LESS-THAN-LETHAL SYSTEMS: SITUATIONAL CONTROL BY OLFACTORY STIMULI

A White Paper

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Overview

Less-than-lethal weapons provide important additional options for force support as well as sending the correct psychological signal to the perpetrators. Force alternatives used by today's defense forces and law enforcement include devices such as tear gas, mpact weapons, kinetic energy rounds, flash grenades, acoustic guns, sticky foam, snare nets, stun guns, strobe lights, etc.

In order to ensure that the best possible solutions to end low-level conflict, without erading public support and confidence, the use of these devices must be coordinated into a force continuum whose level can be adjusted according to the level of provocation and threat.

We propose a new threat response based on olfactory stimuli. approach, when integrated with other innovative technologies, will increase the user's options along this continuum.

Description of Concept

Using olfactory stimuli to change and control behavior is a novel concept for modern warfare (and peacekeeping). The usual non-lethal methodology has been based upon "stopping" a perpetrator and has proven to be effective in many, but not all, situations. Our proposed malordorant technology approach is targeted towards "taking the fight out" and incapacitating the perpetrator without causing trauma to the body. In addition to controlling individuals or groups, another important application could be in denying access to strategic areas or equipment.

The proposed system can be used as a selectable force that causes no collateral damage, is environmentally acceptable, and is benign to the user and/or "friendlys" that need to be protected from its effects. It uses a variety of arready proven technologies for delivery and can be easily deployed.

Our partner is this program, vrp Eco-Tek Corporation, has developed a product to meet the needs of the military and law enforcement officials in areas of crowd control, hostage negotiation, alternative to land mines, and individual "attitude adjustment". This difernative response force relies on the body's physiclogical and psychological response to obnoxious difactory stimuli.

There are two senses in odor detection. One is controlled by the olfactory nerves and is responsible for odor perception and recognition. Its performance is a function of:

- molecular structure,
- configuration of odor reception sites.
- signal generation at these sites as a result of a reaction between the odorant and an enzyme.
- and the relative concentration of the reactant

The second odor perception system is controlled by the trigeminal nerve and serves primarily as a warning system against substances that could be harmful The process of odor perception is described as:

- the odorant molecule arrives and, because of its molecular shape and size, fits into a specific odor receptor site
- a chemical reaction occurs between the odor and the sites resident enzyme.
- the reaction causes production of a specific coded electric signal that is transmitted to the brain
- this signal causes perception and recognition of the adorant characterized by that signal

Our proposed systems deliver a malodorant that is perceived by both the oltactory and trigeminal nerves. The usual response to a person near the malodorant is immediate nausea, gagging, vomiting, and discomfort. Somnolence can also be an effect. Persons in the area of the malodorant will naturally want to avoid the substance and clear the area. More importantly, they will tend to exhibit "flight vs. fight" response to an obnaxious odor, thus lowering the intensity of the conflict. The physiological response to nausea and vomiting usually causes the blood pressure to decrease, also a factor in decreasing intensity of conflict. In addition, since the olfactory axons directly connect with the hippocampus (memory center) and limbic system (emotional center) of the brain, an olfactory response in a mammal quite readily becomes a long-term memory of emotional discomfort. Through this mechanism future behavior can be modified by the threat of an obnaxious odor.

The nauseating effect usually lasts for several hours; this time span can be adjusted by varying the concentration of the malodorant.

The operator of the malodorant delivery system, and/or other "friendly" personnel in the area that need to be protected, are equipped with a specially formulated enzymatic-based "counteractant" agent. This counteragent blocks the perception of the malodorous formulation by consuming the enzyme responsible for the sense of smell. This effectively prevents the generation of the signal necessary for the perception of the malodor. Because they are specific to the formulation, the counteragents are not common substances and would not be readily available to those that the malodorant material is being used against.

These counteragents do not:

- fatigue the olfactory system.
- act as odor masking agents
- · react chemically with the formulation

A combination of maladorous substances and smell intensitiers is used in the formulation of our proposed material. The obnoxious odor is derived primarily from two different classes of chemicals, short chain sulfur compounds and an aromatic intensifier. The amounts of these substances delivered is variable; concentrations with an effective dose are nearly two orders of magnitude less than LD50 producing a safe alternative in non-lethal technology.

The oder can last for minutes or days depending on the formulation and environment in which it is delivered. The material is environmentally safe in concentrations used for crowd control or attitude adjustment and will naturally evaporate over time. A specially formulated bacterial solution can neutrolize the malodorant within 2 to 3 hours after it is applied.

Other components can be added to the maloderant for operation specific purposes. These include marking dyes (permanent/ non-permanent, fluorescent, and iridescent).

Areas of Application

The use of malodorants for situation control can be beneficial in a wide range of areas. These include:

- peaceful dispersion of unruly crowds or mobs
- incapacitation of instigators or other key personnel
- denial of access to specific areas
- beadeful clearing of personnel from siructures and facilities
- control of movement of crowds
- neutralization of vehicles, aircraft, vessels, and facilities
- an adjutant in hastage negotiations where the material may be used with both the perpetrator and some hostages; they would become nauseous with no long term health effects to either. The substance could give the other hostages an advantage in subduing the offender while protecting the safety of the hostages
- an alternative to anti-personnel landmines and/or a first line warning device to civilian personnel not to enter an area

Capabilities of the proposed approach (following the BAA announcement outline) include:

- 1. An adjustable/selectable tool. The material can be used with a number of existing delivery systems including the Under-the-Barrel Tactical Paint Ball System (UTPBS) developed by the U.S. Army, the PeaceKeeper (a 12 gauge shotgun round), a pocket-sized sling-shot, and a 40mm grenace. The UTPBS mounts directly under the barrel of a standard M-16A2 and can use a variety of paint balls toaded with different formulations specific to threat, distance to target, etc. The current range of the UTPBS is approximately 100 meters.
- 2. Capabilities >100 meters. Alterations in the UTPBS and/or ballistics of the paint balls, as well as improvement in the PeaceKeeper can increase the current range limitations. Furthermore, the proposed technology can be used with a variety of other delivery systems, such as such as a unmanned aeral vehicle and remotely controlled sprayers, or by using a round developed for a smoke grenade launcher.
- 3. Control/isolation of personnel, equipment, and areas. This material perimeter deployed/released around incapacitate personnel, seize personnel, deny access to vehicles and personnel, clear facilities of personnel, disable/neutralize the use of vehicles, aircraft, vessels, and other facilities.
- 4. Replacement of AP mines. This technology provides an effective nonlethal alternative to anti-personnel landmines.

Risk Areas

One advantage of the proposed material is that the formulation can be easily changed so that it can be tailored to address specific areas of the world. For example, in areas where open sewers are common, a different maladorant formulation based on that odor alone may be less effective than the proposed material. We estimate that approximately 1% to 2% of the world-wide population will not be effected in a sufficient amount by the maiodorant due to olfactory or brain damage.

The classes of substances that we propose for use in our formulation have a number of handling risks prior to being diluted in the manufacturing process. These are best addressed with proper handling, operational safety training, and the use of profective clothing and respirators in the manufacturing areas. Strict quality control measures will be followed to ensure that the maladorant concentrations in the delivery systems are well below toxic levels.

If a person is shot in the eye by a point ball or shotgun round, there will be damage due to trauma. Also, the maloadrant liquid can cause irritation in the eye.

Program Plan and Estimated Costs

The section above outlines a wide variety of applications for the proposed non-lethal technology. Space imitations for this white paper limit detailed discussions covering this range. However, we can provide a brief description of three projects, containing estimated schedule and costs, as exemples showing how the technology could be developed for less-than-lethal applications.

- 1. Development and test of an optimized delivery system and operational procedures. Working in close collaboration with the Marine Corps (or their designee) SAIC would develop a delivery system optimized for a specific operational scenario using paintballs and/or snotguns. This would include engineering design, fabrication, and tests to assess ballistic properties and improve the performance of the delivery system. It would also include development of operation procedures and training of personnel in the use of maladorants and the prototype delivery system. A field demonstration would be planned and executed near the completion of this program. The proposed ROM cost for this 4-month program would be \$1.50K. Deliverables would include the prototype delivery system, training, and a Technical Report. Estimated ROM costs for each follow on system hardware would be <\$2K.
- 2. Development and test of a mask delivery system for maladarant counteragents. The users of the maladarant, and other "friendlys" in the area must be protected from the effects of the maladarant. The counteragents for this purpose have been developed, however, an effective optimized delivery system for the counteragents has not. Current practice is to rub a small amount of the counteragent liquid under the nose. This has shown to

be effective in short-term testing but it is recognized that it does not present a long-term solution. This program will result in an effective delivery device for long-term counteragent provided protection. Although a number of possibilities exist, it is expected that the most universal use will be found in a face mask, similar to a respirator or gas mask, incorporating a replaceable cartridge containing the counteragent. The program would include training in mask use and a field demonstration would be planned and executed near the completion of this program. The proposed ROM cost for this 12-month program would be \$450K. Deliverables would include a number of the prototype protective systems (<20 units), training, and a Technical Report. Estimated costs for each follow on system haraware would be <\$500.

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3. An Air-borne Spray Delivery System. Current delivery systems are limited in range and area coverage. This program would develop a spray (or stream) delivery system for deployment from an airborne platform. The platform could be a manned (or unmanned) including helicopters, fixed wing aircraft, blimps, and aerofoils. The sprayer would allow a quick release of spray or streams of liquid over a wider orea than that achieved using gun-based The program would include engineering design. delivery systems. fabrication, and performance tests of the delivery system, hardware for attachment to the platform, and the spray release mechanism. It would also include training of personnel in the use of the prototype delivery system and aevelopment of operation procedures. A field demonstration would be planned and executed near the completion of this program. The proposed ROM cost for this 18-month program would be \$500X. Deliverables would include the prototype delivery system, training, and a Technical Report. Estimated costs for each follow on hardware system would be <\$10K.

Because of the variety and range in applicability of our proposed malodorant technology, we believe that the Marine Corps would be best served by discussing potential applications directly with SAIC to focus on a number of effective solutions to specific problems. A detailed proposal could be developed based on these discussions.