

CBRN Annual Review 化生放核(CBRN)年度回顧(譯)

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Whilst the types of Chemical, Biological, Radiological and Nuclear (CBRN) threats in the world have not changed some military forces are altering their equipment requirements to ensure they are better placed to face a wider range of scenarios. In recent decades Western militaries have been very focused on the terrorist threat with potential attacks using CBRN materials either in a built-up area in their home countries as well as in operational theatres overseas.

儘管世界上化生放核(CBRN)威脅的類型沒有改變，但一些軍事力量正在改變其裝備要求，以確保他們能夠更好地應對各種狀況。在最近幾十年中，西方軍隊一直非常關注恐怖分子的威脅，可能在其本國的建築區域或是海外的戰區，使用化生放核(CBRN)物資進行潛在的攻擊。

This focus has now widened to include potential threats from nonstate actors. The most high profile CBRN incidents over the last few years have been in Syria with the use of one of the most toxic chemical warfare agents (CWAs) - Sarin - in Damascus and Aleppo in 2013 from Syrian regime stocks on civilians. Further attacks have taken place in 2016 and 2018. A targeting attack using the nerve agent Novichok took place in the UK in Salisbury by Russian agents that resulted in the death of a civilian. These attacks have been state sponsored and indicate a troubling trend of governments willing to ignore the Geneva Convention and use CBRN agents as an acceptable method of warfare.

現在的重點已經擴大到包括非國家行為者的潛在威脅。過去幾年中，最引人注目的化生放核(CBRN)事件，是 2013 年發生在敘利亞 Damascus 和 Aleppo

，敘利亞政權對平民使用了其庫存毒性最強的化學戰劑(CWA)—沙林(Sarin)。在 2016 年和 2018 年還發生了更多的化生放核(CBRN)攻擊事件。俄國特工使用神經毒劑 Novichok 在英國的 Salisbury 進行了針對性攻擊，導致平民死亡。這些攻擊是很可能是政府贊助的，表明各國政府無視“日內瓦公約”，並使用化生放核(CBRN)戰劑作為可接受的戰爭方法，這個趨勢令人擔憂。

David Collin, Vice President of Research, Development and Programs at FLIR Systems Detection Division told MT: “There is a realization there is a tremendous diversity of threat out there and difficult to prioritize in many ways.” But he said that because of the re-emergence of the CBRN threat from near-peer adversaries rather than terrorist organizations it has “ramifications in our business” as this will affect “thinking about strategies for detection and technologies you might use in the world of detection.”

“FLIR 系統公司”偵測部門研究開發計劃副總裁 David Cullin 告訴“軍事技術雜誌(MT)”，人們意識到存在各種各樣的威脅，並且很難以多種方式確定優先等級。再則，由於近等敵國而非恐怖組織再次出現了化生放核(CBRN)威脅，這將影響關於偵測策略和您可能在偵測領域中使用的技術的思考，因此對我們的業務產生了影響。

That is not to say that the terrorist threat is reduced. According to Katja Kiukas, product manager of bio-detection and CBRN systems at Environics, recent years have seen the growth of many violent extreme organizations and ideologies. He told MT that when some nation-states collapse it provides “a fruitful incubation medium for international terrorism” that are interested in weapons of mass destruction (WMD) and the fact that “existing stockpiles of CBRN agents may be insufficiently controlled both in civilian and military facilities.” This is in addition to dual-use toxic industrial chemicals (TICs) that are intended for civilian use but could also be converted for terrorist purposes.

“Environics 公司”生物偵測與化生放核(CBRN)系統產品經理 Katja Kiukas 告訴“軍事技術雜誌(MT)”，這並不是說恐怖主義威脅減少了。近年來，許多暴力極端組織和意識形態的增長。某些民族國家政權瓦解，就會提供國際恐怖主義滋長，他們對沒有得到足夠的控制的大規模毀滅性武器(WMD)與民用和軍用設施中現有的化生放核(CBRN)戰劑庫存感興趣。除此之外，用於民用的雙重用途毒性工業化學品(TIC)，也可以轉化為恐怖主義用途。

“All in all, it is the combination of the growing number of people familiar with CBRN warfare techniques, spread of scientific knowledge, asymmetric warfare tactics, availability of the agents coupled with poor security of relevant facilities, that could facilitate terrorists in getting hold and using of CBRN

agents,” Kiukas added.

Kiukas 補充說，所有的一切，都是熟悉化生放核(CBRN)攻擊技術人數增長、科學知識傳播、不對稱作戰戰術運用、儲存設施安全性不足，才可能使恐怖分子得以持有與使用化生放核(CBRN)戰劑。

The ‘C’ in CBRN are the CWAs which have grabbed the headlines because of the Sarin gas attacks but other agents are a serious threat in different ways. The ‘B’ - biological agents - have varying incubation times and effective dose levels categorised depending on the easiness to be disseminated or transmitted from person to person, mortality rates, potential for public panic and social disruption caused. Kiukas said the most dangerous category A agents by the US Center for Disease Control and Prevention (CDC) include bacteria like *Bacillus Anthracis*, *Francisella Tularensis* and *Yersinia pestis*, *Variola virus*, *botulinum toxin* and viral haemorrhagic fevers causing viruses.

化生放核(CBRN)中的“化(C)”是化學戰劑(CWA)，因沙林(Sarin)毒氣攻擊而成為頭條新聞，但其他戰劑亦以不同的方式形成了嚴重威脅。化生放核(CBRN)中的“生(B)”是生物戰劑，其具有不同的潛伏時間和有效劑量等級，具體取決於人與人之間傳播或傳播的難易程度、死亡率，引起公眾恐慌和引起社會破壞的可能性。美國疾病管制與預防中心(CDC)最危險的 A 類戰劑包括炭疽桿菌(*Bacillus Anthracis*)、土拉弗朗西斯菌(*Francisella Tularensis*)和鼠疫(*Yersinia pestis*)等細菌，天花(*Variola*)病毒，肉毒桿菌(*botulinum*)毒素和病毒性出血熱(viral haemorrhagic fevers)。

The ‘RN’ element of CBRN are the Radio-Nuclear agents that emit alpha, beta, or gamma radiation that can cause radiation sickness when fine particles are released into the air during an explosion containing radio active powder or pellets (known as a dirty bomb) or in a nuclear explosion. Kiukas said that radioactive aerosols suspended in the air can produce a respiratory hazard and it is “the duration of exposure, distance from source of radiation, and the amount of shielding between source and target determine exposure to radiation.”

化生放核(CBRN)中的“放(R)核(N)”是放射性-核戰劑，他們會發射 α 、 β 或 γ 射線。當含有放射性粉末或顆粒(俗稱為髒彈)爆炸或發生核爆炸時，會將細小顆粒釋放到空氣中時，會引起放射病。懸浮在空氣中的放射性氣溶膠會產生呼吸道危害，且放射性暴露的持續時間，與輻射源的距離，以及輻射源與目標之間的屏蔽量，決定了輻射的暴露劑量。

The unpredictability of the type and method of dissemination of CBRN agent makes them difficult to counter and depending on the threats expected

and the operations being undertaken it dictates what detection equipment is needed and the platform that these are fitted on. Two existing US Army CBRN programmes illustrate the challenges that are faced by most militaries. The first is the Dismounted Reconnaissance Sets, Kits, and Outfits (DR-SKO) programme and the second is the Stryker 8x8 NBC reconnaissance vehicle (NBCRV) programme.

化生放核(CBRN)戰劑的類型和傳播方法的不可預測性，使其難以應對，並且取決於預期的威脅和所採取的操作，決定了所需的偵測裝備與所需要的偵測平台。現有的兩個美國陸軍化生放核(CBRN)計畫，說明了大多數軍隊面臨的挑戰。第一個是“下車徒步偵察機組套件和裝具(DR-SKO)”計畫，第二個是 Stryker 8x8 核生化偵檢車(NBCRV)計畫。

DR-SKO has been around since the US started its Global War on Terror following the 9/11 Al Qaeda attacks. With new deployments overseas to Afghanistan and Iraq to confront the terrorist threats it was expected that US soldiers could encounter unknown CBRN attacks in the field. “DR-SKO came into being because of a need that the military did not have that at the time to deal with that unknown threat at the time,” Cullin said and since the early 2000s FLIR has provided over 300 soldier kits to the Army and US Marine Corp. “DR-SKO relies on a number of hand held and carryable technologies that allow you to identify a pretty broad spectrum of chem-bio-radiological threats,” Cullin explained, “If I come across a laboratory and I want to know what has been going on there then I need something that can collect samples and detect and identify materials from the samples that I collect.” DR-SKO also provides CBRN protection suits to allow operators to go into hazardous environment to take the measurements. FLIR was awarded a contract worth \$27.9 million in January for a further 24 kits for the Army to be delivered by in 3Q2019.

“FLIR 系統公司”的偵測部門研究開發計畫副總裁 David Cullin 說，自從 9/11 Al Qaeda 恐怖組織襲擊之後，美國發起全球反恐戰爭以來，“下車徒步偵察機組套件和裝具(DR-SKO)”就一直存在。隨著在海外向阿富汗和伊拉克的新部署以應對恐怖威脅，人們預期美軍在戰鬥地區會遇到未知的化生放核(CBRN)襲擊。“下車徒步偵察機組套件和裝具(DR-SKO)”之所以應運而生，是因為當時軍隊沒有應付這種未知威脅的必要條件。自 2000 年代初以來，“FLIR 系統公司”已向美國陸軍和美國海軍陸戰隊提供了 300 多個士兵裝備。“下車徒步偵察機組套件和裝具(DR-SKO)”依靠多種手持式和可攜帶技術，可讓您識別相當廣泛的化學-生物-放射學威脅。如果我遇到一個實驗室，我想要知道那裡發生了什麼，那麼我需要一些可以收集樣品，與偵測和識別出我收集樣品中的物質。“下車徒步偵察機

組套件和裝具(DR-SKO)”還提供化生放核(CBRN)防護服，使操作員可以進入危險環境進行偵檢作業。“FLIR 系統公司”於 2019 年 1 月獲得了價值 2,790 萬美元的合同，為陸軍提供 24 套裝備，將於 2019 年第三季度交付。

Operating in full CBRN suits is extremely limiting and therefore any advances in materials and miniaturisation will help improve soldiers' safety in a very difficult and dangerous environment. To avoid troops having to suit-up and put themselves at risk the use of long-range sensors and unmanned systems that can take the measurements instead are being employed. FLIR was awarded a contract for the Stryker NBCRV upgrade in March and it will provide a ruggedized infrared spectroscopy chemical vapour detector that has a range of multiples of kilometers giving a standoff technology. The vehicle will also have an aerosol Light Detection and Ranging (LIDAR) system to look for biological warfare agents released into the air, a laser scanning system that can scan the ground for liquids of solids, and radiation imaging technology that can detect isotopes that could indicate a bomb or other materials releasing radiation. This equipment is being adapted to ensure they can operate whilst the vehicle is moving at speed.

身穿全套化生放核(CBRN)防護服，工作會極為受限，因此，材料和小型化方面的任何進步，都將有助於改善在非常困難和危險環境中士兵的安全。為了避免部隊不得不整裝並使其身處險境，現正採用可進行測量的遠程感測器和無人系統。“FLIR 系統公司”於 2019 年 3 月獲得了 Stryker 核生化偵檢車(NBCRV)升級的合同，將提供堅固的紅外光譜化學蒸氣偵測儀，該偵測儀偵測距離達數公里，可提供遠距偵測技術。Stryker 核生化偵檢車(NBCRV)還配備一個氣溶膠“光偵測與測距(LIDAR)”系統，以尋找釋放到空氣中的生物戰劑。一個雷射掃描系統，可以掃描地面上的固體液體。以及輻射成像技術，可以偵測顯示炸彈或其他物質釋放輻射的同位素。該裝備經改良後，確保車輛在高速行駛時，仍可以執行偵測作業。

To increase the stand-off capability further the NBCRV will use more unmanned air and unmanned ground systems and either mounting them on the vehicle for launch and recovery or connecting to other UV launching assets. “The NBCRV upgrade is really going to rely on stand-off sensing at this point to scan out over many kilometers to be able to detect threat clouds and use them in concert with drone-mounted capabilities to give a more definitive answer by collecting samples as they fly through threat clouds,” Collin said. “It is endeavoring to push the detection and understanding of the environment out ahead of where the soldiers are in order to avoid having to put on a mask, which makes you less effective.” FLIR has acquired UV manufacturer Aerion for this purpose and the challenge is not just to install

CBRN detectors onto small UAVs that have size, weight and power constraints but to increase the level of automation: “The majority of drones have been developed to be utilised by a single operator with a handheld control/joystick. The automation to make that happen without having someone with a joystick to be able to launch quickly, there is a challenge there. We are working to make them part of a system so it can be cued by the system to fly somewhere, launch and recover.” Collin said. The US Army is pushing the Stryker NBCRV programme through a rapid prototyping effort and FLIR is due to present a next generation vehicle by the end of the year.

“FLIR 系統公司”的偵測部門研究開發計劃副總裁 David Cullin 解釋說，為了進一步提高遠距偵測能力，核生化偵檢車(NBCRV)將使用更多的無人空中和無人地面系統，並將它們安裝在偵檢車上進行發射和回收，或者連接至其他無人載具(UV)發射資產。核生化偵檢車(NBCRV)的升級，實質上在所在位置依靠遠距遙感掃描檢測數公里外的威脅雲，且他們與無人機安裝功能配合使用，經由在威脅雲中飛行時，收集樣本來提供更明確的答案。為了避免戴防護面具，使效率降低，努力推動士兵所處位置之前的環境偵測和瞭解。“FLIR 系統公司”為此目的，收購了無人載具(UV)生產商“Aerion 公司”，挑戰不僅是在體積、重量和功率受限的小型無人機上安裝化生放核(CBRN)偵測器，而且要提高自動化水平。現行已開發的大多數無人機，主要供手持控制/操縱桿的單個操作員使用。為實現自動化，是以操作員無需操縱桿就能快速起飛為目標，這是一個挑戰。我們正在努力使無人機成為系統的一部分，以便系統可以提示無人機在某個地方飛行、發射和回收。美國陸軍正在藉由快速的原型製作工作來推動 Stryker 核生化偵檢車(NBCRV)計劃，且“FLIR 系統公司”將在今年(2019 年)年底前推出下一代核生化偵檢車。

Testing with soldiers is expected in 2020 and although the US Army has a fleet 300 NBCRV it has yet to decide how many vehicles it will upgrade.

預計將在 2020 年與士兵進行測試，儘管美國陸軍擁有 300 輛核生化偵檢車(NBCRV)車隊，但尚未決定將升級多少輛車。

The US is not the only country responding to the changing CBRN environment. The Netherlands is set to upgrade its CBRN reconnaissance capability by replacing its 12 FUCHS that have been in operation with its CBRN Response Unit since 2003. A spokes person from the Dutch MoD told MT the programme was in the B-phase research phase of acquisition. In a letter the MoD sent to Parliament earlier this year it stated the deterioration in the CBRN situation citing attacks in Syria and the UK as a concern and that the Fuchs are outdated. The Belgian Armed Forces wants to replace the

FUCHS with a new reconnaissance capability within the next 10 years. The project is set to be approved by 2022 with a maximum budget of €100 million.

美國不是唯一的國家，應對不斷變化的化生放核(CBRN)環境。荷蘭將通過替換自 2003 年以來化生放核(CBRN)應變部隊一直使用的 12 輛狐式核生化偵檢車(FUCHS)，以提高其化生放核(CBRN)偵察能力。荷蘭國防部一位發言人告訴“軍事技術雜誌(MT)”，該計劃已進入 B 階段獲得研究階段。國防部在今年早些時候給國會的一封信中，引證敘利亞攻擊、英國攻擊事件以及狐式核生化偵檢車(FUCHS)裝備過時等問題，來說明當前化生放核(CBRN)威脅情勢的惡化。另外，比利時武裝部隊希望在未來 10 年內以新的偵察能力取代狐式核生化偵檢車(FUCHS)。該計劃預定於 2022 年獲得批准，最高預算為 1 億歐元。

Environics producing detection systems for CBRN reconnaissance vehicle and naval vessels and its ENVI BioScout and ChemPro DM represent the essential bioaerosol and chemical detection capabilities, in the company's Envi Screen CBRN Monitoring Systems. Kiukas said they provide early warning alarms when threats are detected to protect personnel and property from hazardous effects as early as possible “enable further analysis and correct, timely countermeasures and provide situational awareness and guidance in the threat event.”

“Environics 公司”生物偵測與化生放核(CBRN)系統產品經理 Katja Kiukas 說，“Environics 公司”生產的用於化生放核(CBRN)偵檢車和海軍船艦的偵測系統，及其 ENVI BioScout 和 ChemPro DM 在“Environics 公司”的 Envi Screen 化生放核(CBRN)監測系統中代表了必不可少的生物氣溶膠和化學檢測功能。他們會在發現威脅時提供預警警報，以儘早防護人員和財產免受危險影響，能夠進行進一步分析和修正，即時採取對策，並在威脅事件中提供狀況覺知和指導。

A key development in detection systems is the need to improve CBRN data processing that can interface with battle management systems and C4I systems and Environics has developed the Rugged Master Module component for EnviScreen. “This expands system capabilities beyond the basic CBRN monitoring network. The diverse data collected from detectors is harmonized and filtered by the Rugged Master Module in order to optimize the data transfer in the communication network,” Kiukas explained.

Kiukas 解釋說，偵測系統的一項重要發展，是需要改進可與戰場管理系統和 C4I 系統連接的化生放核(CBRN)數據處理系統，“Environics 公司”已開發了用於 EnviScreen 的 Rugged Master Module 組件。這將系統功能擴展到基本的化生放核(CBRN)監控網絡之外。Rugged Master Module 對從偵測器收集的各

種數據進行協調和過濾，以優化通信網絡中的數據傳輸。

It is essential to have real-time situational awareness and up-to-date threat assessments available for decision making at the time of such an event and systems like the Rugged Master Module can provide guidance and software that visualises the event and measurement data. The exchange of information real-time means the speeding up of processes such as detection, warning, verification, intelligence and recognition, estimation about the spread of the hazard, cleaning and decontamination and the preparation of emergency responses such as evacuation and quarantine and emergency wards.

在化生放核(CBRN)事件發生時，即時狀況覺知和最新威脅評估對於決策非常重要，而像 Rugged Master Module 這樣的系統可以提供可視化事件和偵檢數據的準據和軟體。即時資訊交換意味著加快偵檢、警告、驗證、情資、辨識。評估危害擴散、清潔和污染消除。以及準備緊急反應，如後送和檢疫以及緊急病房。

Improving responses to CBRN incidents also requires better training and both user and tactical level training is key to sustaining the skills of personnel in civil and military defense in operational procedures and equipment use.

精進對化生放核(CBRN)事件的反應，還需要更好的訓練，與裝備操作者和戰術層級的訓練，對於維持民防和軍事防衛人員在操作程序和設備使用方面的技能至關重要。

Steven Pike, managing director of Argon Electronics told MT: "There has certainly been a trend towards greater use of simulators which has been driven by a combination of the greater scenario generation flexibility, environmental and health and safety considerations and the overall cost effectiveness relative to the use of actual operational detector equipment."

"Argon Electronicse 公司"常務董事 Steven Pike 告訴"軍事技術雜誌(MT)"，肯定存在一種趨勢，即越來越多地使用模擬器，這是由更多的想定生成靈活性，環境和健康與安全考慮，以及相對於使用實際操作偵測器裝備的總體成本效率，所共同驅動的。

Instructors can effectively create a wide range of realistic scenarios in different environment. Pike said that CWA/HazMat simulators are able to replicate the specific capability of actual detectors, "for example representing detection technologies such as flame photometry and ion mobility spectrometry and their respective benefits and limitations." Radiation simulation technology has also advanced to the point that it is so realistic Argon Electronics was asked during a recent simulation to assure a live

source was not present in the training environment. "The ability to integrate our simulators with third party battlefield training systems and virtual reality systems has also attracted interest where the military are seeking ways to further verify operational CBRN readiness," Pike said. "There is also a desire to create the same 'Disney Experience' of realism currently enjoyed by the generation of first responder's and military personnel who have grown up with 'Fortnite' and 'Call of Duty' video games although a pure video environment has its limitations," he added.

Pike 說，教官可以在不同的環境中有效地創建各種逼真的想定。化學戰劑(CWA)/危險品(HazMat)模擬劑能夠複製實際偵測器的特定功能，例如代表諸如火焰光度法和離子遷移光譜法之類的偵測技術及其各自的優點和限制因素。輻射模擬技術也已經發展到如此逼真的地步。在最近的模擬訓練中，要求“Argon Electronicse 公司”確保訓練環境中不存在活源。將我們的模擬器與第三方戰場訓練系統和虛擬現實系統整合在一起的能力，也引起了人們的興趣，因為軍方正正在尋求進一步驗證化生放核(CBRN)作戰準備就緒的方法。儘管純粹的視頻環境有其局限性，但也渴望創造出一種與「堡壘之夜(Fortnite)」和「使命召喚(Call of Duty)」視頻遊戲一起成長的急救人員和軍事人員，當前所享有相同的現實「迪斯尼體驗」。

Argon has recently developed a new generation of radiation simulation technologies that involved agencies in the UK and USA in trials to improve performance. Pike said the company now has "a first-class gamma simulation capability that also has the capability to support the simulation of radionuclide identification by means of spectrometry simulation."

Pike 補充說明，“Argon Electronicse 公司”最近開發了新一代輻射模擬技術，該技術包括英國和美國的機構進行試驗以提高性能。“Argon Electronicse 公司”現在擁有一流的伽瑪模擬能力，還具有藉由光譜模擬支援對放射性核素識別進行模擬的能力。

Meanwhile Live Agent Training (LAT) in CWA training still plays an important role and Pike said whilst it cannot be substituted by simulation or the use of simulants, simulation plays an extremely important role in supporting LAT. He explained that with the prior use of simulators students are attending LAT "with much improved detector use proficiency and as a result obtaining greater benefit from focusing on the live agents, techniques and procedures rather than revising detector usage. This means that LAT time was being used much more effectively and therefore more beneficial with overall greater learning achieved and better return on investment."

Pike 表示，在化學戰劑(CWA)訓練的實毒訓練(LAT)仍然扮演重要角色，雖

然不能用模擬或使用模擬劑來代替，但模擬在支援實毒訓練(LAT)方面有著極其重要的作用。Pike 解釋說，在先前使用模擬劑的情況下，學員以更高的偵測器的使用能力來參加實毒訓練(LAT)，因此，通過專注於實毒、技術和方法，而不是修改偵測器的用法，可獲得更大的收益。這意味著可以更有效地利用實毒訓練(LAT)時間，因此從總體上獲得更大的學習和更好的投資回報中會更加受益。

A lot of COTS technology used has been around for some time, but new requirements have initiated a pull effect to mature and integrate them into systems for a military environment. This means that new CBRN systems are being introduced in small amounts through an incremental process rather than in large-scale single acquisition programs. Overall older equipment dating back as far as the Cold War is gradually being replaced and tactics, techniques and procedures updated as a result. Improvements in CBRN capabilities will be the result of a mix high quality training methods, the introduction of stand-off equipment to improve detection increase safety and the rapid processing and exchange of data providing enhanced situational awareness.

大量使用商用現貨(COTS)技術已經存在了一段時間，但是新的要求已經開始產生拉動作用，以使其成熟並整合運用於軍事環境的系統中。這意味著新的化生放核(CBRN)系統將經由漸進過程少量引入，而不是經由大規模的單一採購程序引入。可以追溯到冷戰時期的整體舊裝備逐漸被替換，因此戰術、技術和方法也得到了更新。化生放核(CBRN)能力的提升，將得益於高質量訓練方法的混合，採用遠距遙測裝備以改善偵測，提高安全性以及快速處理和交換數據，以增進狀況覺知的結果。



附圖 1 NBC 部隊準備執行任務

照片來源：德國聯邦國防軍([Bundeswehr](#))



附圖 2 由 Kärcher Futuretech 開發的 Bundeswehr 的移動式
化生放核(CBRN)污染消除系統 TEP 90

照片來源：德國聯邦國防軍([Bundeswehr](#))