking water purification units (300,000 units sold) and as a hospital biocide such as patient decontamination, surface decontamination, surgical device sterilization, wastewater treatment and is also used for reducing pathogens in food processing operations (e.g. meat and poultry). ECASOL was used to purify drinking water in Rwanda during the refugee crisis in 1994-1995.

ECASOL is a colorless, odorless aqueous solution made on-site using point-of-use electrolysis of diluted brine. **The brine is exposed to a mild electrical charge as it passes through a patented Flow-through Electrolytic Module (FEM),** a 10” by 1” diameter tubular device that converts the brine into a stream of reactive oxidants. A key benefit of the ECASOL technology is that the oxidant composition can be precisely controlled over a wide pH range. pH is a measure of the acidity or alkalinity of a solution. A ph level of 1 is acidic, and a pH level of 14 is an alkaline. For personnel decontamination, skin contact requires a near neutral pH. **At neutral pH (pH 7) the primary oxidant in ECASOL is the metastable compound hypochlorous acid.** This acid, though safe to skin, eyes and wounds (pH 7), is an effective biocidal agent. The primary military personnel decontaminant for medical application is 0.5% HTH (bleach) which has a pH of 12, is irritating to the skin and not safe for eyes or wounds.

The Marine Corps began testing ECASOL in 1998 to assess safety, efficacy and the potential to scale-up field units for use with first or secondary response personnel. Tests were designed to compare ECASOL’s efficacy versus 0.5% (5,000 ppm) bleach at destroying biological and chemical agents.

Some chemical testing has been conducted but the results were not as promising as those obtained during biological agent tests.

Before 1998 the largest ECASOL unit was an 80 FEM (400 Gallon per hour) unit used in a poultry processing plant. Based on the above test results the Marine Corps built a 600-gallon per hour prototype generator to evaluate the potential for use by first response units in personnel showers. All volume generation targets and solution parameters were met or exceeded during field trials of that unit.

Although ECASOL is generated on-site at the point of use, shelf-life or storage characteristics were examined. **ECASOL solutions stored in sealed containers for seven weeks were found to perform almost as effectively as freshly generated solutions.** Solution parameters of pH, free chlorine and oxidation-reduction potential showed some deterioration (<10%), although overall performance was maintained. Again, while this information is important, the intent of the technology is to produce the decontaminant on site.

Further evaluation is required to identify maximum and minimum effective concentration ranges, effective pH range, efficacy against Toxic Industrial Chemicals and Toxic Industrial Materials (TIC/TIM), **evaluation as an aerosol (fog), and potential for decontaminating waste runoff.**

Materials and components required to generate the ECASOL are salt and water (or brine, seawater), electricity and a device containing FEMs.

ECASOL effluent is environmentally benign and can be drained into a municipality's sewer system (demonstrated in Atlanta, GA and Camp Lejeune, NC).

To summarize, ECASOL is a highly effective biocidal agent. It has a major advantage over 0.5% bleach because it has a neutral pH (7) and is safe for eyes, wounds and skin whereas bleach has a pH of 12, irritates skin and is not safe for eyes or wounds. Although the technology works with aqueous solutions ranging from saturated brine (for producing chlorine) or just plain water (for water purification) in dilute solutions (as examined here) it is safe yet effective. The technology is flexible and has been demonstrated in large scale (600 gallons per hour) as well as small scale (5 gallons per hour) applications.

The ECASOL device developed for testing by the Marine Corps could be utilized to conduct the test for room/building decontamination proof of principle. To produce additional prototypes would require purchase of some custom made long lead items and manufacturing. Three additional prototypes could be functional and delivered in approximately 120 days. In the interim, the existing device is capable of producing 600 gallons of product per hour. A comprehensive test plan has already been developed for additional efficacy testing (chemical and biological) that will include additional live agent testing.

The second promising technology is electrostatic decontamination (ESD) currently under development at the University of Missouri in Columbia, MO. This research and development program was started in 1998.

ESD is an electrostatically charged mist containing a proprietary photosensitizer that is sprayed onto a contaminated surface, victim or a wound. The photosensitizer consists of a hydrogen peroxide base (1-2%), a proprietary additive, and a surfactant. The photosensitizer is then illuminated with a pulsed ultraviolet (UV) light source that activates the photosensitizer destroying all biological agents present. System efficacy against chemical agents is unknown as no tests have been completed at this time. The photosensitizer mist is harmless and will not cause damage or injury to humans or the environment. The pulsed UV light wavelength is used for only 4 to 60 seconds and is not harmful to humans. Eye protection can be provided by regular glasses or by simply closing your eyes. The system operates in ambient conditions from temperatures ranging from freezing to 120 F and provides open-air sterilization.

Testing revealed the following destruction times:

Photosensitizer + Pulsed UV light

Anthrax spores	75 seconds
E. coli bacteria	75 seconds
Salmonella	75 seconds
Water borne virus simulants	75 seconds

Photosensitizer only - No Pulsed UV light

Anthrax spores	8 minutes
E. coli bacteria	8 minutes
Salmonella	8 minutes
Water borne virus simulants	8 minutes

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These results are based on using twice the density of spores required by NATO standards.

The ESD system is comprised of four major elements:

[if !supportLists]1. [endif]Proprietary photosensitizer-hydrogen peroxide solution,

[if !supportLists]2. [endif]Spray applicator,
[if !supportLists]3. [endif]Ultraviolet light source, and
[if !supportLists]4. [endif]Water
All of these elements are commercial-off-the-shelf (COTS) items with the exception of the proprietary photosensitizer. The shelf life of the photosensitizer is 1 to 3 years depending on the purity of the hydrogen peroxide used. Application of the mist shows coverage of 100 m^2/10 liters in 9 minutes. I'd like to note that it has not been developed or evaluated as a room or ductwork decontaminant, but rather as a surface decontaminant; however, we believe that ESD can be misted into enclosed spaces or ductwork to effectively neutralize biological agents.

This developmental effort would require some minor modification of COTS applicators, and testing to ensure proper procedures are in place to maximize agent neutralization in a building/ductwork environment. The effort could be completed in 6-8 months if the appropriate test facilities are made available.

The third technology is a nanoparticle regime that includes materials with particle sizes ranging between 1-100 nanometers (1 nanometer = 10^{-9} meters). Nanoparticles of metal oxides exhibit extraordinary abilities to react with and thereby destroy highly toxic substances and chemical warfare agents. Kansas State University (KSU) and their commercial adjunct firm, Nanoscale Materials, Incorporated (NMI), have been active since 1995 in developing metal oxide nanoparticles and defining their applications with regard to destructive adsorption.

Recently, it was also found that special formulations of these nanoparticles are active against biological warfare agents such as spores of *Bacillus globigii*, which is a simulant of anthrax. With respect to biological agents, nanoparticles have a positive charge that enables them to attach to negatively charged bacteria cells or spores. Once attached to the bacteria or spore the nanoparticle penetrates the cell walls of bacteria destroying the nucleus. For thick-coated protein cells of spores, addition of chlorine as a stabilized free radical to the nanoparticle formulation enhances their ability to penetrate these cells.

Since August of this year Marine Corps Systems Command has aggressively pursued this technology for a wide range of decontamination applications. This project is focused on developing novel dry powder decontamination technologies capable of neutralizing chemical and biological warfare agents. With appropriate funding this technology could be available for use as a biological decontaminant as soon as calendar year 2003.

Sandia National Laboratory (SNL) has developed the fourth technology. This decontaminant (designated DF-100) is a non-toxic, non-corrosive aqueous foam with enhanced physical stability for the rapid mitigation and decontamination of chemical and biological warfare agents and toxic industrial materials. The foam formulation is based on a surfactant system to solubolize contaminants and increase reaction rates with nucleophilic reagents and mild oxidizing agents. The formulation includes water-soluble polymers to enhance the physical stability of the foam. Preliminary test results demonstrate very effective decontamination of chemical and biological threat agent simulants on contaminated surfaces and in solution. Testing also indicates that the formulation may be effective as a general decontaminant on a variety of toxic industrial materials. This decontamination technology offers the following benefits: 1) a single decontaminant solution for both chemical and biological threats 2) rapidly deployable 3) minimal operational and logistics impacts.

Studies conducted on the DF-100 decontaminant to date include chemical agent decontamination efficacy (post-decon contact and off-gas vapor hazards), reaction rates, detector compatibility, toxicity, materials compatibility and biological simulant decon efficacy. Biological simulants tested to date include anthrax and smallpox simulants.

Chemical testing revealed that DF-100 destroyed 99-100% of G, V and H class agents in 10-60 minutes. Biological testing revealed that DF-100 was effective in reducing biological simulants to a safe level. Of particular interest, in a 10E6 challenge (1M spores) using Bacillus globigii (Anthrax Simulants), SNL Foam achieved a 6 log reduction (reduced to 1 spore or less) within 15 minutes. Other simulants tested included smallpox and E. Coli MS2 with similar results.

Material characteristics include a pH of 9.8 and a liquid to foam expansion of 15:1.

Currently two companies are licensed to manufacture and produce DF-100. These companies also manufacture or are licensed to sell application systems capable of dispensing DF-100. These application systems range in size from man-portable (back pack system) to truck mounted. Included in these application systems is the Marine Corps

Compressed Air Foam System (CAFSM), a HMMWV mounted fire fighting system.

Discussion with industry indicates that manufacturing facilities are capable of producing up to 20,000 gallons per day of DF-100. Production/delivery capabilities for application systems range from 1000 per month for small systems to 20 per month for large systems.

Decontamination demonstrations at Dugway Proving Ground and Fort Leonard Wood have shown that DF-100 may be applied with currently fielded decontamination systems or dual use systems i.e. firefighting systems, pressure washers.

Preliminary evaluations and studies conducted on SNL DF-100 under the Joint Service Family of Decontamination Systems program were designed against tactical operational requirements. SNL DF-100 has not been evaluated for room or interior decontamination under the JSFDS program to date.

In conclusion, Mr. Chairman, I want to thank the committee for inviting me to present this information. This is a vitally important issue to the Marine Corps and to our Homeland Defense. The Marine Corps and the Joint Chemical-Biological Defense Program continue to conduct research, development and acquisition of these and other technologies with the sole intent of providing Marines and other service members with the very best capability. I will be happy to address any questions at this time.