Latest 'up-armoured' Scimitar CVR(T) with anti-RPG protection, Bowman radio and latest sighting. In vehicles this small, CBRN systems fight for space with air-conditioning units

Jane's/Patrick Allen: 1180829

# Low-profile technologies conduct a clean sweep against CBRN attack

Current vehicle and personnel protection requirements tend to focus on the ballistic threat, but, as **Tim Dumas** reports, progress is also being made against the chemical, biological, radiological and nuclear threat

**In the 20 years since the demise of the Cold War, changing strategic and operational priorities have reduced the emphasis on the need for nuclear, biological and chemical (NBC) or the more inclusive chemical, biological, radiological and nuclear (CBRN) defence.**

Without the apparently imminent threat of nuclear war, a whole generation has matured without specific and immediate concerns of CBRN attack on the battlefield. As a result, planners naturally concentrated their efforts in areas that are of current importance: the new strategic direction, and current operations.

Many countries nominally maintain a high degree of CBRN defence capability, but analysis of the threat and in some cases operational realities, exacerbated by a fading collective memory of weapon effects, appear to have taken their toll on the priority accorded to CBRN protection.

However, new threats, or a new international construct, require some of the emphasis on CBRN protection to be renewed where it may have been lacking. Changing postures and developing capabilities in some countries are causing concern.

The ability of terrorist groups and others to deploy toxic industrial chemicals (TICs) or possibly 'dirty bombs', which could spread contaminated material in lower intensity conflicts, are focusing minds both in CBRN protection of combat vehicles and the wider context.

In fact, a snapshot of the CBRN protection scene shows that far from the capability reducing, it is in fact increasing in effectiveness. Despite the realities of current operations in which CBRN protection is not the highest priority, it is clear that NATO and other forces continue to give this crucial capability the high overall priority that it demands, not least in core combat vehicle programmes.

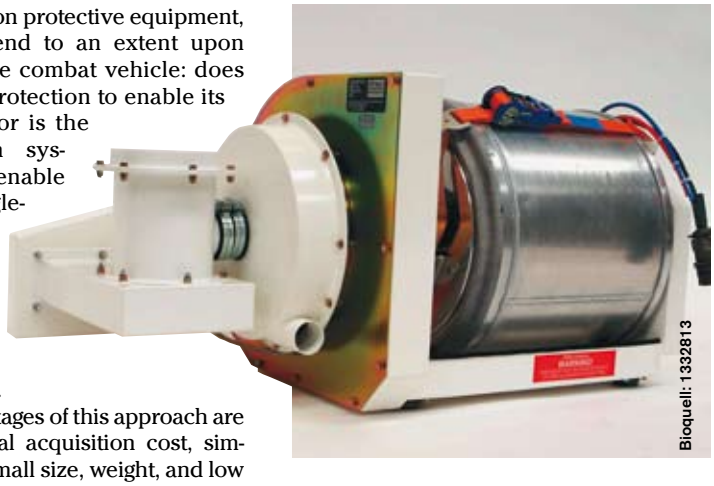
Research and development, resources, commitment and co-operation between customer and industry are producing advances in utility and effectiveness against increasingly sophisticated threats, not only for new equipment, but as upgrades for combat vehicles already in service.

There are two main approaches to provide complete CBRN attack filtration: single-pass and regenerative, also known as regenerable. Both can provide positive pressure (over-pressure) or tethered (assisted-breathing) protection, defending against nerve agents, choking, blood agents, viruses, bacteria and nuclear particles.

When deciding on protective equipment, applications depend to an extent upon the purpose of the combat vehicle: does it require CBRN protection to enable its crew to survive, or is the CBRN protection system essential to enable it to operate? Single-pass systems use high-pressure air through high-efficiency particulate air (HEPA) and activated carbon replaceable filters.

The main advantages of this approach are maturity, low initial acquisition cost, simplicity, relatively small size, weight, and low power requirements.

On the flip side, its disadvantages are the need to change filters in the field after approximately 24 to 48 hours of use, when saturation is approaching with the attendant problem of disposal of the dirty filters, possibly at a crucial tactical moment. Other considerations include logistics (filters are neither small nor light), and through-life costs, as filters are not cheap. In short, single pass systems lend themselves more to the need to survive in a contaminated area than to conduct prolonged operations.




**Bioquell MDH integrated cyclone nuclear-biological-chemical filtration system.**


**Bioquell MDH typical integrated NBC and AC system.**

## Integrated systems

However, increasingly integrated with environmental control systems (ECS) that provide heated or cooled air from a separate low-pressure fan, single-pass CBRN protection systems are mature and have been developed over a long period of time. They are commonly used in a very wide range of combat vehicles, from main battle tanks to small armoured liaison vehicles, and are increasingly seen in combat logistic support vehicles (using tethered systems). Research and development continues to improve such systems, leading to an introduction of new products and components such as coatings for filters to increase their efficiency, automated controls, and filter saturation warnings to ease crew workload.

Regenerative systems for combat vehicles are far more suited to continuous operation in a contaminated area, using a carbon-filter bed, either high or low-pressure fans, and pressure and temperature swing absorption (PSA/PTSA) to provide clean air. They are less mature in combat vehicle applications than single-pass systems and are still in less common use, but confer significant advantages of operability with no requirement for filter-change and potential through-life cost savings.

Some contaminated gases may be dumped into the atmosphere from the system, but this would be expected to be into an already contaminated area. While acceptable in a high-intensity conflict scenario where contaminated areas might be large and contiguous, tight control would be required in scenarios more likely today where small, spot-contaminated areas might be expected, with large clean areas surrounding them.

Other disadvantages include acquisition cost, relatively large size and weight, and higher power usage, all of which have traditionally limited regenerative systems largely to naval vessels where those factors are less of an impediment.

However, combat vehicle user interest has increased as smaller, lighter systems have been developed.

For example, PTSA regenerative systems have been chosen for Trojan and Titan, the UK's new Challenger 2-based engineer vehicles, as well as the future Terrier manoeuvre support vehicle.

Parker Hannifin's domnick hunter (Pdh), won the contract with its low-pressure fan PTSA regenerative CBRN protection system for Trojans and Titans.

It is combined with an integrated ECS that provides climatically controlled air to the crew at their stations, and also directly via hoses to cooling vests. It is claimed to be the world's first series-production regenerative CBRN protection system in an armoured fighting vehicle and is effective against nerve agents, choking, blood agents, viruses, bacteria and nuclear particles.

Technology is now advancing to a degree where regenerative systems might soon confer similar advantages to single-pass systems. Innovative nano-filter technology is currently being developed and tested in the UK that, like existing regenerative technology, will defeat very sophisticated threats, and promises significantly reduced system size and power consumption. Other technologies under development – such as catalytic oxidisers (CATOX) analogous to catalytic converters in automobile exhausts – offer potentially greater efficiency and reduced space claims.

Pdh is already moving ahead in developing new technology that it is confident will provide a solution to size, weight and power concerns, allowing them to target new programmes for smaller armoured vehicles such as the US Future Combat Systems (FCS), and UK Future Rapid Effect System (FRES) or their successors.

The company has also teamed exclusive-

**Trojan and Titan armoured engineer tanks are the first to have regenerative CBRN protection**

Jane's/Patrick Allen: 1198402

ly with nano-porous Solutions Ltd (npSL) to apply npSL's technology, developed at the UK's Bath University, using a molecular sieve of nano-porous hollow-fibre capillary tubes in multiple layers with 10 times the surface area of conventional spherical packed bed materials.

This is claimed to bring a step-change reduction in regenerative system power requirement, size, and weight.

The filtration technology could also lead to improvements in individual protection equipment (IPE). The two companies are 12 months into a 22-month development programme and are confident that their applied technology will soon enable them to provide compact, lightweight, low pressure-drop, low power-demand, regenerative systems for small- and medium-sized combat vehicles.

With current Western operations underway in hot environments, the ability to provide cool, clean air is another challenge. As single-pass systems require high air pressure, the lower fan pressure requirements for air conditioning can only be used concurrently with some low-pressure regenerative systems.

Instead, armoured vehicles widely use sophisticated ECS systems that have separate single-pass CBRN and climate-control components, with direct outlets to crew stations. These may additionally have hose attachments to crew IPE, and also provide cooled air in some cases to crew cooling vests. Operator convenience can be provided through a common control panel.

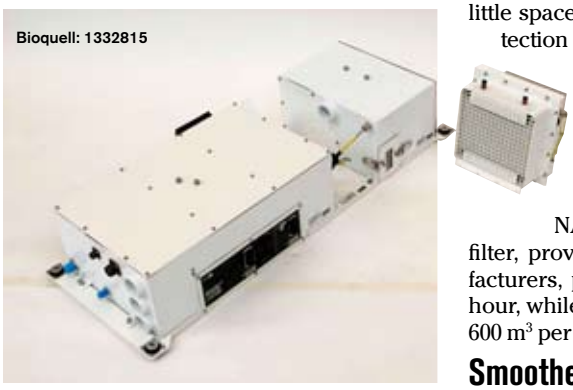
## Low-risk operations

The CBRN risk in current operations, particularly in Afghanistan, has been assessed at such a low level that space previously occupied by CBRN protection systems has been given over to climatic management in some armoured vehicles, such as the UK Combat Vehicle Reconnaissance, Tracked (CVR[T]). Operations at extreme ambient temperatures have become a very high concern, with temperatures in some manned compartments reported as high as 70 degrees Celsius, risking unplanned shutdowns of vital equipment, not to mention the effect on personnel. Operational realities also dictate the extent to which resources can be currently committed to CBRN.

In the UK, Bioquell's MDH defence division has hitherto integrated its single-pass CBRN solutions with pleated-paper biological and activated-carbon chemical filters into British Army CVR(T)s, Stormer and Shielder air-defence and remote mine-laying derivatives, as well as Challenger 2 MBTs to what is now NATO AEP 54 standard.


Bioquell: 1332816

**Bioquell MDH AFV training filter. Single-pass systems need regular filter changes**



Bioquell: 1332815

**Bioquell MDH CVRT crew cooling and heating system.**

**The Ametek CBRN system.**

Ametek: 1332817

Tethered systems enable the crew to connect their IPE directly to the over-pressure system by hose, giving them protection should the cabin over-pressure be compromised, or if operating heads-up. However, smaller vehicles can find themselves cast in an either/or situation. The CVR(T)'s CBRN systems have been removed in favour of a crew-cooling system for Afghanistan, for example, and there is little space available to refit any CBRN protection at the same time.

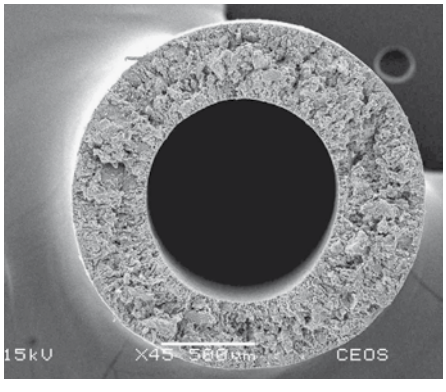
Further complicating the issue, CBRN fan motors produce high pressure and low volume, while air-conditioning (AC) fans produce high volume and low pressure. By way of example, the NATO-standard No 1 composite filter, provided by MDH and other manufacturers, provides 170 $m^3$ of clean air per hour, while MDH's CVR(T) AC system shifts 600 $m^3$ per hour.

## Smoother integration

In an effort to smooth integration, MDH offers separate CBRN and AC systems that can be controlled from the same panel for user convenience. The company is now developing a similar system controlled by CANBus databus for BAE Systems Hägglunds, complete with an indicator to warn when a filter change is needed.

Turkey's FNSS has chosen MDH CBRN systems for its tracked Armored Combat Vehicle, while Saudi Arabia is to receive an undisclosed number of unified control outfits for its M113 upgrade programme, and Malaysia is to receive 48 Adnan infantry fighting vehicles (IFVs) with a similar fit.

The company has further provided 2,500




nano-porous Solutions Ltd: 1332820

**The end of an npSL fibre, the exploitation of which could lead to substantial reductions in regenerative filter dimensions.**

## UK MoD CBRN defence sector transformation

**The UK Ministry of Defence (MoD) has long worked in partnership with its NATO allies to provide the best possible protection against CBRN attack and continues to be a leader in the development of appropriate technologies and capabilities, both at Dstl's renowned Porton Down establishment and in its partnership with industry.**

**Recognition both that CBRN protection remains a key UK defence capability, and concern over the best way to provide the capability, is reflected in the importance placed in the recently formed Team CBRN. Its aim is to transform the sector by creating a joint Integrated Project Team between the MoD and industry for an initial one-year pilot phase, to conduct business more efficiently.**

**Thirteen companies expressed an interest in being considered by the UK MoD for six capability areas: physical protection; sense (biological); sense (chemical); sense (radiological); knowledge management; and hazard management. Seven companies and consortia have been selected to be invited to tender: QinetiQ Consortium, EADS, Finmeccanica UK (Selex Galileo) and Serco, Northrop Grumman Mission Systems, EDS, Thales UK Land and Joint Systems and KBR. Team CBRN will be used to pull in the best technology from far afield, making use of capabilities on offer by established practitioners and also potentially new entrants, much as its earlier counterpart Team Complex Weapons has done for missiles, smart weapons and their components.**

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FULL PAGE AD

CBRN packs for the US' Force Protection and General Dynamics Cougar mine-resistant ambush-protected (MRAP) vehicles, incorporating either standard NATO No 1 composite filters or other composite filters such as the US M48 (100 cfm).

UK-based Ametek Airscrew has developed its own single-pass filtration and regenerative combat vehicle CBRN protection systems, integrated with ECS.

It makes a filter conforming to the NATO No 1 composite filter-specification and continues to develop single-pass technology as the most suitable for the combat vehicle market where size, weight, power consump-

## Counter-CBRN

**Counter-CBRN work now embraces a wide range of military and civilian research efforts at national levels across Europe, as well as within NATO and the EU.**

**According to EU specialists in the field, most European CBRN protection and clearance equipment rests in the hands of armed forces and too much dates from the Cold War, if not chronologically, then in concept: large, heavy pieces of equipment designed for single-threat detection or perhaps altered for multimodal threats and operable only by highly trained specialists.**

**"All this stuff is reliable and proven, but often slow or difficult to use," an EU military official tells *Jane's*. "Very little is suited for nimble manoeuvre against urban asymmetric terrorism – among the biggest worries for our military and civil security forces. That is our challenge: to develop deployable multimodal CBRN equipment and systems, whose test and certification norms are standardised – or at least comparable – across Europe."**

**Planners intend to tackle this in various ways.**

**At the theatre level, NATO's International Security Assistance Force (ISAF) in Afghanistan has had a 'flying' CBRN platoon consisting of Czech specialists who carry out CBRN reconnaissance, decontamination and sampling tasks anywhere across the country at the request of the ISAF commander. One of the tasks is to carry out routine detection and surveillance on a daily basis.**

**"You don't want soldiers on patrol stationed or resting in potentially hazardous places. In Bosnia you had soldiers sleeping wherever they could, sometimes in old factories where toxic chemicals were everywhere," a former allied officer and CBRN adviser to NATO tells *Jane's*.**

**A CBRN battalion has been part of the NATO Response Force (NRF) on a rotating basis since 2003. Offering integrated CBRN detection capabilities and consequence management, it has been deployed several times to protect NATO summits and other events around Europe.**

**Technical advice from both the NRF and ISAF units is fed to the alliance's military headquarters at Supreme Headquarters Allied Powers Europe (SHAPE), where planners are reviewing whether to add CBRN capabilities to a smaller but permanent NRF package. The size of the NRF is supposed to be 25,000 but the force has suffered chronic force-generation shortfalls since its launch in 2003, due to operational strains on the allies.**

**"The good thing about the response force's CBRN element is that it has been embedded as a standing training requirement," says the CBRN expert. "Since the whole force rotates every six months, they regularly have large training exercises and part of that covers CBRN, forcing the whole system to address the challenge."**

**Another challenge has emerged for the European Defence Agency (EDA) and its 26 military authorities, regarding decontamination and detection standards. "We have no standard way today to approach quality control regarding clean CBRN decontamination equipment, so that soldiers can quickly re-use the equipment," an EU military officer tells *IDR*. "Lessons learned from [NATO and EU mission] operations show that before we can bring the equipment back into Europe, we've had to follow all these varying national health and customs authorities' rules and regulations and we're not accustomed to providing that documentation. We need new scanners and I'm also thinking of detectors that can be installed on [hazardous waste or sampling] bins which also provide proof for documentation." The EDA is soon to run a feasibility study on the latter.**

**Equipment decontamination standards are only one of a set of forthcoming CBRN equipment and capability requirements the agency plans to pursue with its constituent national defence ministries. In May, for example, it expects to get approval from the 26 EDA countries to launch a biological detection and monitoring equipment development and enhancement programme, or Bio-EDEP.**

**Consisting of eight separate research and development (R&D) projects, by 2015 Bio-EDEP aims to pull together a comprehensive system that is modular-based so that each EDA country can buy into it according to its national budgetary and capability needs.**

**The first seven projects will, among other goals, focus on development of lightweight bio-threat monitoring, detection and protective gear for individual soldiers and non-specialist units for tactical purposes. This would extend up to strategic level too, where the idea is to develop such impervious bio-attack protection that it would function as a deterrent. The projects will also develop mobile laboratories and stand-off capabilities for use on unmanned aerial or ground vehicles.**

**The eighth and last project will carry out sensor-fusion work to integrate the other projects' capabilities into a comprehensive system based on reduced logistics support and energy consumption.**

**The most expensive research goal will be number six: the development of second-generation deployable tactical field analysis – mobile laboratories – with an estimated budget of EUR36 million (USD47.5 million). Project number two, to develop stand-off biological detection and forensic capabilities, will be the next most expensive at EUR23 million.**

**Platforms for these capabilities will include unmanned aerial and ground vehicles, mobile laboratories and a follow-on version of the Fox CBRN reconnaissance and Stryker-variant vehicles.**

**The agency hopes to get approval by 18 May to launch Bio-EDEP with a core group of countries. So far about half a dozen EDA nations intend to participate, although the agency hoped to join as the programme gets off the ground.**

**The launch will set in motion a 20-month preparation phase during which a common "staff target" or requirement will be defined for each of the eight projects. Once the requirements are completed by the end of 2010 or early 2011, the EDA will turn to European arms procurement organisation OCCAR (Organisation Conjointe de Co-operation en matiere d'Armement) to take over Bio-EDEP, developing a demonstrator by 2015.**

**The EDA has been careful not to duplicate any bio-detection work in the civilian sector since it wants to use policy and technology R&D to tighten the surveillance, control and accountability of Europe's industrial and commercial NBC materials and precursors to prevent them from falling into the wrong hands.**

**It is an ambitious idea, as laid out in a 79-page report released in January 2009 by the EC's CBRN task force.**

**The report's recommendations will be the basis for a formal EU CBRN action plan, which the commission plans to unveil in June as a political document to the 27 member nations' activities in the future.**

**The task force's sub-group on chemical threats, for example, calls for an EU-wide certification, testing and trial schemes to evaluate the quality of chemical-detection systems, tools and facilities. The report's recommendations on countering bio-threats also point to the risk of divergent capabilities across the EU. Not all member states have adequate laboratory capabilities and there is a "challenge to rapidly dispatch collected samples to the reference laboratories across borders," says the sub-group on bio-threats.**

**As for the radiological sub-group, it urges the EU to implement a risk-based approach to radiological security by establishing a list of radioactive sources "of highest individual concern and prioritising prevention measures".**

**While warning that the EU should not duplicate similar processes at NATO or the International Atomic Energy Agency, the radiological-threat recommendations to the Commission are remarkably similar in their needs analysis to those of NATO and the EDA.**

**They say the EU should develop: transportable equipment for emergency responders, including neutralisation and detection equipment for bomb squads; decontamination equipment; radiological and nuclear forensics; storage of contaminated evidence for extended periods; disposal of contaminated materials; detection of particle size and distribution, and potential chemical composition changes following an explosion.** ***Brooks Tigner***

nano-porous Solutions Ltd: 1332822

End view of an npSL heated fibres bundle...

tion and cost may be considered the most important factors.

A single-pass system integrated with an Ametek ECS has been chosen for the Polish Rosomak IFV programme. The first of a planned 690 are already in service in Afghanistan. The filter system has also been chosen for General Dynamics' ASCOD IFV, while Ametek has supplied Turkey's FNSS with a combined CBRN and ECS system for the UAE's ICV300 programme.

The company's system for 8x8 wheeled IFVs provides 200 $m^3$/h of airflow through another supplier's filter, as specified by the customer. It features a bypass valve to preserve the life of the CBRN filter, providing a similar airflow rate regardless, and operates in conjunction with an Ametek ECS.

Ametek's tracked IFV single-pass system provides 170 $m^3$/h of CBRN-filtered airflow. In non-operational use, it can be operated using a 'peacetime' filter, which provides dust filtration and allows the CBRN filters to be kept in long-term storage. It also operates in conjunction with an Ametek ECS.

## Regenerative option

Ametek's regenerative CBRN system, developed in conjunction with PALL, has been chosen for the UK's Terrier manoeuvre support vehicle due into service in 2013. It uses PSA chemical filtration. This offers high levels of protection against a wide range of chemicals, including TIC, and provides sufficient filtered airflow to satisfy the ventilation requirements of the crew, at the same time as continuously regenerating the PSA filter beds. Clean air is delivered to the vehicle crew compartment via Ametek's ECS.

Portsmouth Aviation (PA) is better known for its naval CBRN collective-protection equipment than for military vehicles, but it has teamed with US-based Hunter Manufacturing to focus on the forthcoming competition for the UK's FRES requirements.

Like Bioquell MDH, Hunter considers single-pass filtration to be the most effective system for its weight and volume, using the lowest energy.

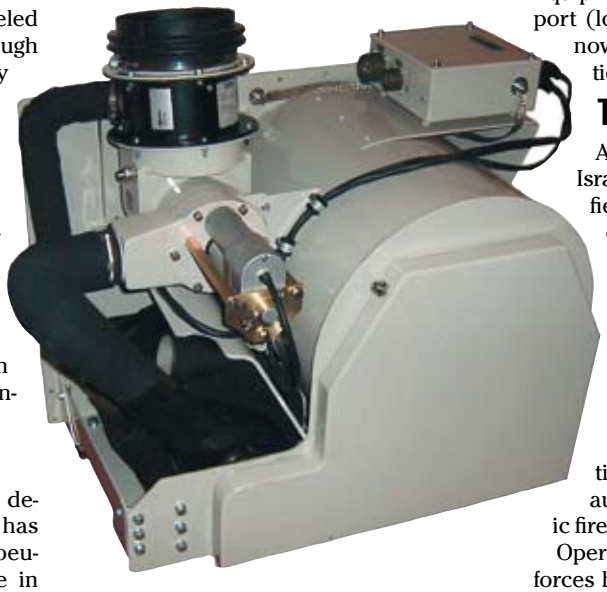
PA claims to have a CBRN unit integrated with an ECS air-management system that is essentially ready to go with reduced costs and risk. This could also be of interest to light- and medium-weight combat vehicle programmes in Europe, the Middle East, the US and elsewhere. Although details are scarce, it is likely to be a single-pass HEPA filtration and activated carbon system in an integrated filter and fan assembly to keep power usage and space to a minimum, with semi or fully automated control.

Hunter's work on CBRN systems for MRAP vehicles and other wheeled armoured vehicles place it well for requirements in these burgeoning sectors of the combat vehicle market.

Hunter CBRN protection products and filters can be found in Abrams MBTs, Bradley IFVs and cavalry vehicles, Paladin howitzers and M270A1 Multiple Launch Rocket Systems, with tethered systems in Stryker family vehicles, High Mobility Multipurpose Wheeled Vehicles (HMMWV) and Heavy Equipment Transporters. More combat support (logistic and specialist) vehicles are now being provided with CBRN protection for crews.

Ametek: 1332819

Ametek Terrier CBRN pack.



Ametek 3-way NBC pack. Ametek: 1332818

Kinetics: 1332823

Kinetics CBRN AFV protection system.

nano-porous Solutions Ltd: 1332821

... and npSL heated fibres bundle in a module.

## Tackling TICs

Another major industry player is Israel's Kinetics, which develops, qualifies, produces and fields systems and components for a wide range of tracked, wheeled, stationary and airborne military platforms. It uses single-pass filtration over-pressure systems, which can be provided as stand-alone protection or integrated within a comprehensive Life Support System.

This latter can include CBRN detection, heating, ventilation and AC, an auxiliary power unit, and an automatic fire-suppression system.

Operational realities faced by Israeli forces have led Kinetics to reconsider systems design, as the threat is not limited to CBRN warfare conditions, and is considered a real threat in lower-intensity warfare and other areas where terrorism may be expected.

Experience has shown that vehicles are vulnerable to attack using commercially available TICs and other contaminants.

Kinetics' CBRN system uses a by-pass valve as standard, enabling the filter to be installed on the vehicle without performance degradation for up to 10 years. A fresh-air dryer maintains low relative humidity of the airflow to the filter to avoid clogging of the impregnated carbon with water molecules.

A maintenance-free inertial particle separator removes dust to a claimed efficiency of approximately 99 per cent, which significantly increases the CBRN filter's life and avoids rapid dust clogging of the HEPA filter. ■

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