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on deployable labs

Analyse This!

At the summit of the North Atlantic Council (NAC) in Prague on 21 November 2002, the heads of state and government approved the implementation of five defence initiatives against nuclear, biological and chemical (NBC) Weapons of Mass Destruction (WMD). The creation of NBC Deployable Analytical Laboratories (NBC-DAL) is one of those initiatives and this article discusses this.

The alliance wants to fight terrorism wherever it is necessary and, in order to do so, it needs to undergo a profound transformation, capable of facing those new risks and those new threats. In Prague, we witnessed the birth of three initiatives: the Prague Capabilities Commitments (PCC), the Nato Response Force (NRF), and the new Command Structure of Nato.

The PCC were designed, among other things, to improve the anti-terrorism capabilities of the alliance and to ensure that all European armies are equipped accordingly, to be able to move "quicker and further" and to use strength in an effective way, guaranteeing self-sufficiency in combat. The commitments consist of eight parts::

- CBRN defence;
- intelligence, surveillance, and target acquisition;
- air-to-ground surveillance;
- command, control and communications;
- combat effectiveness, including precision-guided munitions and suppression of enemy air defences;
- strategic air and sea lift;
- air-to-air refuelling; and
- deployable combat support and combat service support units.

In addition, the leaders of the alliance endorsed the implementation of five NBC weapons defence initiatives, which will enhance the alliance's defence capabilities against WMDs:

- a NBC Deployable Analytical Laboratory;
- a NBC event response team;
- a virtual Centre of Excellence for NBC weapons defence;
- a Nato Biological and Chemical Defence Stockpile; and
- a disease surveillance system.

The NBC Deployable Analytical Laboratory (NBC-DAL)

What is a NBC-DAL? For Nato, an NBC-DAL, based on STANAG 4632, is a highly specialised complex, constituted by the following elements: command-and-control element; sampling teams; NBC EOD/IEDD team; radiological, biological and chemical labs and decontamination team.

According to STANAG 4632, the aim of a NBC-DAL is to provide the commander with the capacity to take samples, analyse and identify in them radiological, biological and chemical agents, in order to carry out a quick risk-assessment and confirm the presence, type and consequences of pollution in an actual or suspected contaminated area. This support would be framed in a broad range of military operations on land, sea and in the air, as well as all kinds of crisis situations that range from support after natural disasters to large-scale conflicts.

The command-and-control team works together with a consulting element, the JAT (Joint Assessment Team), which coordinates and satisfies operational and logistic needs of the NBC-DAL as a whole. It is made up of the following elements: head of the NBC-DAL, NBC Defence Health Service (NBC/MED), administrative/supply specialists, CIS/communication specialist and transport specialist.

The sampling team must be technically capable of collecting all kinds of samples and, above all, capable of doing it so as to fulfil all the SIBCRA requirements (STANAG 4356, AEP-10 Handbook for the Sampling and Identification of Biological, Chemical and Radiological), in a way that will allow it to prove unambiguously the first use of this kind of agents by hostile forces. Type, amount, method of acquisition, preservation, transportation and chain of custody of the sample depend greatly on the aim of the sampling. The process is started with a clear purpose that incorporates a specific request for analysis that, at the same time, determines an appropriate sampling plan.

The NBC EOD/IEDD team is made up of a group of experts on explosive ordnance disposal, specialised in biological, chemical and radiological weapons, whose mission is to support the sampling teams. The NBC EOD/IEDD team should be capable of supporting simultaneously several sampling teams.

Radiological, biological and chemical labs shall have sufficient material and human resources to achieve a confirmed identification of potentially dangerous NBC agents. Because the range of samples and substances to be analysed may be very broad, STANAG 4632 annexes established minimum NBC threats, in the form of lists of biological, and chemical agents, and also ranges of energy for the different kinds of radiation (alpha, beta and gamma) and neutrons whose analysis must be undertaken. If it were necessary, the samples could be divided and prepared to be shipped to a reference lab for achieving an unambiguous identification.

The decontamination team is responsible for decontamination of personnel, material, and equipment of all components of the NBC-DAL. It must be trained and equipped to fight against all kinds of NBC and industrial pollution.

NBC Laboratories

Nato conceives the work of a NBC-DAL as based on three independent modules or labs: a biological lab, a chemical lab, and a radiological lab. Each one of these modules must be capable of working independently from each other and be transportable by land, sea or air, and must have independent functionality for at least three days after being deployed with NBC protection against electromagnetic pulse, and must be provided with all means of communication necessary.

In a real situation, wherever a NBC-DAL is, the material subjected to analysis

will include a very small number of samples from a supposed attack with NBC agents. Most samples and most analysis requests will relate to daily hazards, so water will have to be analysed in order to determine if it is potable, soil analysis to assess its potential pollution, and to evaluate the risks associated to their use, air analysis to determine indoor and outdoor pollution, and even blood analysis or urine analysis in extreme cases.

In any case, the importance of the task to be done is such that analysis teams must be updated to use state-of-the-art technology. The staff in charge of its use must be properly qualified.

Laboratory equipment

To be able to successfully analyse a wide range of samples in the most unexpected and complex analytical parameters' range, the different modules should include not only fixed, but also portable instruments. Along with portable NBC detectors, which would be part of the sampling team equipment, their functioning based on different kinds of technologies to accomplish a confirmed identification, it would be convenient to incorporate some portable analysis system, such a handheld Fourier Transform Infrared spectrometer, handheld Raman spectrometer, portable XRF analyser, or portable real-time PCR (Polymerase Chain Reaction) instrument.

For the biological module, besides sampling and sample concentration systems, with or without attached detection systems (dispersion, laser, fluorescent, etc), other different systems for identification and analysis should be considered, for example, Gas Chromatography-Mass Spectrometry (GC-MS) and/or High Performance Liquid Chromatography-Mass Spectrometry (HPLC-MS), a system based on Time Of Flight-Mass Spectrometry (MALDI-TOF-MS), an UV-visible spectrophotometer with 96-well UV plate reader, enzyme immunoassays systems (ELISA) for high molecular weight toxins, virus and bacteria, an optical microscopy system capable of working with different observation modes, a system of analysis based on PCR and, and, of course, a classic system of microbiological culturing.

The chemical module should allow for the most basic analysis, as well as the most complex ones, both qualitative and quantitative. In order to do so, besides basic equipment such as pHmeters, ion selective meters, UV-visible spectrometer and Fourier Transform Infrared (FTIR) spectrometer with different sampling accessories, hyphenated techniques such as GC-MS or/and HPLC-MS, and an X-ray fluorescence spectrometer must be considered.

The radiological module should include not only alpha, beta, gamma and neutron analysis. It should also be able to determine total alpha and beta activities, should include a liquid scintillation counter, a portable high-purity germanium gamma-ray spectrometer, a sodium iodide gamma-ray spectrometer, and dust and air sampling equipment, among others. It also could be provided with other less frequent instruments, intended for the measurement of electromagnetic fields (300 MHz-40 GHz), or, for example, dosimeters and dosimeter reader, gas cromatograph with different injection (that is, thermal desorption and head space) and detection (FPD, MSD, etc) systems and, finally, noise meters.

Is it necessary to deploy an analytical lab?

Due to its functional features and human and technical resources, an NBC-DAL requires an expensive initial investment and it has also high maintenance costs. It needs to work in very safe working conditions (adequate not only for the appropriate performance of any lab handling of very hazardous substances) but also in a secure environment. It should be taken into account that the lab itself could become a target for a regular attack or by special forces, so it must always be located in the rear guard and under suitable protection. Reconnaissance teams should be equipped with small portable identification systems (Raman Spectroscopy, Infrared and Mass Spectrometry); much cheaper and easier to use, they could achieve an identification level comparable to that obtained in a NBC-DAL.

Is it only for NBC agents?

A NBC-DAL, even though it is designed to ultimately analyse NBC agents, will hardly reach an unambiguous identification. Thus, the definitive and crucial step is sampling and sample chain of custody until the analysis in a reference and accredited laboratory can proceed.

Because, on the battlefield, the information requirements are many, and few are the events with "classical" NBC agents, the lab will receive other very diverse samples to analyse, different in type (solids, liquids or gases, aqueous or oily, inorganic or organic, etc.) and in the parameters requested. Thus, a NBC-DAL needs specially trained staff, capable of performing very different tests in many types of samples for very different purposes.

Laboratory tasks could range from a simple drinking-water analysis to a complex problem to the identification and quantification of a polluting agent for risk assessment. But what will happen in the majority of cases is that the analysis requester does not state very clearly which parameters should be determined in the sample, so this crucial decision must be made by the head of the laboratory.

Technical or military personnel, or both?

This is the weak point of an expensive and sophisticated system. If the price of the different modules is already very high, to deploy it means an enormous expenditure, but also its functioning and maintenance are considerable. Having enough personnel with the expertise required is extremely difficult but essential. To think about good laboratory performance, when its staff is only military personnel without proper training and updated scientific knowledge (chemistry, microbiology, etc) is wasting money and time.

The head of the NBC-DAL should have not only broad and adequate technical knowledge, but he should also have enough and varied skills, because his/her task is to lead a multidisciplinary team involved in solving complex problems. Vehicle drivers are not assistants for the labs, but lab assistants may drive as well. Assistants must be correctly trained and experienced in order to develop the tasks that have been assigned.

As a conclusion, putting together a work team with these characteristics can be achieved only with patience and time, after adequate theoretical and practical training and with enthusiastic and professional personnel.