Dr Christina Baxter, CEO of Emergency Response TIPS, takes all the footwork out of traipsing around the bazaars

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As 2021 comes to a close, many people have now been unable to attend conferences and symposia for two years, to learn new techniques and tactics or evaluate new technology solutions. We therefore thought it wise to bring to your attention a few of the evolving solutions.

The world in which hazardous materials (hazmat)/CBRN teams operate has carried on and evolved throughout the pandemic. This has included a new focus on the use of flammable gases like hydrogen in transport and energy generation, and batteries and energy storage systems. Many new battery types are becoming available commercially, and they bring new challenges. Extinguishing fires involving lithium-ion batteries can be difficult, and besides, they generate a range of toxic combustion products causing toxic environments. As supply chains expand again to catch up after the past two years, we can expect more transport and storage related incidents involving hazardous materials.

Add in the stress of the evolving threats of domestic extremism and terrorism, and the burden and expectations on the hazmat/CBRN community are up further. On the domestic front, increased throwing of corrosive materials, spraying with homemade irritants, and the inclusion of oils and waxes with these materials all remind us to ensure that our decontamination methods are suitable. As regards terrorism, the transition from groups to lone wolves has made the identification of bad actors and the prevention of attacks harder. Finally, assassinations and attempts have continued, targeting both high profile and everyday people, with agents traditionally defined as CBRN materials (VX, Novichoks, nicotine, tetrodotoxin, and others). It's all a serious reminder to ensure we continually prepare, test our preparations, and keep abreast of the trends and new technologies to help our responses.

Detection

The biggest changes in operational capability come by way of new detectors and how we integrate them into our responses. First, new tools are becoming available to deal with the age-old problem of locating natural gas leaks. Unfortunately, in many instances teams do not have the tools to measure the natural gas at a safe stand-off distance. The early, tuneable diode laser absorption spectroscopy (TDLAS) based instruments used for detection of natural gas showed limitations with uneven surfaces, or at corners, and did not provide sufficient stand-off. The new Gazoscan remote laser methane detector (RLMD) addresses the issues with grip, surfaces, and corners while also doubling the detection range out to 100metres (330ft).

Raman spectroscopy has become a standard tool for most hazmat/CBRN teams over the past 20 years since the release of the first Ahura instrument in the early 2000s. There are now many products on the market, each having its own strengths and weaknesses whether that be in product design, algorithms, ease of use, ability to deal with fluorescence, raster scanning, mixture deconvolution, or something else. Even with a market rich with capability, there are two main standouts that have the potential to revolutionise the way we perform Raman spectroscopy in the field. First, Pendar Technologies released the first handheld proximity, or stand-off, Raman spectroscopy instrument. In addition to the 2metre (6ft) stand-off distance, the Pendar X10 incorporates differential Raman spectroscopy combined with chemometrics-based algorithms for data-rich spectrum analysis. It offers raster scanning where no single sample point is analysed twice resulting in enhanced mixture analytics and increased safety with dark, sensitive materials; and utilises an eye safe 3R laser.

The second revolutionary advance in field based Raman spectroscopy is from a newer company in the hazmat/CBRN space, Serstech of Sweden. In addition to its unique SharpEye autofocus protocols, the company has developed the Serstech surface enhanced Raman spectroscopy (SERS) kit, with its elegant and foolproof design. The system features a disposable magnetic sample interface to ensure proper seating, a quick sample preparation step, and then attaches directly to the standard sample interface. Once attached, the sample is rotated and vibrated in unison to ensure excellent mixing and analysis. In addition to these new product offerings, there are yet more new Raman based technologies and sampling approaches under development so continue to watch this space.

With the public recognition of fourth generation and pharmaceutical based agents in the past several years, it is clear that all hazmat/CBRN teams are

Proengin's new AP4C+ allows it to be mounted on a UAS ©Proengin

going to need instruments that are capable of detection and identifying aerosols. Hazmat/CBRN personnel must, therefore, consider how they will detect and identify aerosols. The team at 908 Devices released an aerosol interface for the MX908 in 2021, which allows the operator to continuously measure gases while the system captures aerosols and periodically thermally desorbs the potential threat materials. This interface has already been proven as a unique way to capture and identify airborne fentanyl analogues in field operations. The other instrument that is proving useful in the collection and detection of aerosols is the Proengin AP4C and its new counterpart the AP4C+. The latter takes all the capability of the original AP4C instrument and packs it into a smaller profile instrument that can be handheld or mounted on vests, robots or UAVs. In addition, Proengin released a Simtoolkit which allows the original AP4C systems to perform wirelessly and in multiple training scenarios. Finally, to address more emerging threats, the Proengin team has hinted at the upcoming release of a new high temperature S4PF sampling system.

Keep a close eye on this space over the next few years as significant investments in wearable detectors come to fruition. The US Department of Homeland Security Science and Technology Directorate funded Clear Scientific and Vaporsens detectors for synthetic opioids are in the final testing and commercialisation stage. The US Joint Program Executive Office for Chemical, Biological, Radiological, and Nuclear Defense is also working on the compact vapour chemical agent detection programme (see October 2021 *CBRNe World*). This programme funded Hamilton Sundstrand, Teledyne FLIR, N5 Sensors, and GE to develop wearable devices capable of detecting chemical warfare agents and toxic industrial chemicals while monitoring for oxygen and flammable atmospheres. All these projects, suitable for military and civilian first responder use, are in the later phases of development and operational testing.

To round out the chemical detection realm, two more products have been demonstrating enhanced operational capability. The RedWave team developed a Gas Module for the ThreatID capable of detecting and identifying gases at operationally relevant levels (between the occupational exposure standards and immediately dangerous to life and health levels). This breakthrough brings gas phase FTIR instruments into the mix, allowing for the unique identification of a broad range of gaseous substances.

The gas module attaches to the ThreatID platform with two clips and the system automatically recognises its presence and modifies the software in real time. Rather than developing yet another sampling system for the user to carry, the ThreatID gas module can be hooked in-line with a photoionisation detector or other sampling device. Finally, the FLIR G510 is a gas chromatograph mass spectrometer (GCMS) that's easy to use and maintain. While GCMS is considered the gold standard for chemical detection, most commercial instruments have been difficult to operate and maintain. The method selector wizard brings GCMS capability into the hands of all operators, with no need for advanced training on method development and

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operations. The system uses a simple integrated syringe injector and heated sampling probe to analyse solids, liquids and gases. If an aerosol capture device is used in conjunction, the system is also perfectly capable of detecting and identifying aerosols.

Finally, a new biological sampling and detection product has hit the market, namely SE Defense Technologies' Safe Sampling And Multiplexing Indicator (SSAMI). The multi-use sample collector uses a pre-moistened sponge to collect the sample - whether that's biological, chemical, explosives or narcotics. The swab is then re-inserted into the sampling device. This is coupled to the lateral flow strip assembly container, which holds up to 12 threat assays. While detection technology based on immunoassays is not new, the SSAMI sampler used in conjunction with the simultaneous deployment of 12 threat assays is unique. Additionally, the SSAMI sampler captures a second sample that is retained within the device for confirmatory testing, laboratory submission, or retained for evidence. At a time of significant increase in white powder calls, the SSAMI can be used to provide presumptive scene clearance for a variety of threats simultaneously. The past 18 months have seen an unprecedented investment in PCR, reverse transcription loop-mediated isothermal amplification, and other advanced bio-detection technologies; however, these are not quite ready for field operations.

Protection

While there have been no great changes in hazmat/CBRN protection products in recent years, there is the presumption of new products soon after the release of the new NFPA 1990 Standard for Protective Ensembles for Hazardous Materials and CBRN Operations (2022 edition). This document combines all the NFPA chemical protective standards under one cover and introduces a new NFPA 1994 Class 5 garment for use when responding to chemical threats where the primary hazard is flammability rather than dermal threats at concentrations of interest. This new class of garment will build upon the NFPA 1951 Standard on Protective Ensembles for Technical Rescue Incidents with added requirements for liquid repellency.

The Covid pandemic has challenged our understanding about the spread of biological agents through aerosols rather than larger droplets. Consequently, we must review our respiratory protection strategies and reconsider the products available for responders in hospitals, emergency medical services and hazmat/CBRN teams, such as full face air purifying respirators for high risk applications. While not every situation requires full face capability, this provides the ability to expand the products' use considerably, into such areas as terrorism and wildfires. With the attention that's been focussed on respiratory protection over the past 18 months, it is highly likely that improvements for all levels of protection will soon be realised. This will likely include innovations at all levels of protection from barrier face coverings to medical masks and respirators.

Decontamination

The decon space continues to evolve into a hybrid approach where any observable threat material is first blotted from surface, a decon agent is applied if desired, and any residual materials are removed. (You may know this as the blot, apply, rinse or BAR method.) This is then followed by enhanced ventilation, dry wiping, or wet decon where necessary. In most instances, wet decon is reserved for corrosives and oxidisers. While much of this is just a change in tactics, there is now a variety of small, unit-based decon platforms to choose from, with the First Line Technology Enhanced Decon Kit (EDK) and the United Tactical Supply SPEEDS Expedient Personnel Decontamination System leading the way.

Decision Support

Vlahi's Chemical Emergency Response E-Service (CERES) is a relative newcomer to the hazmat/CBRN response area although software engineers have been working in this space for many years. It offers free versions of the product (web-based and app) for emergency response teams that allow for hazard prediction modelling, an emergency response guidebook, Google maps, location services, distance measurement tools, assessment of impacted places, drawing tools, and more. Advanced versions also incorporate internet weather, live weather stations, more chemicals, blast model and sensor integration, etc, for relatively low to moderate service fees depending upon the desired capabilities.

Finally, the Emergency Response Decision Support System (ERDSS, aka Chemical Companion) has another new release on the way. This product remains free to civilian and military emergency response personnel in the US, Australia, and partner countries. In addition to the many new chemicals, new tools include destruction, fire combustion, fire extinguishment, gas cylinder recognition, munitions identification, self contained breathing apparatus air management, skin protection, and solution sprayer. The destruction tool walks users through the chemical and/or thermal destruction routes for explosive, biological, and chemical threat materials. The fire combustion tool provides the user with the thermal degradation products of different hazardous materials that may be involved in a fire, provides exposure and detection guidance, and then links the user to lists of detectors that can be used for direct detection or via cross-sensitivities.

Overall, there have been some great strides forward in the hazmat/CBRN space. We look forward to the days when we can all be face to face at conferences again and get hands-on with all the new capabilities coming our way. Traditionally, attending conferences has provided opportunities to review the threat environment and consequently, your detection, protection, decontamination and decision support needs, and how they can be used to improve the safety of your responders and communities. Stay safe.