*System Assessment and Validation for Emergency Responders (SAVER)*

# Explosive Protection Technology Guide

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***Prepared by U.S. Army Natick Soldier Research, Development, and Engineering Center***

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# FOREWORD

The U.S. Department of Homeland Security (DHS) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions. Located within the Science and Technology Directorate (S&T) of DHS, the SAVER Program conducts objective assessments and validations on commercially available equipment and systems, and develops knowledge products that provide relevant equipment information to the emergency responder community. The SAVER Program mission includes:

- Conducting impartial, practitioner-relevant, operationally oriented assessments and validations of emergency responder equipment; and
- Providing information, in the form of knowledge products, that enables decision-makers and responders to better select, procure, use, and maintain emergency response equipment.

SAVER Program knowledge products provide information on equipment that falls under the categories listed in the DHS Authorized Equipment List (AEL), focusing primarily on two main questions for the responder community: "What equipment is available?" and "How does it perform?" These knowledge products are shared nationally with the responder community, providing a life- and cost-saving asset to DHS, as well as to Federal, state, and local responders.

The SAVER Program is supported by a network of Technical Agents who perform assessment and validation activities. As a SAVER Program Technical Agent, the U.S. Army Natick Soldier Research, Development, and Engineering Center (NSRDEC) has been tasked to provide expertise and analysis on key subject areas, including personal protective equipment (PPE), rapid deployment shelters, and shelf stable food, among others. In support of this tasking, NSRDEC prepared a technology guide on explosive protection technologies, which fall under the AEL reference number 02EX-02-TLEX, Tools, Explosive, Suppression, Deflection, Protection.

Visit the SAVER website on First Responder.gov (http://www.firstresponder.gov/SAVER) for more information on the SAVER Program or to view additional reports on explosive protection or other technologies.

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# EXECUTIVE SUMMARY

Depending on the emergency event at hand, different emergency responder agencies may be first at the scene. Many times the cause of the incident is not known immediately and the emergency responder may have little, if any, information. Furthermore, emergency responders do not usually wear specialized clothing or bring specialized equipment needed to perform operations in an unknown threat environment. If an explosive device is present, emergency responders may be injured because their normal personal protective equipment (PPE) lacks explosive protection. Therefore, selection of equipment for explosive threat protection requires emergency responders to be aware of the capability of the protective products, any improvements made to these protective products over time, and areas where emerging technologies may be considered.

This SAVER Technology Guide offers insight into available resources to assist in the technology selection process and review of individual protection. Specifically, this guide outlines technologies and products that protect against the harmful effects of the blast overpressure and/or flying fragmentation caused by explosive devices. The focus is on body-worn PPE, emplaced mitigating equipment (e.g., flexible and/or inflatable barriers, and/or electronic explosive defeat devices), and emerging explosive protection technologies (e.g., materials and textiles). This guide does not include armored emergency response vehicles or explosive ordnance disposal (EOD) responder-specific equipment, such as bomb suits, robots, or other specialized equipment.

Emergency responders need to consider their agency and individual needs when assessing individual blast overpressure and fragmentation protection.

# 1. INTRODUCTION

This SAVER technology guide outlines technologies and products that protect against the harmful effects of the blast overpressure and/or fragmentation caused by explosive devices. The focus is on body-worn personal protective equipment (PPE), emplaced mitigating equipment (e.g., flexible and/or inflatable barriers and/or electronic explosive defeat devices), and emerging explosive protection technologies (e.g., materials and textiles). This guide does not include armored emergency response vehicles or explosive ordnance disposal (EOD) responder-specific equipment, such as bomb suits and other specialized equipment.

Explosive devices cause damage through three main mechanisms: blast overpressure, fragmentation, and thermal. Fragmentation is by far the most lethal because fragments can travel great distances and easily inflict serious injury to humans. The blast overpressure affects a more limited range than fragmentation. Thermal is another potential injury mechanism from explosives; however, it is not addressed in this guide.

Since large-scale events such as the 1995 bombing of the Oklahoma City Alfred P. Murrah Federal building and the September 11, 2001, terrorist attacks, the number of PPE and other tools associated with blast overpressure and fragmentation protection available to emergency responders has increased significantly. Emergency responders need items that protect vital organs, do not restrict movement, are synergistic with job function, and do not require extensive maintenance and training. This guide provides information for emergency responders to consider when assessing their individual blast overpressure and fragmentation protection needs. It is not intended to be a collection of all types of blast overpressure and fragmentation protection items available.

# 2. BACKGROUND

Research and other efforts to support information gathering for this guide included interviews with ballistic and explosive subject matter experts, Requests for Information (RFIs) posted on the Federal Business Opportunities website (Appendix A), and Internet research. Furthermore, extensive interviews were conducted with multiple emergency responders, including EOD and non-EOD (e.g., hazardous material [HazMat], Special Weapons and Tactics [SWAT], other law enforcement, firefighters, and emergency medical services [EMS] personnel) (Appendix B).

The following sections focus on explosive threats, mechanisms of explosive injury, and standards and regulations.

## 2.1 Explosive Threats

The use of explosive devices such as those in the 2013 Boston Marathon is unfortunately a real and credible threat that must be addressed. Regardless of the explosive's design or size, it is intended to injure through blast overpressure and/or fragmentation effects. These devices range in size from mere ounces to thousands of pounds of explosive material. Improvised explosive device (IED) design and construction has many variables. Therefore, these bombs could be carried in backpacks, briefcases, gym bags, or simply prepositioned (e.g., parked) to conceal the threat. In addition, the possibility of using multiple IEDs designed to attack emergency

responders as they enter the scene with minimal or no PPE needs to be considered in the blast overpressure and fragmentation protection decision-making process.

Given the potential variability of threats and the associated evacuation distances (Table 2-1), multiple protection solutions must be considered since a single product or technology cannot provide the protection required for the broad range of threats. Products and technology may address both blast overpressure and fragmentation together or simply address blast overpressure or fragmentation.

**Table 2-1. IED Threat Examples and Evacuation Distances**

| Threat | Threat Description | Explosive Capacity | Building Evacuation Distance | Outdoor Evacuation Distance |
|---|---|---|---|---|
| | Small Package/letter | 1 lb | 40 ft | 900 ft |
| | Pipe Bomb | 5 lb | 70 ft | 1,200 ft |
| | FedEx Package | 10 lb | 90 ft | 1,080 ft |
| | Vest/Container Bombs | 20 lb | 110 ft | 1,700 ft |
| | Parcel Package | 50 lb | 150 ft | 1,850 ft |
| | Compact Car | 500 lb | 320 ft | 1,900 ft |
| | Full Size Car/Minivan | 1,000 lb | 400 ft | 2,400 ft |
| | Van/SUV/Pickup Truck | 4,000 lb | 640 ft | 3,800 ft |
| | Delivery Truck | 10,000 lb | 860 ft | 5,100 ft |

*Table courtesy of News & Terrorism Fact Sheet: IED Attack, The National Academies and Department of Homeland Security, 2009.*

## 2.2 Mechanisms of Explosive Injury

For any type of explosive device, there are three main mechanisms of injury: blast overpressure, fragmentation, and thermal. Fragmentation is by far the most lethal because fragments can travel great distances and easily inflict serious injury to humans. The blast overpressure affects a more limited range than fragmentation. At long ranges, blast overpressure can cause hearing loss, while at closer ranges the injury is more severe. Thermal is another potential injury mechanism from explosives; however, it is not addressed in this guide.

The explosive injury categorization, summarized in Table 2-2, provides information on four basic injury mechanisms and types of injury that may occur. These observations are important in assessing products and technologies designed for explosive and fragmentation protection. They are also important in determining a technology's applicability to provide explosive and fragmentation protection.

**Table 2-2. Categories of Explosive Injury**

| Characteristics | Body Part Affected | Types of Injuries |
|---|---|---|
| **Category: Primary** | | |
| Unique to high explosives, results from the impact of the over-pressurization wave with body surfaces | Gas filled structures are most susceptible such as lungs, gastrointestinal tract, and middle ear | • Blast lung (pulmonary barotrauma)<br>• Tympanic membrane rupture and middle ear damage<br>• Abdominal hemorrhage and perforation<br>• Globe (eye) rupture<br>• Concussion (traumatic brain injury without physical signs of head injury) |
| **Category: Secondary** | | |
| Results from flying debris and bomb fragments | Any body part may be affected | • Penetrating ballistic (fragmentation) or blunt injuries<br>• Eye penetration (can be occult) |
| **Category: Tertiary** | | |
| Results from individuals being thrown by the blast wind | Any body part may be affected | • Fracture and traumatic amputation<br>• Closed and open brain injury |
| **Category: Quaternary** | | |
| All explosion-related injuries, illnesses, or diseases not due to primary, secondary, or tertiary mechanisms.<br>Includes exacerbation or complications or existing conditions. | Any body part may be affected | • Burns (flash, partial, and full thickness)<br>• Crush injuries<br>• Closed and open brain injury<br>• Asthma, Chronic Obstructive Pulmonary Disease, or other breathing problems from dust, smoke, or toxic fumes<br>• Angina<br>• Hyperglycemia, hypertension |

*Table courtesy of The Centers for Disease Control and Prevention (CDC), Explosions and Blast Injuries: A Primer for Clinicians, May 2003 (http://emergency.cdc.gov/masscasualties/explosions.asp)*

## 2.3 Standards and Regulations

This guide focuses on protecting against blast overpressure and fragmentation using non-EOD responder-specific equipment. Currently, there is not a commercial standard that covers both blast overpressure and fragmentation protection; however, there are NIJ standards and guidelines for EOD suit protection (e.g., NIJ Standard 0117.00, Public Safety Bomb Suit). This standard outlines fragmentation requirements but very limited measures for blast overpressure. Also, there are applicable test procedures and standards for quantification of fragmentation for head protective equipment (e.g., NIJ Standard 0106.01, Ballistic Helmets), but none for blast overpressure.

Military standards provide the most representative assessment guidance for protection against fragmentation. Nonetheless, standards and regulations have been and continue to be defined and established across multiple regulatory organizations, including the following (https://www.llis.dhs.gov/knowledgebase/standardslist):

**National Institute of Justice (NIJ)**

- NIJ Standard 0101.06 for Ballistic-Resistance of Body Armor, July 2008;
- NIJ Guide 100-01, Selection and Application Guide to Personal Body Armor, 2001;
- NIJ Standard 0106.01, Ballistic Helmets, December 1981;
- NIJ Standard 0108.01, Ballistic Resistant Protective Materials, September 1985; and
- NIJ Standard 0117.00, Public Safety Bomb Suit, March 2012.

**Underwriters Laboratories (UL)**

- UL752 The Standard of Safety for Bullet-Resisting Equipment, September 2005.

**ASTM International**

- ASTM E2902-12 Standard Practice for Measurement of Body Armor Wearers – only associated with proper fit, not called out as mandatory requirement;
- ASTM Work Item (WK) WK42400 – New Specification for Clay Backing Material Used in Ballistic-resistance Testing – The specification will build upon NIJ Standard 0101.06 requirements. How the clay is handled prior to and during testing has been demonstrated to have a significant effect on deformation of the clay when the armor sample is struck by a non-perforating round; and
- ASTM WK42557 – New Terminology for Body Armor – Inconsistent application of terms and variations in words and descriptors are used by manufacturers, suppliers, conformity assessment bodies, purchasers, trainers, and wearers.

**U.S. Department of Defense (DoD)**

- DoD – Department of Defense MIL STD 662F – V50 Ballistic test for armor, December 1997.

**European or NATO Standards, Standardization Agreement (NATO) (STANAG)**

- STANAG 2920 Ballistic test method for personal armor materials and combat clothing, July 2003;
- STANAG 4569 Ballistic protection for light armor vehicles, January 2004; and
- UK/SC/5449 Ballistic test method for personal armors and lightweight materials, March 1996.

**American National Standards Institute (ANSI)**

- ANSI Z87.1 – *American National Standard for Occupational and Educational Eye and Face Protection Devices.*

# 3. OVERVIEW AND CATEGORIZATION OF EXPLOSIVE PROTECTION TECHNOLOGIES

The following sections outline current and emerging explosive protection technologies within three categories: worn PPE, emplaced mitigation equipment, and emerging explosive protection technologies.

## 3.1 Current Technologies

Available product types and technologies for emergency responder protective equipment, to a great extent, address blast overpressure and fragmentation protection. These technologies include, but are not limited to, soft materials such as fibers/fabrics that are subjected to multiple processing techniques (e.g., woven, high pressure pressing, vacuum pressing), polymers, and hard materials such as ceramics and metals.

### 3.1.1 Worn Personal Protective Equipment

Based on an emergency responder's discipline or area of expertise, they are positioned in anticipated safe zones. Nonetheless, on occasion, they may find themselves in a "hot" or a dangerous zone. Based upon the urgency and response preparation time, an emergency responder may have a need for readily available, transportable, and versatile blast overpressure and fragmentation protection. Further, as the military continues to research and develop explosive protection technologies, it is anticipated those technologies will eventually become available for emergency responders.

In general, unless explicitly specified, the worn PPE is designed to protect against limited fragmentation, but not against blast overpressure. Body coverage combined with rigid mass is needed to mitigate blast overpressure injuries. Furthermore, each of the items outlined below provide some level of protection individually, but the combined coverage of as many vital areas (e.g., head, eye, ear, torso) as possible is needed to provide significant protection.

#### *3.1.1.1 Head Protection*

Helmets generally consist of a shell, an energy absorbing system, and a retention mechanism (e.g., chin strap). A helmet can provide protection to the wearer against impact/shock from fragmentation and debris. The design and purpose can vary based upon supplemental requirements for ear covers and eye/face protection. The majority of ballistic helmets are labeled as NIJ helmet standard compliant. Ballistic helmets may be tested according to NIJ Standard 0106.01, Ballistic Helmets, December 1981, which only goes up to Level II as defined in this standard. Protection beyond Level II needs to be addressed with the supplier.

Advances in technology now allow multiple levels of ballistic protection to be integrated into modular head protection systems. Although there are improvements in protection against fragmentation, the effects of blast overpressure are continuing to be addressed with energy absorbing materials and techniques integrated into a head protection ensemble. However, current test procedures or standards do not address blast overpressure protection for helmets or head protective equipment. Therefore, claims that quantify blast overpressure protection are likely based upon product manufacturer testing techniques and not standards established by NIJ or DoD.

Additional protection for the neck can be added to the helmet. Collars, also known as nape protection, can provide variable levels of protection from blunt impact to ballistic protection. These items typically attach to the base of the helmet and drape around the sides and back of the neck. Because of the changing threats, it is becoming necessary to protect an individual's face, neck, extremities, and other areas. Weight and mobility continue to be a driving factor. However, the increased availability of helmet attachments or neck protection accessories provides a wider range of head area coverage options. The SAVER *Law Enforcement Tactical Protective Helmets Market Survey Report*, June 2008, provides a survey of available products (http://www.firstresponder.gov/SAVER).

#### *3.1.1.2 Eye Protection*

Safety goggles, spectacles, or face shields can provide the wearer protection from a variety of hazards such as ballistic impact, fluid splash, or sunlight. Both spectacles and goggles can be produced to protect from standard impact hazards per American National Standards Institute (ANSI) Z87.1 and/or provide enhanced ballistic protection per military standards. The state of the art in military ballistic goggle design is lightweight, low-profile goggles for use with night vision equipment. In addition to stand alone eye protection, face shields may be integrated into a helmet to provide both eye and face protection from ballistic threats.

In general, eyewear is too lightweight to provide significant eye and head coverage for blast overpressure mitigation. Face shields that are integrated onto a helmet can provide a level of blast overpressure mitigation to the head and face. Generally, more mitigation of blast overpressure is provided as the materials are heavier, cover the face, and retain a streamlined, aerodynamic, profile. Only limited testing of the blast overpressure protection of lightweight face shields has been performed.

Feedback from law enforcement and emergency responders identified comfort and aesthetics as important considerations when wearing protective eyewear in normal response situations. The types and styles have changed, but the core technologies and equipment functions are consistent. Advances in protective eyewear offer increased performance, which may increase the probability of responders using protective eyewear on a regular basis. The SAVER *Eye Protection (Tactical Goggles) Market Survey Report,* April 2008, provides a survey of available products (http://www.firstresponder.gov/SAVER).

#### *3.1.1.3 Ear Protection*

Ear muffs and ear plugs are devices that are made from sound deadening material, usually acoustic foam, which protects the ears from excessive noise and pressure that can cause harm to the inner ear. These devices can be used individually, or for extra noise attenuation, they can be used together to provide maximum protection. Some ear muffs utilize active sound protection also known as electronic protection. These electronic ear muffs use external microphones and internal speakers allowing communication between users while attenuating louder sounds and; therefore providing protection from blast overpressure. Ear muffs are also available to attach directly to helmets. Electronic ear plugs used by the military are finding their way into law enforcement to provide protection from impulse and continuous loud noises while enabling natural hearing or amplified sounds for situational awareness.

#### *3.1.1.4 Torso Protection*

Torso protection, typically referred to as body armor or ballistic vests, is intended to protect vital organs from ballistic threat (e.g., fragmentation) and to provide modular, load-bearing capability for duty gear. Maneuverability is a trade-off with ballistic protection; however, there are lightweight options available. The options for inserts, from hard ballistic plates to lightweight soft trauma protective options, have increased. Torso protection in the form of lightweight soft armor ballistic vests without hard armor inserts mitigates less blast overpressure. Generally, torso protection requires an appreciable-sized plate with high mass/high density to reflect blast overpressure. Blast overpressure protection is improved as the area of the rigid plate is increased.

Many torso ballistic protection options compliant to NIJ Standard-0101.06 for Ballistic-Resistance of Body Armor may be found at https://justnet.org/other/ballistic_cpl.html. The SAVER *Operational Vests Market Survey Report,* July 2008, provides a snapshot of the growth in vest availability (http://www.firstresponder.gov/SAVER).

#### *3.1.1.5 Extremity Protection*

Protective pads or other protective gear can provide the wearer impact, ballistic, and abrasion protection for hands, elbows, groin, knees, and shins. With the exception of bomb suits, most extremity protection is not sufficient to resist high velocity blast overpressure or fragmentation. Most law enforcement and other emergency responders sacrifice extremity protection for ease of mobility. The SAVER *Tactical Protective Padding Market Survey Report,* January 2008, provides information on gear applicable to law enforcement (http://www.firstresponder.gov/SAVER). Vendors include sports and training gear providers who market whole body padding options. The SAVER *General Purpose Outer Work Gloves Market Survey Report,* May 2012, provides glove options rated for various types of protection including puncture, cut, and abrasion (http://www.firstresponder.gov/SAVER).

### 3.1.2 Emplaced Mitigation Equipment

A variety of equipment has been developed to weaken blast overpressure from emplaced explosive devices. This equipment typically utilizes polymer-based materials distributed within a supporting structure to form a bag or panel configuration. The bags or panels are then placed around and in close proximity to an explosive device to suppress and redirect the blast overpressure away from the area that is being protected. The protective material typically provides very little protection from fragments and may be integrated with a material that provides fragmentation protection to provide protection from both hazards.

Beyond protective barriers, electronic technology options exist that are designed to prevent the explosive device from detonating. Frequently, electronic communication methods are used to remotely trigger an explosive device. Both active and passive methods can be used to shield a device from receiving electronic communications. Shielding a device from receiving communications provides additional time for EOD personnel to arrive on scene.

See Table 3-1 for types of mitigating devices.

**Table 3-1. Types of Emplaced Explosive Mitigation Devices**

| Sample Image | Description |
|---|---|
| **Flexible** | |
| Photo courtesy of SEMA World | • Rings, bags, blankets and tents are forms of protection.<br>• Blast curtains are available and designed to protect against fragments of glass and other secondary materials. The curtain size and thickness will determine the level of protection. They are promoted as lightweight and transportable and available in various configurations or custom designed.<br>• Flexible devices capture fragments and redirect blast overpressure away from the area being protected. |
| **Inflatable** | |
| Photo courtesy of Cintec | • Inflatable enclosures surround an explosive device and use water or super absorbent polymers to suppress the fragmentation and blast overpressure generated. |
| **Electronic** | |
| Photo courtesy of Kirintec Limited | • Electronic devices prevent wireless electronic communication between the trigger electronics for an explosive device and the trigger source. |

## 3.2 Emerging Material Technologies

The application of existing materials and technologies continues to evolve. Essentially, protection is evolving through improvements in material properties or capabilities, product processing techniques, testing fidelity, and increased understanding of injury dynamics. Over the past decade, military interactions with ever changing IED threats have accelerated the incorporation of new materials, manufacturing techniques, and injury prevention methodologies into individual protection. These technological applications have been successful in countering the extreme blast overpressure, fragmentation, and thermal environments of IED detonations.

Beyond the aforementioned advances, the capability to electronically disrupt or jam communications is an emerging technology that has merit as an explosive device suppression tool. Although the technology is useful in select military applications, law enforcement is unable to use jamming devices or electronic items. The use of jamming equipment by emergency responders may very well be in violation of the Federal Communications Commission (FCC) Communications Act of 1934 since jamming or disruption of telephone use may violate the law. Jamming devices are authorized for official federal government use per the Communications Act of 1934, 47 U.S.C. § 302a(c); 47 C.F.R. § 2.807(d). Therefore, depending on whether the Government organization in the explosive device situation is federal, state, local, or other, the

responding Government organization may have access to jamming equipment. However, these IED countermeasures require further refinement, FCC guidance, and protocols before they are available for widespread emergency responder utilization.

Emerging technologies for the protection and mitigation of blast overpressure and fragmentation range from novel applications of existing products to advanced foams and textiles. Examples with relative information on novel applications are provided in the following subsections. It is not intended to be a collection of all new or emerging blast overpressure and fragmentation protection technologies available.

A variety of new materials and material production processes are emerging for blast overpressure and fragmentation protection. These new materials can provide unique properties advantageous for blast overpressure or fragmentation protection. A few examples include films and tapes, foams, coatings, and sheets:

- Films and Tapes:
  - Peel-and-stick protective solution
  - Absorbs energy and mitigates fragmentation during an explosion
- Foams:
  - Collection of small glass spheres mixed into a resin
  - Able to withstand extreme pressures and provide protection from blast overpressure, which can cause serious long-term injury
  - Applications include protection against explosive devices for floorboards, undercarriage shielding, door guards, and firewalls
- Coatings:
  - Protective coatings can provide blast overpressure and spall mitigation when applied to structures
  - The coatings allow for high amounts of elongation and prevent the collapse of structures
- Sheets:
  - Fiberglass Laminates:
    - Bullet-resistant sheets manufactured to ballistic levels defined by Underwriters Laboratories (UL) Standard UL 752
    - Manufactured to defeat most levels of weaponry as described by UL and NIJ performance standards including handgun and rifle threat levels
  - Composite Panels:
    - Multiple layers of woven fiberglass encapsulated within a resin system by the pultrusion process that produces a rigid panel with exceptional ballistic resistance
    - Offer superior ballistic resistance at a weight less than 25 percent of a comparable steel panel

The fabric weaving processes have been modified to enhance a fabric's ability to withstand blast overpressure and/or fragment impact. A few examples include:

- Auxetic Fabrics (materials that increase in thickness perpendicular to an applied force):
  - Based on a blast overpressure-resistant material technology
  - Capable of stopping fragments and flying debris from explosive events
  - Requires fewer layers than legacy fabrics, thereby reducing cost and weight
  - Applications include blast curtains, military tent liners, vehicle panels for IED protection, bomb-disposal blankets and protective gear, and shielding for demolition and mining projects
- Monolithic Fabrics (materials composed of one piece):
  - Product of needle felting technique
  - Infuses Z-directional staple-length fibers directly into the fabric stack
  - May significantly reduce backface trauma while increasing ballistic and fragmentation protection
  - Technique said to eliminate the need for layer counting, quilting, and lamination

# 4. VENDOR CONTACT INFORMATION

Additional information on explosive protection products discussed in this technology guide can be obtained from the vendors listed in Table 4-1.

**Table 4-1. Vendor Contact Information**

| Vendor | Product(s) | Contact Information |
|---|---|---|
| Advanced Fabric Technologies LLC | Blast Fabrics<br>Xtegra Auxetic Fiber<br>Blast Curtain | 222 Pennbright Drive<br>Houston, TX 77090<br>281-872-7272<br>http://www.advancedfabrictechnologies.org<br>info@advancedfabrictechnologies.org |
| BAHIA 21 Corporation | Blast/Fragmentation Ring<br>Blast Ring | 2275 Research Boulevard<br>Suite 500<br>Rockville, MD 20850<br>301-296-4246<br>http://www.bahia21.com |
| Blackhawk Products Group | Vests<br>Armor Plates<br>Helmets<br>Ballistic Goggles<br>Gloves | 6160 Commander Parkway<br>Norfolk, VA 23502<br>800-694-5263<br>http://www.blackhawk.com<br>gs@blackhawk.com |

| Vendor | Product(s) | Contact Information |
|---|---|---|
| BlastGard International Inc. | Blast Mitigation Material<br>Blast/Fragmentation Blankets<br>Blast Wrap | 2451 McMullen Booth Road<br>Suite 212<br>Clearwater, FL 33759<br>727-592-9400<br>http://www.blastgardintl.com<br>info@blastgardintl.com |
| Bravo Zulu Services | Blast/Fragmentation Panels | 663 Hillcroft<br>Suite 215<br>Houston, TX 77081<br>713-271-3030<br>http://www.bzsinc.com<br>bzsinc@bzsinc.com |
| Eye Safety Systems Inc. | Ballistic Glasses<br>Ballistic Goggles | 160 7th Street West<br>P.O. Box 3151<br>Ketchum, ID 83340-3151<br>877-726-4072<br>http://www.esseyepro.com<br>csinfo@esseypro.com |
| HighCom | Vests<br>Armor Plates<br>Helmets<br>Face Shields<br>Body Shields<br>Blankets<br>Ballistic Goggles | 2851 S. Parker Road<br>Suite 418<br>Aurora, CO 80014<br>800-987-9098<br>http://highcomsecurity.com<br>sales@highcomsecurity.com |
| Kirintec Limited | Electronic Shield Enclosure<br>REBUS—RF Inhibitor for RCIED | 400 Madison Street #2208<br>Alexandria, VA 22314<br>703-448-0440<br>http://www.kirintec.com<br>sales@kirintec.com |
| Max Pro Armor | Armor Plates<br>Helmets<br>Face Shields | 7 Industrial Way<br>Salem, NH 03079<br>877-876-5423<br>http://www.maxpropolice.com<br>mpsales@maxproarmor.com |
| Mistral Security | Blast Containment Receptacles<br>EOD Robot Tools<br>Explosive Detection | 7910 Woodmont Avenue<br>Suite 820<br>Bethesda, MD 20814<br>301-913-9366<br>http://www.mistralgroup.com<br>securitysales@mistralgroup.com |

| Vendor | Product(s) | Contact Information |
|---|---|---|
| Peltor (3M) | Ear Plugs<br>Ear Muffs | 3M Center<br>Building 235-2W-70<br>St. Paul, MN 55144-1000<br>800-328-1667<br>http://www.peltormilitary.com |
| Premier Crown | Helmets<br>Face Shields<br>Body Shields | 100B Hunter Place<br>Youngsville, NC 27596<br>800-356-7311<br>http://www.sirchie.com/premiercrown.html<br>sales@sirchie.com |
| Protech Tactical | Armor Plates<br>Helmets<br>Face Shields<br>Body Shields | 3120 East Mission Boulevard<br>Ontario, CA 91761<br>800-347-1200<br>http://www.protechtactical.com |
| QinetiQ, North America | Fragmentation Bags | 11091 Sunset Hills Road<br>Suite 200<br>Reston, VA 20190<br>571-521-7700<br>https://www.qinetiq-na.com<br>vendorsandpartners@qinetiq-na.com |
| Revision | Helmets<br>Integrated Ballistic Shields<br>Ballistic Glasses<br>Ballistic Goggles | 7 Corporate Drive<br>Essex Junction, VT 05452<br>800-383-6049<br>http://www.revisionmilitary.com |
| Rothco | Helmets<br>Ballistic Goggles<br>Ear Plugs<br>Ear Muffs<br>Arm Guards<br>Gloves<br>Leg Guards | 3015 Veterans Memorial Highway<br>Ronkonkoma, NY 11779-0512<br>800-645-5195<br>http://www.rothco.com<br>info@rothco.com |
| Tripwire Operations Group LLC | Blast/Fragmentation Mitigation Kit<br>Blast Sax | 1685 Baltimore Pike<br>Gettysburg, PA 17325<br>888-330-7015<br>http://www.tripwireops.org<br>explosive@tripwireops.org |
| United Shield International | Helmets<br>Armor Plates<br>Body Shields | 1606 Barlow Street<br>Unit 1<br>Traverse City, MI 49686<br>800-705-9153<br>http://www.unitedshield.com<br>pjbanducci@charter.net |

| Vendor | Product(s) | Contact Information |
|---|---|---|
| Wiley X | Ballistic Glasses<br>Ballistic Goggles | 7800 Patterson Pass Road<br>Livermore, CA 94550<br>800-776-7842<br>http://www.wileyx.com |

# 5. OPERATIONAL CONSIDERATIONS

Operational considerations for the use of explosive protection technologies include, but are not limited to, the following:

- Explosive related emergency response procedures will vary amongst agencies and will influence the explosive protection technology procurement decision-making process.
- Understand potential explosive threats and the technologies available to address those threats. As non–EOD emergency responders enter into an unknown or rapidly evolving situation, personal protection is fundamental and various technologies and approaches may be applied to protect from blast overpressure and/or fragmentation.
- For a majority of emergency responders, budgets may be tight. Consequently, smaller community emergency responder agencies, which may be made up of volunteers, may depend on the resources of their surrounding areas. Therefore, communities that do not have access or the ability to acquire new or technologically advanced equipment may focus on opportunities to train together, become familiar with the pertinent equipment, and share access to applicable emergency resources.
- Emplacing protective barriers at the source of a suspect explosive item (covering or barricading) may be possible. However, unless the barrier enables rapid and unobtrusive interrogation by EOD teams, such emplacements by non-EOD responders can deter proper identification and timely mitigation of the item by the EOD teams. Currently, most barriers obscure visual contact, hinder radiographic imaging, and render current disruption equipment useless. This requires EOD technicians to remove the barrier, which increases time and exposure to threats.
- Do not assume that items certified for ballistic protection provide protection against blast overpressure and fragmentation. For example, NIJ Level IIIA rated PPE, as defined in NIJ Standard 0106.06, is designed to provide protection against bullets, but may only provide limited protection against blast overpressure and fragmentation. The improvised use of a product offers a false sense of protection. Work with the product vendor to understand the protection levels and acquire multipurpose testing data that would enable product assessment for appropriate equipment use during product review, selection, and procurement processes.

# 6. CONCLUSION

Varied explosive threats have been used and will continue to be a concern to the emergency responder community. Explosive protection technologies continue to be improved to protect against blast overpressure and fragmentation threats. Historically, military funded efforts have driven advances in blast overpressure and fragmentation protection and mitigation equipment. These advances are eventually placed into available products for emergency responders. Despite these advances, there are gaps in blast overpressure and fragmentation protection.

A selection process can separate products into three categories: body-worn PPE, emplaced mitigation equipment, and emerging explosive protection technologies. Emergency responder agencies that consider purchasing explosive protection equipment should carefully research each product's overall capabilities and limitations in relation to their agency's operational needs.

# 7. REFERENCES

*Emergency Responder/SME Interviews* (August-October 2013).

"IED Attack, Improvised Explosive Devices Fact Sheet." National Academies and the Department of Homeland Security, 2009.

SAVER. *Market Survey Report on Ballistic Shields,* January 2010.

SAVER. *Market Survey Report on Eye Protection,* April 2008.

SAVER. *Market Survey Report on General Purpose Outer Work Gloves,* May 2012

SAVER. *Market Survey Report on Law Enforcement Tactical Boots (LE Boots),* February 2008.

SAVER. *Market Survey Report on Law Enforcement Tactical Protective Helmets (LE Helmets),* June 2008.

SAVER. *Market Survey Report on Law Enforcement Tactical Protective Padding (LE Padding),* January 2008.

SAVER. *Market Survey Report on Operational Vests*, July 2008.

# APPENDIX A. REQUEST FOR INFORMATION

Home | Getting Started | General Info | Opportunities | Agencies | Privacy

Buyers: Login | Register  Vendors: Login | Register  Accessibility

## A--REQUEST FOR INFORMATION ON EXPLOSIVE SUPPRESSANT TECHNOLOGIES FOR EMERGENCY RESPONDERS

**Solicitation Number: W911QY-RFI**
Agency: Department of the Army
Office: Army Contracting Command
Location: ACC-APG - Natick (SPS)

Notice Details | Packages | Interested Vendors List  Print  Link

**Complete View**

Original Synopsis
*Sources Sought*
Sep 03, 2013
11:35 am

Changed
Oct 22, 2013
8:33 am

Return To Opportunities List | Watch This Opportunity | Add Me To Interested Vendors

**Solicitation Number:** W911QY-RFI
**Notice Type:** Sources Sought

**Synopsis:**
Added: Sep 03, 2013 11:35 am  Modified: Oct 22, 2013 8:33 am  Track Changes

THIS IS A REQUEST FOR INFORMATION ONLY -

The US Army Research, Development and Engineering Command (RDECOM), Natick Soldier Research, Development, and Engineering Center (NSRDEC), Natick, MA, is conducting a Request for Information (RFI) on Explosive Suppressant Technologies for Emergency Responders (ER). This is a Market Survey, not a Request for Proposal.

Law Enforcement patrol officers frequently respond to a broad range of threats for which they typically have no opportunity for pre-operation planning. Further, many other groups of ER personnel, to include Emergency Medical Response, typically have even less personal protective equipment when responding to an incident. Meanwhile, explosives remain a serious and credible threat, as exemplified by the recent Boston Marathon bombings.

The purpose of this RFI is to investigate, identify, and outline existing and emerging technologies designed to provide suppression, deflection, and protection against the ballistic and blast effects of explosive incidents and mitigate collateral injury during ER operations. NSRDEC will document these technology product options collected from the RFI, and other sources, in a Market Survey report to be made available to the ER community for their awareness and consideration.

Responses should include product performance and applicability to ER personnel based upon the proximity to an explosive event. In addition, information pertaining to the product's ease of use, deployment and mobility for the casual user (i.e. someone who is trained in the use of the equipment, but is not required to use it as part of their primary role or responsibility) as their primary protective equipment or as alternate mitigation measures, is requested.

All interested firms, regardless of size, are encouraged to submit information

**GENERAL INFORMATION**

**Notice Type:**
Sources Sought

**Original Posted Date:**
September 3, 2013

**Posted Date:**
October 22, 2013

**Response Date:**
December 6, 2013

**Original Response Date:**
October 31, 2013

**Archiving Policy:**
Automatic, on specified date

**Original Archive Date:**
November 2, 2013

**Archive Date:**
December 21, 2013

**Original Set Aside:**
N/A

**Set Aside:**
N/A

**Classification Code:**
A -- Research & Development

**NAICS Code:**
541 -- Professional, Scientific, and Technical Services/541712 -- Research and Development in the Physical, Engineering, and Life Sciences (except Biotechnology)

to NSRDEC and are encouraged to submit the following information:
Manufacturer
Product Name (and product graphics, if available)
Product Description:
Deployment Format (e.g. worn, detached shield, blanket/wrap, etc)
Features (e.g. weight, dimensions, time to deploy, time to dismantle, etc.)
Applications/Uses
Suppression format (e.g. protects against blast, fragmentation, both?, electronic prevention?, etc.)
Operating Requirements (i.e. resource or additional component needs - such as water/foam/ power/ other?)
Performance certification (e.g. level of protection?)
Pricing
Availability (i.e. is the product commercially available, in production, in product test and evaluation phases, under research/emerging?)
Contact Information - include company name, address, website URL, email address, and phone number for interested parties

Write-up submissions shall not exceed 10 pages in length and graphics are encouraged and do not count against the 10 page limit. Proprietary information must be labeled as such and will not be disclosed outside of the US Government. Nothing shall be construed herein or through the RFI process to commit or obligate the Government to further action as a result of this RFI. Firms responding to this RFI shall bear all risk and expense of any resources used to provide the requested information, and all information submitted in response to this request shall become the property of the US Government, and will not be returned to the submitter. Responses shall be submitted by 6 DECEMBER 2013 and shall be sent via email to david.j.audet2.civ@mail.mil or by regular mail to US Army RDECOM, NSRDEC, TSPID (ATTN: David Audet), Kansas Street, Natick, MA, 01760. DO NOT CONTACT THE CONTRACTING OFFICE.

**Contracting Office Address:**
ACC-APG - Natick (SPS), ATTN: AMSRD-ACC-N, Natick Contracting Division (R and BaseOPS), Building 1, Kansas Street, Natick, MA 01760-5011

**Place of Performance:**
ACC-APG - Natick (SPS) ATTN: AMSRD-ACC-N, Natick Contracting Division (R and BaseOPS), Building 1, Kansas Street Natick MA
01760-5011
US

**Point of Contact(s):**
Darlene Rideout, (508) 233-6134

ACC-APG - Natick (SPS)

# APPENDIX B. SURVEY RESPONSE QUESTIONNAIRE

Market research and interviews were conducted for this technology guide. A list of emergency responders and subject matter experts (SMEs) was compiled and those contacted willingly shared their time, experience, and personal understanding. Due to the variety in subject matter, a basic list of questions was used and interviewees elaborated in their areas of expertise, which provided exceptional insight and input into this technology guide. Sensitive information related to their operations has been removed so that the information provided was not specific to one particular organization or operation. The list of questions included the following:

- This information may be used in a technology guide submitted to the U.S. Army Natick Soldier Research, Development and Engineering Center for use in a guide used for the Department of Homeland Security System Assessment and Validation for Emergency Responders Program (SAVER). Any concern using information for this Guide?
- If necessary, can we use your name and organization to list individuals contacted or to obtain follow-up information?
- Can you provide a summary of your organization roles and responsibilities and provide information, in general terms, how your organization responds to an emergency?
- What equipment is used or available in an emergency response where blast overpressure and fragmentation may be a concern? For instance, a situation similar to the 2013 Boston Marathon bombing.
- What type of equipment do you have or use for blast overpressure and fragmentation protection?
- Any limitations of equipment used?
- Any equipment that you are aware of that would be helpful?
- Any thoughts on areas of improvement?
- Any other knowledgeable emergency responders that should be contacted for additional information?