WHITE PAPER:

Operational Response to Fourth Generation Agents

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Introduction

The poisoning of Sergie and Yulia Skripal in Salisbury, United Kingdom on March 4, 2019 heightened the concerns around Fourth Generation Agents (FGAs) around the world. Operational guidance for emergency response personnel has been limited and general in nature. This document provides evidence-based operational response guidance to further prepare responders with commercially available solutions to detect, identify, decontaminate, destroy, and confirm the destruction of the A-series agents using commercially available products from 908 Devices, First Line Technology, and Proengin.

The Novichok series of agents, also known as A-series or "newcomers," are Fourth Generation Agents (FGAs) developed by the Soviet regime in 1971 and later approved for use by the Soviet Army in all types of munitions beginning in 1990.[1] They are most closely associated with the V-series of agents. The United States Government provides a website for basic information on this class of materials.[2]

Until the poisoning of the Skripals, most information on this class of compounds was not freely shared amongst Government entities. As occurred in the United Kingdom, it is very likely that the first knowledge of an event involving the A-series agents will be from the medical community treating a patient. Early indications will likely lead the first responders to synthetic opioids exposure or organophosphate exposure as the causative agent. Until those patients are transported to a medical establishment and undergo continuous treatment, it is unlikely that an A-series threat would be determined. It should first be noted that if you suspect a nerve agent incident, your protocols for contacting the FBI Weapons of Mass Destruction (WMD) Coordinator and the National Guard WMD-Civil Support Teams (WMD-CSTs) should be activated immediately.

No illicit use or manufacture of an FGA or other nerve agents is known to have occurred in the United States, and there is no known threat of any nerve agent use in the U.S.[2]

Hazard Classification

FGAs are predominantly dermal hazards, but they can also be absorbed into the body via mucous membrane contact, inhalation, or ingestion.[2] The lethal dose via the dermal route is estimated to be around 1 mg for the average person.[3] In contrast, the estimated lethal dose via inhalation would be in the micrograms. General signs and symptoms of a dermal exposure can also be significantly different from those following an inhalation exposure. Localized sweating, nausea, vomiting, urination, defecation, overall weakness, and difficulty breathing are signs of a dermal exposure.[3] Miosis might not be observed following a dermal exposure unless the exposure location was in or around the eyes.[3] The extent of symptoms and the time from exposure to onset of symptoms (minutes to days) are very dependent upon the dose of material received.

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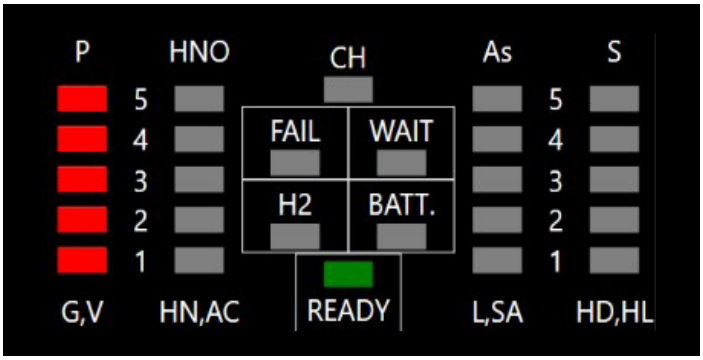
Remember, the human skin is an excellent barrier material and it takes considerable time for a material to penetrate this barrier and then permeate into the blood stream.

Protection

Due to the available information about the persistence of the A-series agents and their ability to permeate through the skin, NIOSH has recommended the use of NFPA 1991 vapor protective ensembles or NFPA 1994 Class 1 and Class 2 ensembles for initial entries. Operationally, the NFPA 1994 garments are a better choice as the totally-encapsulating NFPA 1991 garments are known to have physical restrictions in movement, hand function, hearing, and loss of comfort associated with them. Once the detection and identification devices confirm the threat identity, NFPA 1994 Class 3 ensembles can also be utilized.

Detection and Identification

There are several technologies capable of detecting and/or identifying the A-series agents. Unfortunately, many of them, such as Raman, FTIR, and colorimetric, have limits of detection (LODs) too high to be operationally relevant against the toxicological end points of interest. For example, Truetech's M8 Chemical Agent Detector Paper is cross-sensitive to this class of chemicals demonstrating a yellow/green or green/blue color quickly (30 seconds) followed by fading to yellow over time (up to 10 minutes) but is only suitable for larger amounts of threat material (estimated LOD of 400 µg).[2,4] The materials can also be detected and identified using FTIR and Raman technologies, but the levels required for standard handheld instruments are in the milligrams and few, if any, unclassified systems have spectra available for these threat materials.



Proengin's AP4C, a flame spectrophotometer, detects the A-series threats at 2 ppb in the aerosol phase or an estimated 25 picograms in the liquid phase.[5] The instrument is measuring total phosphorous content in the P Channel of the instrument and is not specific to the A-series agents. For an incident like the attack on the Skripals, the liquid scraper attachment is required. It is important to note that the instrument data is not quantitative when used with the scraper but can be used to qualitatively determine areas of higher and lower contamination based upon the screen display.

The MX908® from 908 Devices is the only device available, outside of a mobile laboratory, which is capable of both detecting and identifying the A-series threats. The LOD for the MX908 is 100-200 ng for the A-series[6], including in the presence of interferences. As a high-pressure mass spectrometer (HPMS), the MX908 also provides the mass spectrum of the sample for follow on analysis and can identify priority drugs, like opioids, which may present some similar symptomology. HPMS delivers unparalleled selectivity to accurately discriminate priority threats from the myriad of interferents that lead to false alarms with other technologies. Recent interference testing at MRI Global demonstrated the MX908 detecting A230 at 200 ng challenges at 100% reproducibility even with interferents present at 2000 ng (10 times the sample concentration).[6]

The long-term effects health effects of low-level exposures to these materials is currently unknown, but the combination of the AP4C and the MX908 in addition to the benchtop gas chromatography mass spectrometry instruments in the WMD-CST mobile laboratories are capable of providing detection and identification at operationally relevant levels.

The figure below shows the limits of detection of recommended detection technologies in comparison to toxicological endpoints.

Decontamination

One of the major concerns with FGAs is their persistence in the environment and, specifically, in water.[2] Increasing the pH of decontamination solutions may speed hydrolysis but care must be taken to minimize the production of degradation products like hydrofluoric acid, hydrochloric acid, hydrogen cyanide, and downstream oximes. Solutions with very high pH, like bleach, should not be used due to the production of toxic metabolites. During efficacy studies on Dahlgren Decon with pH modification, the optimum pH for complete and rapid destruction of the A-series agents was found to be slightly basic (pH 8).[7]

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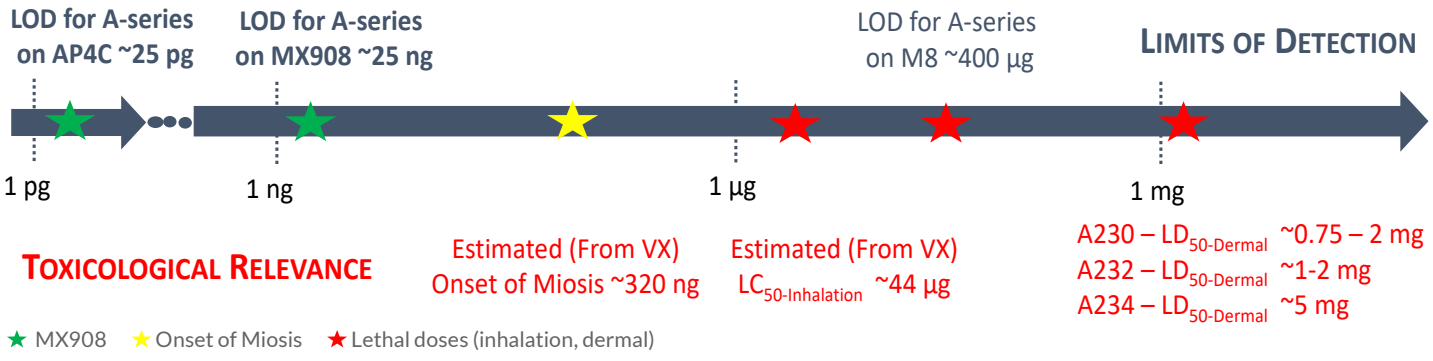
Decontamination of both people and equipment (PPE, detectors) require a hybrid decontamination approach.[8] If skin, human or animal, were to contact the threat material, it is critical that it be removed quickly. First, blot (do not wipe) the affected area with a Fibertect wipe. Second,



Instrument LODs in comparison to Toxicology.

remove any clothing that may have contacted the threat material. Third, Reactive Skin Decontamination Lotion (RSDL) can be used for spot decontamination.[2] Finally, consider washing off the residual RSDL with soap and water. [Blot >> Apply >> Remove]

When decontaminating the protective equipment, or other objects like detection devices, first blot the affected area using a Fibertect wipe; then, apply Dahlgren Decon and allow to remain in contact for the specified amount of time (2 applications, 15 minutes dwell time each); and, follow up with another Fibertect wipe. You might be required to doff the contaminated gear prior to the complete degradation of the threat material, so use care in doffing to avoid secondary contamination. [Blot >> Apply >> Remove].

It is imperative with threats like this that detection and identification be used to ensure a complete decontamination and degradation of the threat material occurred. Remember, this class of materials will remain viable in wash water, so complete degradation is necessary. Follow up with any decontamination and destruction of threat materials with detection and identification with the AP4C and the MX908.

REFERENCES:

1. Mirzayanov, V. 2009 State Secrets. Denver, CO: Outskirts Press, Inc. **2.** CHEMM website, https://chemm.nlm.nih.gov/nerveagents/FGA.htm (accessed 30 September 2019). **3.** Ellison, D. H. 2007 Handbook of Chemical and Biological Warfare Agents. Boca Raton, FL: CRC Press. **4.** Brletich, Nancy R., Mary Jo Waters, Gregory W. Bowen, Mary Frances Tracy, "Worldwide Chemical Detection Equipment Handbook," Chemical and Biological Defense Information Analysis Center (CBIAC), October 1995, p. 413; Special Assistant for Gulf War Illnesses, "M8A1 Automatic Chemical Agent Alarm" (Information Paper), October 30, 1997, web site www.gulflink.health.mil/m8a1alarms/. **5.** The following assumptions were used to determine LOD for the AP4C using the scraper: (1) Combustion of material within the scraper is effectively instantaneous. (2) T90 is 1 second. (3) During normal vapor operation, the AP4C has a sampling rate of 1.33 liters/minute. The analysis airflow in the burner is 58 mL/minute. (4) Systems will actually range in efficiency. The best LOD for the A-series agents would then be 12.5 pg and the worst would be 32.7 pg. 25 pg was chosen as an intermediate number. **6.** MRI Global Memo to 908 Devices, dated 20 September 2019. **7.** MRI Global report on Dahlgen Decon. **8.** Hybrid Decon (First Line Technology)

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