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SPIEZ LABORATORY

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SPIEZ LABORATORY

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Dear readers,

Weapons of mass destruction, whether nuclear, chemical, biological or radiological, continued to pose one of the major challenges for Swiss and international security policy in 2012:

In 2012, Iran also failed to comply with the demands of the UN Security Council and the International Atomic Energy Agency (IAEA) to suspend its uranium enrichment and heavy water programme and to cooperate with the IAEA.

As in the past, North Korea still refused to cooperate with the international community; it launched another long-range missile in 2012 and carried out a nuclear test in the beginning of 2013.

In July 2012, the Syrian leadership threatened to use chemical weapons in the event of foreign intervention. This was the first time that a non-signatory to the Chemical Weapons Treaty admitted possessing chemical weapons. Syria's stocks are said to include sarin, mustard gas and possibly VX. In addition, according to the Nuclear Threat Initiative (NRI), Syria also possesses Scud and SS-21 rockets as carrier systems.

New risks could emerge through the increasing overlap between chemistry and biology. New types of warfare agents that are non-lethal but which are designed to alter human behaviour are not adequately covered by the current arms control treaties.

The vision of 'a world without weapons of mass destruction' which SPIEZ LABORATORY has adopted as its cause is completely at one with the fundamental thrust of Swiss arms control policy, as also stated in the Federal Council´s 2012 Disarmament Report: Our country is committed to a ban on all types of weapons of mass destruction. In order to achieve this objective, Switzerland intends not only to press on with disarmament efforts but also to combat the dangers of proliferation. SPIEZ LABORATORY is pursuing this aim in several individual areas:

At the Nuclear Security Summit held in Seoul in 2012, the Swiss delegation cited as its priority human safety which is also threatened by nuclear terrorism. By reducing the number of nuclear weapons and the availability of weaponisable fissile material, nuclear terrorists can be denied a basis. Switzerland continues to participate in the meetings of the Global Initiative to Combat Nuclear Terrorism (GICNT). SPIEZ LABORATORY has become a member of the ALMERA network (ALMERA – Analytical Laboratories for the Measurement of Environmental Radioactivity). This network, established by the IAEA in 1995, is made up of over 100 specialist laboratories which are able to reliably analyse

Control room of the international nuclear test monitoring agency in Vienna

Dr. Marc Cadisch
Director SPIEZ LABORATORY

environmental samples in the event of a release of radioactivity. Plans also exist to make a contribution in the area of nuclear forensics. To this end, the relevant know-how at SPIEZ LABORATORY is being expanded and the analytical capacity increased (page 6).

At the 2nd Review Conference of the CWC in 2008, Switzerland submitted a document on the 'non and less lethal chemical agents' (incapacitating chemical agents). Switzerland intends to advance this initiative further at the 2013 Review Conference in order to clarify the use of these new agents. In the scientific sphere, SPIEZ LABORATORY provides valuable support to the OPCW. As one of the organisation´s 19 designated specialist laboratories throughout the world, it has been making chemical analysis data records available for many years. Furthermore, Stefan Mogl, head of the chemical division, is currently chairman of the OPCW´s Scientific Advisory Board (page 32).

In regard to biological security, Switzerland assists the World Health Organisation (WHO) with preventive and countermeasures against biological hazards. A biosafety laboratory is being commissioned at SPIEZ LABORATORY for this purpose. In addition to its core task – verifying pathogens and biological warfare agents – this new laboratory will also offer advanced training courses in biosafety in collaboration with the WHO. At present, the biosafety level 3 laboratories are scientifically operational; work will be able to start at level 4, the highest containment level, in 2014 (page 18).

In order to make scientists aware of the risks of misusing bio-technological advances and of the dual use problem, SPIEZ LABORATORY is participating in various programmes designed to draw the attention of bio-scientific personnel to this subject area and to require them to treat the technological possibilities in a responsible manner. Involving researchers is vitally important for preventing the misuse of biotechnology and for implementing and further developing the BWC at the national level. (page 26).

Forensics in nuclear security

Dr. Mario Burger

According to the 2012 Disarmament Report of the Federal Council, Switzerland intends in the near future to make a considerable contribution in the field of nuclear forensics in order to combat nuclear terrorism. For this purpose, SPIEZ LABORATORY's expertise and analytical capacity is to be extended.

For decades, contractual agreements have been in force that prohibit the proliferation of nuclear material (Treaty on the Non-Proliferation of Nuclear Weapons, NPT). The general conditions pertaining to nuclear arms control policy are, however, becoming more and more complex. National organisations alone are no longer sufficient to respond to the new forms of threat that originate from non-state actors. At two summits (nuclear security summits) in Washington (2010) and in Seoul (2012) an action plan was passed to prevent the use of nuclear material for terrorist purposes. The states were called to cooperate better as an international community and to provide mutual assistance if requested.

In particular, the securing of nuclear materials is an important prerequisite that weapon grade fissile material (e.g. highly enriched uranium or plutonium) as well as other nuclear material (low enriched uranium, radioactive substances from hospitals or research laboratories etc.) does not fall into the hands of terrorists. All participating states at the nuclear security summits are called to close any capacity gaps existing at the national level . A corresponding analysis has shown that in Switzerland there is a gap in nuclear forensics. Nuclear forensics is the comprehensive analysis of confiscated or intercepted material of illegal character, inclusive its respective packaging, in order to establish its attribution, prove the origin of the material and to gain evidence of the perpetrators. Ideally it will be possible to find out in which reactor the fissile material sample was radiated and from which uranium mine it originated.

In collaboration with the Federal Intelligence Service and the integration of other federal agencies, SPIEZ LABORATORY with its Physics Section will provide the technical component for the project to close this capacity gap. The objective is to establish a Swiss nuclear forensics agency over the coming months. The respective processes, tasks and competencies of the organisations that are to be integrated will have to be clearly defined and, at the same time, integration and exchange of information established within the corresponding networks.

Members of the Seattle Fire Department check for radiation during a mock nuclear dirty bomb explosion, as part of a 36-hour terrorism response exercise

Since the project started, the following partial goals were attained in the course of 2012:

- A core group consisting of representatives from the FIS, fedpol, FOCP SPIEZ LABORATORY is working on the subject and making progress. Further federal agencies, including the supervisory ones (Federal Office of Public Health, Swiss Federal Nuclear Safety Inspectorate, Swiss Accident Insurance Fund) have been informed about this project.
- The FIS with its Central Agency for Nuclear Issues serves as Switzerland's point of contact (POC) und manages both national and international information pertaining to nuclear forensics.
- SPIEZ LABORATORY plays the pivotal role in nuclear forensic analysis and has been integrated in the international technical working groups.
- In principle we will retain our well-established alert procedures – nuclear forensics is to be integrated.

After the project was launched, the Physics Section of SPIEZ LABORATORY with the support of the Department of Foreign Affairs and the Federal Intelligence Service joined the international technical working groups by participating in respective activities. These consist mainly in cooperation within the following bodies:

- International Atomic Energy Agency (IAEA):
  - Office of Nuclear Security

- Global Initiative to Combat Nuclear Terrorism (GICNT):
  Implementation & Assessment Group
  - Nuclear Detection Working Group
  - Nuclear Forensics Working Group

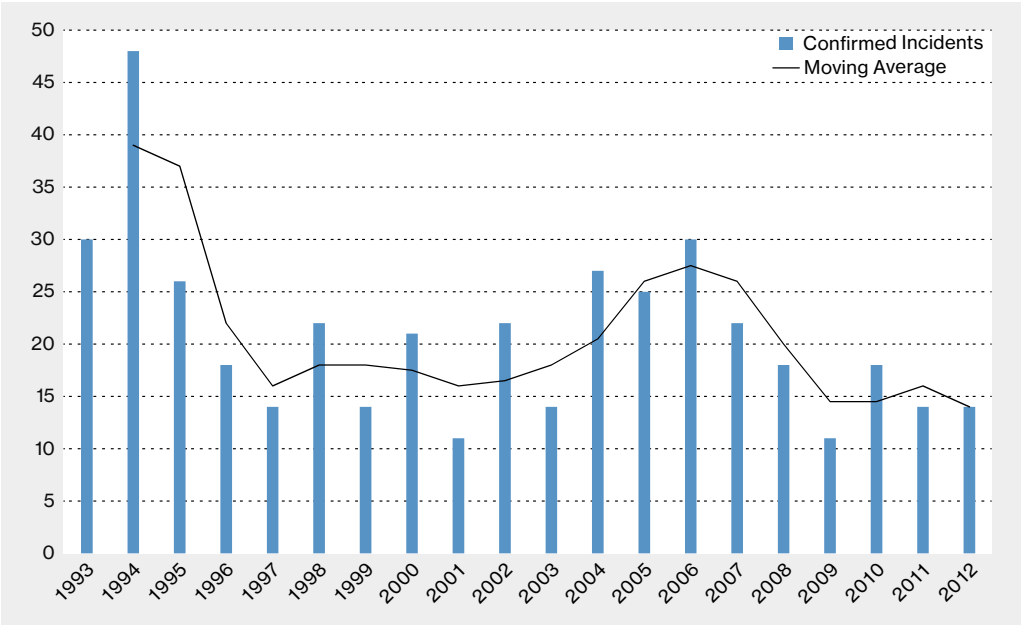
- Nuclear Forensics International Technical Working Group (NF ITWG):
  This working group is associated with the Netherlands Forensic Institute (NFI) as well as partner organisations such as the IAEA, EURATOM, INTERPOL, EUROPOL and UNICRI (United Nations Interregional Crimeand Justice Research Institute).

These technical working groups are currently defining terms, procedures etc. In addition to the case of confiscation, the working groups also agree that nuclear forensics should if possible be capable of determining the origin of material or of deducting its history after an incident – i.e. after radio isotopes have escaped into the environment.

The Physics Section with its ISO/EN 17025 accredited test facility of the Radioactivity Team will integrate the additionally required nuclear forensic analytical capacity and possibly augment its already existent special mass spectrometric examination methods with further techniques. At the same time it is becoming apparent that Spiez's room capacity will have to be extended by augmentation of today's type C and B radio chemistry laboratories with a type A lab, i.e. the highest radiological class with the most stringent work safety standards.

With these additions to Spiez's infrastructure SPIEZ LABORATORY will be in a position to work on the complex issues in radiochemistry and radio analytics and to provide those comprehensive deductions expected by the international community by means of relevant isotope ratios along with other quantitative isotope data. The fact that the Environment Analysis Section has useful expertise in the non-radioactive field, i.e. in heavy metals etc., also should be made use of in investigations. In parallel to such work, the Arms Control Section will considerably enhance the use of laboratory data for calculating the origin of nuclear material. Close collaboration with various international institutes active in this field is being prepared.

With the extension of additional competencies at SPIEZ LABORATORY Switzerland will contribute further to international efforts in the field of nuclear security and be able to positively augment the existing networks.



Confirmed incidents reported to the IAEA Incident and Trafficking Database (ITDB), involving unauthorized possession and related criminal activities, 1993-2012
(Illicit Trafficking Database ITDB IAEA)

Chemical forensics: attribution analysis

The OPCW and its designated laboratories are technically highly skilled in identifying chemicals related to the Chemical Weapons Convention. The purpose of such analyses is to reliably identify chemical agents or their precursors and derivates in a variety of sample types (water, ground, surfaces of objects etc.). Because today non-state actors too are more frequently suspected of releasing chemical agents, a new question has gained in importance: to what extent can the origin or mode of production of a chemical agent be derived from a sample? To date only few laboratories have addressed this question. Generally, the idea is to gain as much information from a sample as possible in order to identify the possible manufacturer of an agent or who was responsible for its liberation. Therefore, various verification labs are working on the development of methods enabling the attribution of toxic chemicals or their precursors to a certain source or manufacturing process. Possible respective approaches entail the identification of certain impurities, statistic comparison of complex GC-MS chromatograms, as well as the comparison of isotope ratios in mass spectrometers.

Important questions in forensic investigations to attribute a chemical warfare agent are:

- Can its synthetic pathway be derived from the by-products in the combat agent?
- If the substance has been manufactured in an improvised 'cellar lab', such a lab will leave a signature resulting from the substances and instruments used and the respective impurities will result. Are such fingerprints sufficiently unambiguous to enable explicit attribution of a sample to that improvised lab?
- Are such signatures stable over time and independent of location, so that the 'manufacturer' can still be identified unambiguously with environmental samples even after an agent has been liberated?

Extensive international cooperation is required to establish such forensic analytical capacities for OPCW laboratories. The main problem in attributing samples to certain sources is the absence of reference data. To what extent the origin of toxic chemicals can be derived from samples, will become apparent in respective studies over the coming years.

Stefan Mogl

Environmental investigations for armasuisse

Alfred Jakob

Apart from safety considerations, the observation of the Environmental Protection Act has a high priority in operating and maintaining a shooting range. To ensure compliance with the Environmental Protection Act, the Environmental Analysis section is regularly referred to for investigations. Thus, analysis of mud at the bottom of the sedimentation tank at the Bure tank firing range revealed that excavated material is not contaminated and does not have to be disposed of at high cost. Representative sampling for analysis is essential, for correctly answering such questions.

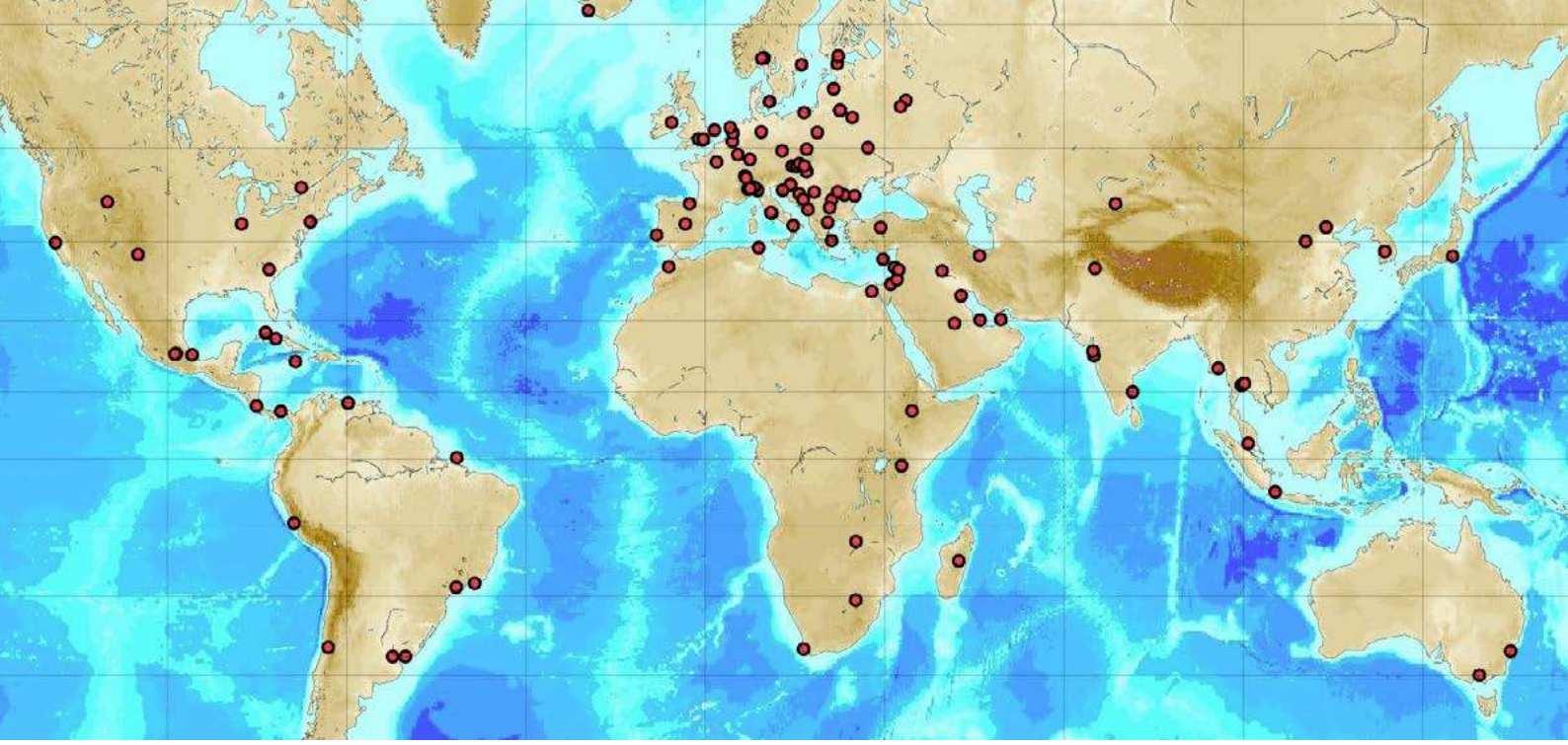
At the Bure military training area armoured tracked vehicles cause ground erosion in the field, which is washed out by rain as a fine mud. It is collected at the training area in large sedimentation tanks as sludge. As long as the sediment is not polluted with oil residues, lubricants or heavy metals, it can be returned to the training area. Preliminary examinations by an engineering company had suggested that the sediments might be polluted. This would entail extensive costs for appropriate disposal of the contaminated earth. The environmental analysis section of SPIEZ LABORATORY was referred to for an independent investigation of the environmental impact. For each environmental investigation representative sampling for analysis is decisive for achieving correct and representative results. Extensive sampling of the sedimentation tank was the first decisive step in this investigation.

Accredited testing of the mixed samples for heavy metals and oil residues showed that the ground is not polluted and so no disposal costs should ensue. The difference in results are to be clarified further. This example shows clearly that DDPS-internal random checks are valuable.

Backstops of shooting ranges

In Switzerland there are about 2,000 active and 4,000 closed shooting ranges. Every year, military personnel and riflemen fire 400 tons of lead and several tons of antimony in the form of ammunition. As a result, the earth in the vicinity of the backstop is particularly polluted. The immobilisation of heavy metals in the ground has been examined experimentally within the context of a diploma thesis with the University of Applied Science Sion. Antimony is an alloy component of ammunition and can be dissolved by water in the ground, i.e. it is highly mobile and may contaminate groundwater. The purpose of the study was to minimise the mobility of heavy metals, in particular that of antimony by adding metal binding substances to the contaminated ground. The efficacy of metal binding substances was analysed in column experiments. The results are promising. A combination of binding substances is capable of almost completely immobilising antimony and thus preventing groundwater pollution. The practical application of these new findings are being pursued further.

Taking a sample from a sedimentation tank



The IAEA's ALMERA Network

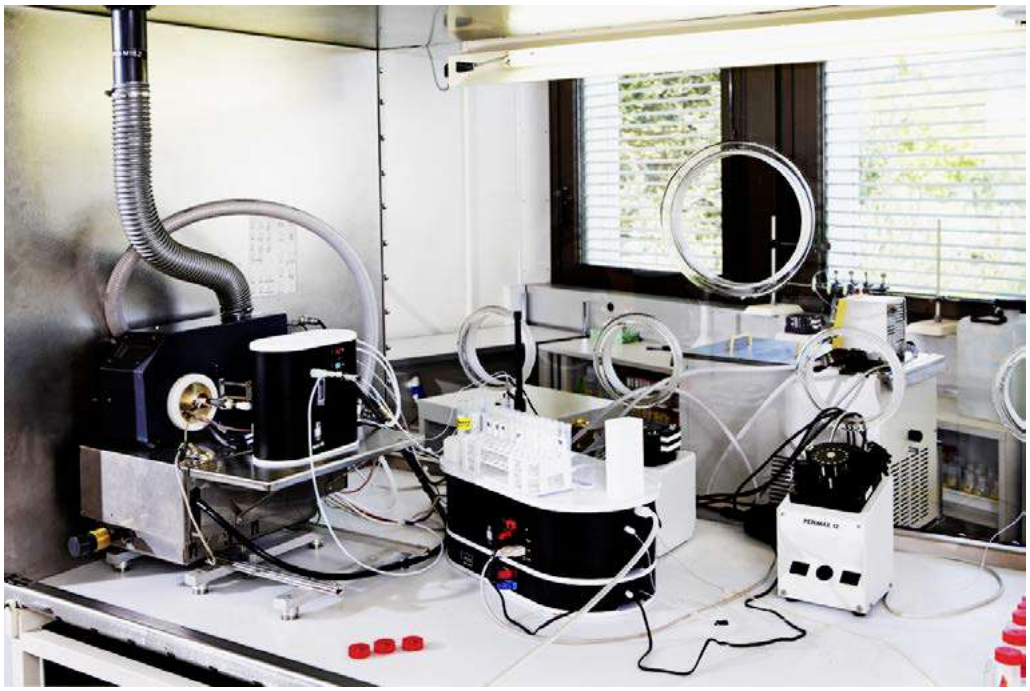
Dr. Mario Burger

SPIEZ LABORATORY officially joined the ALMERA network in 2012. This network was established in 1995 by the International Atomic Energy Agency (IAEA) and is made up of over 100 laboratories that are able to reliably analyse environmental samples in the event of a release of radioactivity. The IAEA coordinates the work of the network, develops standardised sampling methods and organises inter-laboratory tests and suitability checks as part of its external quality control mechanisms.

SPIEZ LABORATORY has maintained close relations with the IAEA for years. During this time, it has investigated a variety of problems, including the use of uranium munitions and the nuclear accidents at Chernobyl and Fukushima. In 2011, the IAEA asked the Physics section to play a more active part in the analytical networks. The members of the ALMERA network are nominated by the governments of the member states (ALMERA – Analytical Laboratories for the Measurement of Environmental Radioactivity). The process whereby SPIEZ LABORATORY was designated as an ALMERA laboratory was initiated by the Federal Office of Energy; formal accession to the network occurred in 2012 following the annual ALMERA conference that was held in Ankara in 2012.

ALMERA is aiming to ensure that analysis is of a high quality throughout the entire network. Accordingly, network laboratories that are well equipped to do so, both technically and analytically, are offering various instructional and training opportunities to less advanced partners within the network. At the same time as building up local capacity in smaller laboratories, groups of experts from ALMERA are working out new and important measuring methods for the network. These new methods will be officially published by the IAEA following a validation phase to be conducted in several designated laboratories.

At least once a year, a comprehensive proficiency test is carried out on complex sample materials. The ALMERA laboratories report satisfactory completion of the initial task by issuing a set of measurement results from the sample materials within 72 hours. The results from the sample materials are then processed in a second phase that lasts between three and eight weeks. Evaluation of the inter-laboratory test usually requires between 1 and 1.5 years and serves to further optimise the network.



Inductively coupled plasma mass spectrometry (ICP-MS) in Spiez. This method enables high-precision isotope analysis

Based on a decision taken at the annual ALMERA conference, it was proposed that the Physics section should participate as a project partner in two new expert groups that are to be formed anew. The two new groups will focus on rapid methods for determining Sr-90 in a matrix that is difficult to analyse (e.g. seawater, soil) and on analysing naturally occurring radioactive material (NORM). In addition, the Physics section will contribute to the discussion about cascade correction and gamma spectrometry quality assurance.

Because the STS 028 testing laboratory's working procedures have received ISO/EN 17025 accreditation and because of its comprehensive analysis capability, SPIEZ LABORATORY exceeds the basic requirements for a specialist laboratory in the ALMERA network. The Physics section's Radioactivity team will organise its accredited field in such a way that in the future it will be able, at any time of the year, to deliver incident-related results within 48-72 hours of short-notice receipt of a sample.

IAEA
International Atomic Energy Agency

OCHA / SHA – Mission Brazzaville, Congo

Marc Stauffer

On 4 March 2012, a series of explosions occurred at an ammunition depot in Brazzaville, Republic of Congo. To evaluate the effects of the explosions on the environment with possible consequences for humans, an environment specialist from SPIEZ LABORATORY was integrated into the UNDAC (United Nations Disaster Assessment and Coordination) team.

The Explosion was devastating within a circumference of several hundred metres. The blast spread lots of unexploded ordnance over a large radius around the source of the explosion in the town. Several tons of different material had exploded, including explosives, rifle and artillery ammunition, possibly even rocket propellants. Some 20,000 inhabitants in the immediate vicinity had to be evacuated. 250 people were killed by the accident and more than 3,000 injured.

A day after the explosion that even broke the windows in the neighbouring town of Kinshasa, the local UN coordinator called in the OCHA (Office for the Coordination of Humanitarian Aid) to assist in assessing the environmental situation. The OCHA turned to the Swiss Agency for Development and Cooperation SDC with its request for assessment of contamination of the town with residues from explosives and heavy metals. The Swiss Humanitarian Aid Unit SHA is associated with the SDC that prepared and realised the mission with the help of the SPIEZ LABORATORY.

Directly after arriving in Brazzaville, a comprehensive introduction to the UNDAC team was given, including instructions on safety regulations for operating in mined areas and to coordinate the various relief organisations. Preliminary information on the weather situation and the course of the explosion cloud were available. Ground and water sampling was planned on the basis of preliminary reconnaissance and according to the information of explosive ordnance experts.

With the aid of a distribution model, sampling was conducted in such a way that contamination could be assessed both directly at the damage site and for increasing distances from the incident. Samples were also taken from locations that were not affected by the explosion, allowing comparison with the background value.

A resident stands outside with his belongings after a series of explosions destroyed buildings in the Mpila neighbourhood of Brazzaville

A plume of smoke rises from across the river in neighbouring Brazzaville, as seen above the skyline of Democratic Republic of Congo's capital Kinshasa

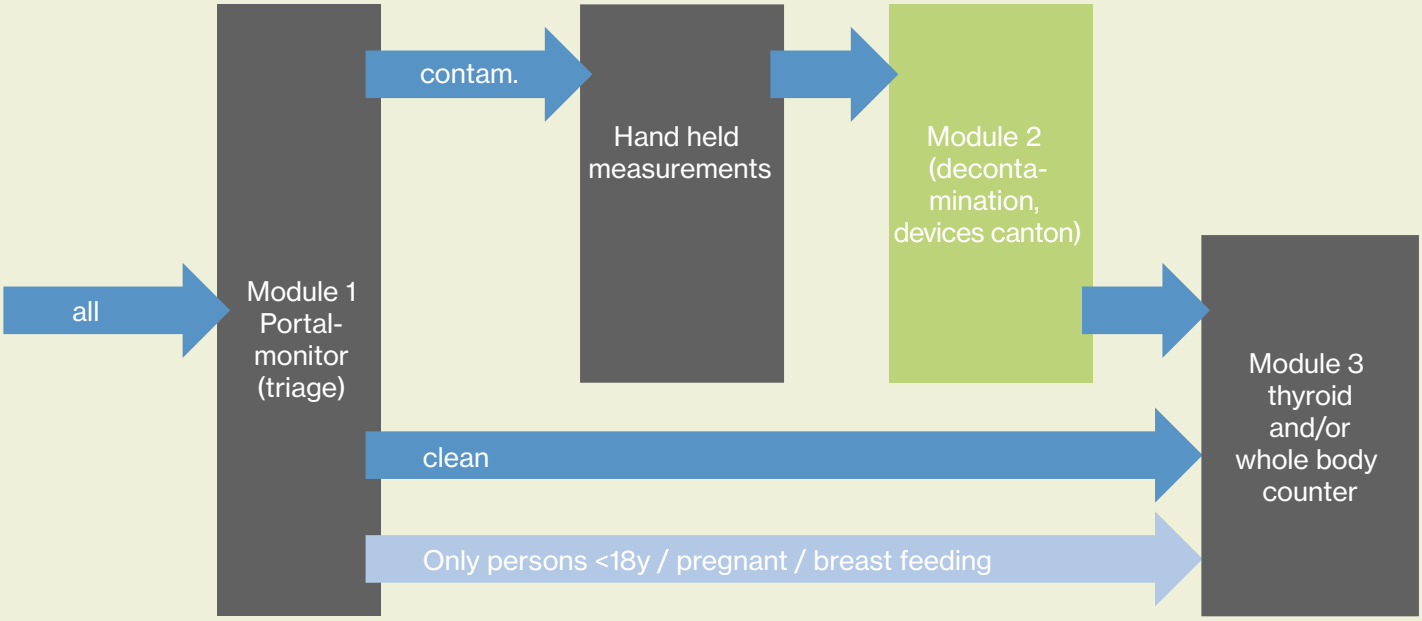
With a portable X-ray fluorescence device (XRF) the concentration of heavy metals that could originate from ballistic parts, fuses as well as ammunition casings, could be directly and reliably analysed on location. These measurements already provided the facts required to decide on the further procedure within the UNDAC teams. So it was, for instance, already clear in Brazzaville that none of the samples collected exceeded Swiss threshold values for heavy metals.

Already in Brazzaville, all samples were packed for in-depth explosives and heavy metal analysis and taken back to Spiez. Detailed examinations yielded traces of lead, mercury and trinitrotoluol, amino-nitrotoluols as well as HMX and RDX (explosives) in ground samples. None of the concentrations, however, were so elevated that a threat to the population had to be assumed. The water samples were unpolluted. Various measures were defined to prevent further threats to the human food chain through residues of ammunition and explosives. These included removing large amounts of the stocks from the town and protection against weather exposure.

Through this mission SPIEZ LABORATORY was able to actively assist in dealing with this accident. The adverse operational conditions provided valuable findings regarding what practical procedures are needed in the case of accidents where pollutants are released into the environment (accidents involving explosions, industrial plant disasters, floods) or incidents relating to armed conflicts.

UNDAC

The United Nations Disaster Assessment and Coordination (UNDAC) is part of the international emergency response system for sudden-onset emergencies.
UNDAC was created in 1993. It is designed to help the United Nations and governments of disaster-affected countries during the first phase of a sudden-onset emergency. UNDAC also assists in the coordination of incoming international relief at national level and/or at the site of the emergency.
UNDAC teams can deploy at short notice (12-48 hours) anywhere in the world. They are provided free of charge to the disaster-affected country, and deployed upon the request of the United Nations Resident or Humanitarian Coordinator and/or the affected Government.



Information Center Radioactivity

*Dr. Béatrice Balsiger, Dr. Daniel Storch**

The contact centre serves to establish the radiological situation, triage as well as psychological-medical care of persons in the event of an accident causing an increase in radioactivity. Public health services are greatly taxed after such an incident and has to be relieved. Affected persons can seek advice from the contact centre and are referred further if necessary. With the Emergency Response Team of the DDPS (A-EEVBS) SPIEZ LABORATORY provides the required measurement instruments and task forces.

The Confederation assumes its duty in particular as responsible agency for organising measurements in the event of increased radioactivity. In the case of an incident the Federal NBCN Crisis Management Board is tasked to mobilize the contact centre. The cantons are responsible for its operation.
The contact centre has the capacity to address approximately 1,000 persons a day and is designed primarily for assisting persons involved from zone 1 and the affected sectors of zone 2 in the prevailing direction of the wind. Rapid protection measures are demanded for zone 1 with a radius of approx. 3 to 5 kilometres around the nuclear power plant where a danger can originate for the population. Zone 2 is adjacent to zone 1 and comprises an area with a radius of approx. 20 kilometres.
In principle we work on the basis that the population has followed the instructions given by the authorities regarding protective measures (radio reports, remaining within the house, consumption of iodine tablets etc.). Thus it is not to be expected that persons who have been severely exposed to radiation will report to the contact centre. The contact centre offers the following services if required:

- Contamination check at the entrance
- Decontamination check upon showering
- Measurement of thyroid gland, especially for endangered segments of the population (pregnant women, children)
- If required whole body measurement
- Calculation, respectively estimation of total body dose caused by the incident

With the assessment aids doctors are able to give persons at the contact centre a rough estimate of their individual risk due to their additionally absorbed dose. In addition, visitors to the contact centre are advised on how they are to proceed further.

The mobile measuring resources of the A-EEVBS are deployed to the contact centre.

Monitoring devices of federal institutions and cantons (green) used by the information centre

The time-consuming measurement of persons after the decontamination check is carried out with the assistance of the cantonal task forces. SPIEZ LABORATORY provides the following support as part of the A-EEVBS:

- Mobile lab blue with two detector systems for thyroid gland and whole body measurement
- Portal monitor
- Hand held meters
- Mobile gamma ray detectors for monitoring the waiting room
- Dosimeter for dose measurements of the technical specialists
- Laptops with tools for dose estimation
- Spare clothes for persons that are obliged to pass through module B (decontamination shower). We assume that this will apply to 200 persons a day.
- Seven task force persons for measurements including a technical nuclear adviser who coordinates the technical specialists (A-EEVBS, chief emergency doctors and radiation protection experts)

The project for revising the contact centre concept has been running for several years. In 2012 the concept was passed by a working group of 20 members from various federal offices (Federal Office for Civil Protection, Federal Office of Public Health), representatives from cantons, from the Coordinated Medical Services as well as the Swiss Accident Insurance SUVA and the Swiss Federal Nuclear Safety Inspectorate ENSI and was authorised by the Federal NBCN Crisis Management Board. In 2013, the contact centre is to be tested within the context of the ODYSSEUS overall emergency exercise.

In the event of an incident the contact centre is called up via the Federal NBCN Crisis Management Board (or the National Emergency Operations Centre). The canton that is called up provides the necessary infrastructure (outside zone 2) at pre-defined locations. Thus, in the event of a nuclear plant accident, the contact centre can be made operational already 12 hours after the radioactive cloud has passed by.

*Swiss Federal Office of Public Health (SFOPH), Radiological Risks Section

Testing for possible nuclear radiation exposure at an evacuation center in Koriyama, Fukushima Prefecture, April 2011

Radioactivity testing of decommissioned military equipment

Markus Zürcher

Every year, the Swiss Armed Forces decommission thousands of equipment items. From overall trousers to complex weapon systems such as the M-113 armoured personnel carrier, all sorts of items are disposed of, either through armed forces surplus shops, or donated for humanitarian purposes, or transferred to the Central Agency for Historical Military Equipment. The DDPS Competence Centre for Radiation Protection assesses this equipment, draws up rules for radioactivity testing and takes on-site measurements. This ensures that disposal occurs in the safest possible way.

The life cycle of armed forces equipment from its procurement, throughout its service life until it is decommissioned is complex and bound up with any number of rules and regulations. So that this equipment is not passed to third parties indiscriminately, it is essential that it is checked. This task is carried out by the DDPS Competence Centre for Radiation Protection. When any material is due to be decommissioned, a database can be accessed to discover whether it needs to be checked. If radioactivity testing is necessary, this will be set out in a written statement of requirement in the decommissioning order. The equipment will then be subjected to on-site testing. If radioactive substances are detected, the equipment is removed from the inventory and properly disposed of. Every year, several hundred items fall under the heading of radioactive waste. As far as possible, their radioactive components are segregated in order to keep the volume of effectively radioactive waste and, consequently, costs as low as possible.

Obsolete items containing luminous radium paint

In order to ensure that military systems were operationally effective during the hours of darkness, luminous paint containing radioactive substances (radium, Ra-226) was used in the Second World War and in the post-war period. These luminous paints were also used in the manufacture of watches and other similar displays for personal use. Radium with a half life of 1,600 years is easily measurable which can lead to problems in its disposal. Today, the armed forces use practically no systems containing radium. It is a different matter when it comes to historical military equipment. Here, there are substantial holdings, e.g. vehicle and aircraft instruments, transmission equipment, compasses or fuses that contain luminous radium paint.

Testing of battery-instrument (luminous paint)

Museums and collections, as well as private individuals may own such items. Within the DDPS, the Central Agency for Historical Military Equipment (CAHME), established on 1 January 2009, ensures that radioactive items are handled as prescribed by law. In collaboration with the DDPS Competence Centre for Radiation Protection, the CAHME is making museums and collectors aware of the luminous paint problem. The Federal Office of Public Health has issued a related directive (L-04-04) that can be found on the internet (www.bag.admin).

Anemometer with radium luminous paint

Betalight (h2)

Validation of the biocontainment laboratory

Dr. Marc Strasser, Dr. Andreas Bucher

Before SPIEZ LABORATORY is able to fully utilise the capacities of its new biosafety lab, the complex technical lab systems have to be validated integrally, in order to ensure safe operation. The technical expenditure required for this was initially underestimated and, as a result, the planned schedule for entry into service of the highest biological safety level (BSL 4) could not be met.

The new biocontainment lab (BL) in Spiez allows the safe handling and diagnosis of highly infectious pathogens, also regarded as potential biological agents. Thus the BL closes an important gap in our national protection against biological threats, as effective countermeasures with specific medical support and treatment is only possible when a pathogen can be identified and characterised.

Working with highly dangerous pathogens necessitates a sophisticated containment system. It includes safety installations and individual protection equipment such as safety cabinets, integral protection suits, hermetically sealed rooms, negative pressure laboratories as well as a complex system of sluices and barriers. Personnel leave the labs via chemical showers where the outside of their integral protection suit is decontaminated. Exhaust air as well as all solid and fluid refuse have to be inactivated microbiologically before leaving the BL. Solid refuse has to be heat inactivated before passing the sluice, liquid refuse, including waste water from the decontamination showers have to be retained in storage tanks and inactivated via water vapour sterilisers.

Before the highest biosafety level (BSL 4) could enter into service, technical challenges delayed the original deadline for beginning scientific work. It was originally assumed that all lab units could be made scientifically fully operational in a little over a year after official inauguration of the BL by Federal Councillor Maurer in the summer of 2010 . At the time of inauguration, construction and technical installations of the lab complex had been completed within set deadlines and according to financial parameters.

However, due to technical difficulties it was impossible to meet the ambitious timetable for putting into service, integral tests (mutual coordination of the individual systems) and validations. Validations serve to prove that the individ-

Detail of air handling systems

ual lab units of the BL and technical installations can always be set to meet a safety-relevant status so that there is never a risk of contamination with microorganisms either inside (personnel) or outside the facility (environment).
Already during the integral test it became evident that technical components of various manufacturers were not optimally harmonised. This was also because during planning the focus had been consistently on obtaining the most advanced and environmentally least harmful technologies for whose application yet little or even no experience existed to date.

Thus for instance, we used peracetic acid for the chemical showers instead of the usual quaternary ammonium compounds as the latter are only badly degradable in water environments. Difficulties arose in connection with the fresh air and exhaust air ventilation systems which, although they functioned perfectly on their own after construction work had been completed, led, when combined with the nitrogen installation, to undesirable overpressure situations. For safety reasons the autoclaves and the systems for gassing rooms and filters had to be slightly adapted as well. Due to the long delivery periods from manufacturers (including special designs for sterilisation tanks and overpressure valves, etc.) these adjustments took a lot of time.

Since February 2012, risk level 2 and 3 pathogens can be safely processed in the BL. Entry into service of level 4 is well underway, in 2014 it will also be available for scientific work. Then our Civil Protection organisation will be able to rely on a complete and rapid laboratory analysis encompassing all safety levels and SPIEZ LABORATORY will be able to fully assume its new central role both in health and security policy.

Wastewater treatment facility

Francisella tularensis

Ticks as vector for tularemia in Switzerland

Dr. Christian Beuret, Dr. Matthias Wittwer, Fritz Wüthrich, Sandra Paniga and Dr. Nadia Schürch

Tularemia, also called rabbit fever, is an infectious disease caused by the bacterium Francisella tularensis. In Switzerland individual cases were sporadically reported over the past years that coincided with the incubation period of tick bites. For determining the prevalence of F. tularensis in ticks, some 80,000 Ixodes ricinus ticks were collected throughout Switzerland in 2009 and 2012 and analysed with molecular biology methods. A total of 24 tick samples from 5 endemic areas were identified as positive. Cultivation and isolation of the pathogen was successful from 13 samples. This now makes it possible to conduct detailed epidemiologic studies.

Tularemia is a classic zoonotic disease that occurs exclusively in the northern hemisphere. In Europe there are several endemic regions, in particular in all of Switzerland's neighbouring countries too. The biological cycle of F. tularensis is not fully known, but appears to be complex and to vary regionally. Rodents and lagomorphs are considered to be reservoirs. The infection can be transferred to other animals and humans – through direct contact with diseased animals or their excrements, through consumption of contaminated, insufficiently heated meat, through inhalation of dust containing the pathogens as well as through hematophagous insects. The highly infectious pathogen is considered to be environmentally persistent and is able to survive for weeks and months under moist and cold conditions in the ground, in surface water (presumably inside amoeba) and in animal corpses.

We distinguish between four subspecies of F. tularensis; only the subspecies holarctica is endemic in Europe. In accordance with the wide range of transmission paths and depending on the endemic region, various professions (hunters, gamekeepers) and recreational activities in the woods constitute risk factors for an infection with F. tularensis. Clinical disease symptoms vary, depending on the mode of infection (through the skin, eyes, mouth or respiratory tract) and the infectious dose. Depending on the portal of entry, tularemia forms develop with local primary boils and swelling of regional lymph nodes. Systemic development of the disease is less frequent.

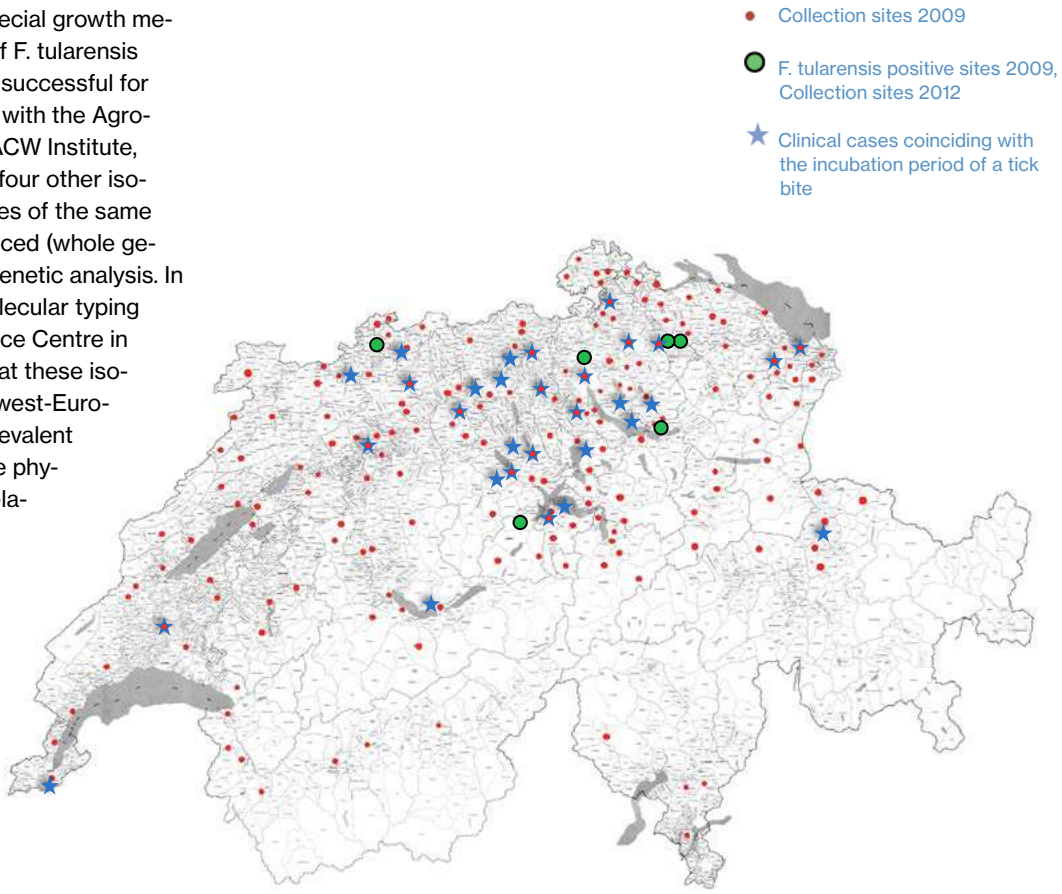
Tularemia is a notifiable disease in Switzerland since 2004. But no monitoring programme exists, so the number of cases published by the Federal Office of Public Health (FOPH) are only indicative: 2007: 8; 2008: 13; 2009: 4, 2010: 13; 2011: 16; 2012: 38. A growing tendency can be observed in neighbouring countries too. However, it cannot be excluded that the increase is only due to a greater awareness of doctors and improved laboratory diagnostics. Then, although the suspected type of exposition is registered in the reporting system, it is not clarified epidemiologically in the laboratory. Nevertheless, it is remarkable that about a third of the cases coincide with the incubation period of a tick bite.

For quite a long time, ticks have been suspected to serve as a vector for F. tularensis. But to date, no research group has succeeded in isolating living germs, thus confirming this transmission path. In a small study the former B service of the armed forces already collected 6,071 ticks in 1999 and established a prevalence of 0.1% for F. tularensis with molecular biology methods.

In order to gain a more detailed understanding of tick-associated diseases, SPIEZ LABORATORY and NBC Defence Lab 1 collected 62,343 ticks at 165 locations in Switzerland (red dots in the survey map) in 2009. Of these, 6 proved positive for T. tularensis with molecular biology methods (green dots). This corresponds to a prevalence of only 0.01 ‰. In collaboration with the Robert Koch Institute in Berlin and with the help of special growth media, cultivation and isolation of F. tularensis from two of the samples was successful for the first time. In collaboration with the Agroscope Changins Wädenswil ACW Institute, these two isolates as well as four other isolates from clinical human cases of the same year were completely sequenced (whole genome sequencing) for phylogenetic analysis. In agreement with an earlier molecular typing study of the National Reference Centre in Bern it could be confirmed that these isolates also correspond to the west-European genotype that is also prevalent in France, Italy and Spain. The phylogenetic tree shows close relationship of the genomes and confirms their clonal origin.

For further clarification of the epidemiologic dynamics of F. tularensis, 14,446 ticks were again collected with the support of NBC Defence Lab 1 in June 2012 at locations (green dots) that had been positive in 2009 and analysed with molecular biology methods. Of the 18 positive tick samples all but one originated from locations in the canton of Zurich, which could thus be confirmed as an endemic region for infected ticks. Over the last years and in particular in 2012, clinical tularemia cases have accumulated in this region (blue stars). Although the number of cases in the cantons of Lucerne and Aargau has also increased, no coincidence with infected ticks could be observed for 2012. However, the number of samples is not sufficiently large for significant results. Therefore, in the summer of 2013, NBC Defence Lab 1 will again be collecting ticks at the clinical hot spots.

By optimising the sample preparation process, it has been possible to double the rate of successful cultivation, so that now 11 of the 18 positive tick sample isolates are available for a precise genome analysis. As the prevalence of F. tularensis in the wild population is also an important factor for clarifying its epidemiologic potential, authorities and institutes have also become active in this field. Therefore, SPIEZ LABORATORY plans to launch an extensive epidemiologic study based on whole genome sequencing within the context of multi-disciplinary cooperation with various national and international partners. The comparison of strains isolated from wild animals, humans and ticks will help us to better understand the biological cycle of F. tularensis in Switzerland.



Detection of hantaviruses in Swiss bank voles

Dr. Olivier Engler, Jasmine Portmann, Johanna Signer, Dominik Gygax, Rebecca Krebs, PD Dr. Gerald Heckel, Dr. Christian Beuret und Dr. Marc Strasser

In recent years, infections with hantaviruses have greatly increased in certain regions of central Europe. In most cases these viruses are transmitted to humans via the excretions of infected rodents and can cause severe diseases. Because of the great increase in hantavirus infections in Germany in the beginning of 2012, bank voles in risk areas close to the Swiss border were tested for hantaviruses. In collaboration with the Zoological Institute of the University of Bern 217 bank voles were caught along the border to Germany and France and tested with molecular biology methods for hantaviruses in SPIEZ LABORATORY. As a result, the Puumala virus, a human pathogen, was detected in two bank voles from the Jura region near the border. Currently, phylogenetic relationships with other European hantaviruses are being assessed by comparing genome sequences.

Approximately 20 hantaviruses are known throughout the world that can give rise to an infection in humans. Hantaviruses multiply in rodents, every type of virus having its own preferred host. In times of intense virus propagation they may be transmitted to humans and cause characteristic disease symptoms. In 2012, several hantaviruses made themselves noticed at the same time: in Europe there were outbreaks of the European hantaviruses Puumala and Dobrava in various regions, and in the USA infections with the highly pathogenic hantavirus Sin Nombre caused concern. Due to the exceptionally extensive propagation of the Sin Nombre virus in the local deer mouse population in Yosemite-National Park in the United States, at least ten park visitors were infected. Those who fell ill suffered from functional lung disorders and developed a hantavirus-induced pulmonary syndrome (HPS). Three of the patients died as a result of the infection. All over the world persons who had visited the Yosemite Park were urged to consult a doctor in the event of respective symptoms, to determine whether they had been infected with the Sin Nombre Virus. In Switzerland too, several suspect cases had to be clarified.

Contrary to the American hantaviruses that lead to a functional lung disorder, infections with European hantaviruses typically cause re-

Staff of Institute for Ecology and Evolution of the University of Bern catching bank voles in select forest area

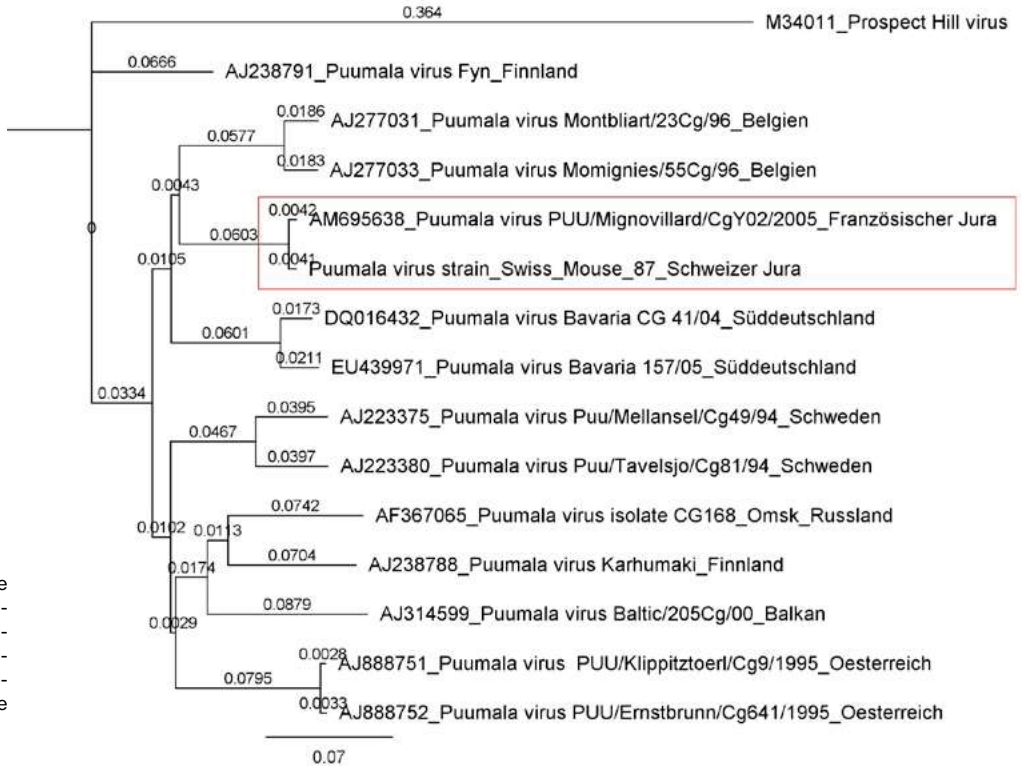
nal complaints. The disease symptoms of the Puumala hantaviruses endemic to northern Europe (Finland, Sweden and Norway) and central Europe (Belgium, Germany, France and Austria) are comparatively mild and only occasionally affect kidney function to such an extent that dialysis is required. Infections with Puumala viruses are, however, much more frequent and have led from 2,000 to 7,000 infections annually over the past ten years in northern and central Europe. The Dobrava virus, endemic to the Balkans, often causes a blood coagulation disorder (haemorrhagic fever) in addition to impaired renal function. Therefore the course of this form of disease is much more often severe (lethality of 5 - 10 %).

Hantaviruses are spread by rodents (mostly mice, voles and rats), every virus preferably replicating in a different species of rodent. The virus is excreted with the urine, saliva and faeces of infected animals and humans are infected by inhaling contaminated aerosols or dried particles. Camping and collecting wood and fungi as well as staying in or cleaning out rarely used forest huts and garden sheds in regions with infected rodents is considered a risk. Clustering of hantavirus infections (hanta years) occur in central Europe periodically in cycles of 2-4 years and correlate with the population density of the rodent. The latest larger outbreaks of the disease occurred in 2005, 2007 and 2010 in Germany and in France, although investigations of bank voles in Germany and France showed that virus-infected bank voles also live in the immediate vicinity of the Swiss border. Despite this geographical closeness (Baden-Wuerttemberg and French Jura) only few patients infected with hantavirus were registered in Switzerland during the last years giving rise to the question, whether hantavirus infections are principally not sufficiently recognised in Switzerland or hantaviruses really are considerably less endemic here than in the near abroad.

In the spring of 2012, a renewed strong increase was registered in Germany for patients with Puumala virus infections. Due to preliminary bank vole investigations in Germany, one had to expect a hanta year for 2012 as well, which is why it was also planned to examine in Switzerland bank voles, the main host and vector for Puumala viruses. On the basis of the incidence data from 2010 and the beginning of 2012 taken from the German and French border regions and with regard to the distribution of bank voles, potential hanta virus risk regions in the Jura and the vicinity of Schaffhausen were defined in collaboration with the Institute for Ecology and Evolution of the University of Bern. From August to October, staff from the Institute for Ecology and Evolution caught bank voles in select forest areas.
To prevent a transfer of viruses to personnel, protective gear was used for critical work steps. The bank voles caught were marked and conserved at -20°C prior to further examination. The precise trapping locations were registered with GPS coordinates. During the 2012 trapping period, 113 bank voles were obtained from six forest areas in the Jura and 104 bank voles from nine forest areas in the vicinity of Schaffhausen (cf. map). Analyses were carried out in the bio safety lab of SPIEZ LABORATORY. The bank voles were dissected in a biological safety cabinet and tissue samples taken from lung, heart and kidney. For serological analyses a pulmonary effusion (rinsing of thoracic cavity with buffer solution) was taken. In a first step, the lung tissue samples were tested with molecular biology methods for genetic traces of hantaviruses. In two of the 217 bank voles, the RT-PCR (real–time polymerase chain reaction) used for screening gave a positive signal. As confirmation, the positive tissue samples were tested with a classical PCR method and a short sequence of 695 nucleotides of the viral genome was amplified. Through sequencing reaction, the genetic information of the viral genome section could be deciphered and its sequence compared with other viral genomes.

In identifying Puumala viruses in bank voles, the presence of Puumala viruses in bank voles in Switzerland could be proven for the first time. Although infections with hantaviruses had already been diagnosed in patients from Switzerland, it usually stood to reason to suspect that the person had been infected abroad. In identifying the virus within the local bank vole population, presence of the source of infection in Switzerland too could be verified for the first time.

Interestingly, the infected bank voles come from a village close to the Jura, whereas bank voles caught at other locations, in particular from the vicinity of Schaffhausen, were not in-



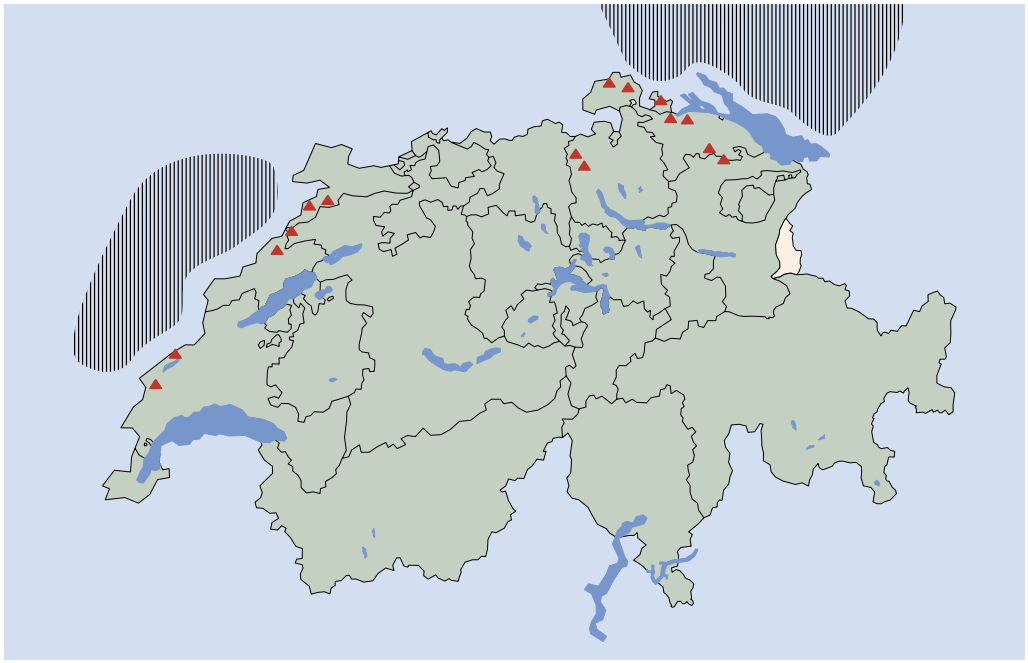
Decoding of sections of the viral genome allows comparison with other Puumala viruses and representing their genetic relationship in a phylogenetic tree

fected with Puumala viruses. Serological tests confirmed these molecular biology results too. Only in the case of one bank vole caught in the Jura were antibodies against the Puumala virus detected in its pulmonary fluid. However, more comprehensive areal investigations would be necessary to allow general statements on the situation in Switzerland.

The decoding of sections of the viral genome enabled us to make a comparison with other European Puumala viruses and to depict their genetic relationship in a phylogenetic tree. The great similarity with isolated virus strains from the French Jura suggests that the viruses might have spread from France to Switzerland. Investigations in coming years will show whether the Puumala viruses will spread further in Switzerland and whether, as a result, the frequency of transmission to humans will increase. Also of interest is the fact that, despite intensive search, no Puumala viruses could be detected yet in bank voles inhabiting north-eastern Switzerland, although due to the high infection rate in Germany, spread from the north has been considered to be more likely. Whether geographic barriers, such as the Rhine, prevents the mixing of bank vole populations or whether genetic factors limit the viruses' dissemination will be the object of further research.

As there are no limits to human mobility, it is hardly surprising that whenever an infectious disease breaks out somewhere in the world, travellers returning to Switzerland may be affected. Accordingly, several patient samples were tested for Puumala, Dobrava and Sin Nombre viruses at SPIEZ LABORATORY last year.

The bank vole is one of the most common mammals in Europe. It is a major pathogen-carrier of hantaviruses in the endemic areas.



Endemic areas along the swiss border and collection sites for bank voles (red triangles)

Export controls: call for a responsible conduct in dual-use research

Dr. Cédric Invernizzi

In April 2012, the Dutch government demanded an export permit from researchers for the publication of their results in an American scientific journal. In categorising their research work as requiring an export permit, it has created a precedence case that could affect research throughout the world.

Already in 2001 – the year of the Anthrax attacks – a debate ensued on what is known as dual-use research. This designation is given to legitimate research that can also be misused for harmful purposes. The debate was triggered by several scientific publications, including the description of a genetically recombined mouse pox virus against which vaccines have no effect as well as the synthesis of a Polio virus where an infectious virus capable of replication was assembled out of modular chemical units. Subsequently, the USA founded the National Science Advisory Board for Biosecurity (NSABB) that also is tasked with issuing recommendations relating to dual-use research. Today, the focus of the NSABB is on 'dual-use research of concern' (DURC). DURC refers to that section of more broadly defined dual-use-research that has a direct potential for abuse and thus constitutes a significant threat with far-reaching implications on public health or national security for example. This category also includes two studies published in 2012 on the H5N1 avian influenza virus and its possible transmissibility among humans.

The work of both research groups from the Netherlands and the USA triggered a violent debate on dual-use research, also in regard to responsibility or freedom of research of scientists. Initially, rejection of the complete publication in its existing form of the experiments was recommended by the NSABB in November 2011. Thus for the first time, the NSABB brought censureship into play in bioscience. After months of debates and a self-imposed moratorium of the researchers on work relating to the transmissibility of H5N1, many more details about the experiments became known. The researchers repeated their statements

Medical workers monitor a scan machine for high body temperature among passengers at Taoyuan International Airport, Taiwan 2009

and the initially apocalyptic sounding scenarios finally became results that faithfully reflect the experimental data. After re-evaluation, the NSABB finally did away with any censorship, so that the two research groups were able to present their complete results in the two scientific journals 'Nature' and 'Science'.

An important detail of the debate remained unnoticed, however: For the definite publication of the results of the Ronald Fouchier research group at the Erasmus Medical Centre in Rotterdam the Dutch authorities demanded an export permit for the transfer of the technology involved. Export control legislation of the EU requires exporters to apply for an export permit for the transfer of technology relating to certain goods. These also include various pathogens such as the H5N1 avian influenza virus as well as respective genetic elements.

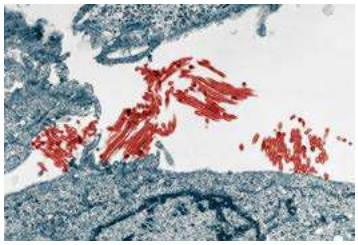
Nevertheless, certain exceptions to this export rule exist: While applied research is principally subject to export authorisation, basic research is exempt. The case at hand was categorised as applied research by the Dutch authorities. This interpretation is controversial. The work seems far removed from practical application. And correspondingly, the group was reluctant to comply, but still applied for the permit notwithstanding their dissent. After thorough analysis, the Dutch authorities granted their request for a permit and authorised the export, on the basis of research results on the one hand as well as the arguments of the debate on the other. The export authorisation did not deter the research group from appealing against their research results being made subject to export authorisation. A judicial verdict is still pending.

Considering the fact that their work was categorised as applied science, the question arises what is regarded as basic research today and what should be seen as applied science. It is a fact that the fight for research funds has become harder over the years. Throughout the world, an increasing number of projects are faced with a less rapidly growing body of financial resources. Accordingly, it is hardly conceivable that today bioscience research is financed without possible applications of research results being convincingly presented or at least an explanation as to what added value such research might bring to society. Could this mean that the majority of research projects on listed pathogens might have to be regarded as applied science because of the arguments required for their financing? With such an interpretation does this type of research now generally drift into the focus of export controls where their publication calls for export permits? Will we, apart from the current peer review process, also require an evaluation by export control authorities in the future?

So the pending judicial verdict in the Netherlands may be awaited with anticipation. Because with their categorisation the Netherlands have established a kind of precedent that could affect research worldwide and will provide sufficient material for further global debates. Solutions are now called for that are as widely supported as possible. Greater awareness of the dual-use dilemma is generally indicated for all involved, especially among researchers.

The statements initially made by the researchers certainly bear witness to a poor awareness of the dual-use dilemma. Only after a global storm of indignation had already erupted, did the researchers pursue a factual style of communication. This reveals in exemplary fashion the great importance of a responsible communication strategy that is implemented from the start. Professional handling of dual-use research which is based on facts should be part and parcel of every researcher's responsible code of conduct.

R. Fouchier, Erasmus Medical Centre (r.) and Y. Kawaoka, University of Wisconsin-Madison



H1N1 Virus (Yoshihiro Kawaoka)

Analytics of marine toxins

Marc Avondet

The Chemistry and Biology sections of SPIEZ LABORATORY have been studying the marine saxitoxin (STX) and working on its analytical detection for years. This is because this marine toxin has been classified in the global Chemical Weapons Convention (CWC) as what is called a Schedule 1 compound [1]. Schedule 1 chemicals are subject to far-reaching prohibitions. As designated OPCW (Organisation for the Prohibition of Chemical Weapons) laboratory SPIEZ LABORATORY must be capable of detecting saxitoxin in complex real samples.

Marine toxins are formed by certain types of phytoplankton (diatoms or dinoflagellates), possibly in symbiosis with certain bacteria [2]. Under favourable conditions such as warm water and plenty of food they can multiply massively and cause what are called algal blooms. The latter can easily be identified by their extensive colouring of the sea (see page 31).

About 40 dinoflagellate species produce one or several highly toxic compounds that may accumulate in mussels or other seafood. No algal blooms are necessary for the production of toxin, it can be formed already in the presence of very small not yet visible amounts of algae. Mussels are especially threatened because they filter large amounts of seawater and usually spend their lives at the same location. Mussels (like other seafood) contaminated with toxins may cause severe illness in humans such as diarrhoea, paralysis and amnesia. If they contain too much toxin, eating mussels can even lead to death. Disorders arise within a few hours of eating seafoods containing the toxin, as they have an acute toxic effect. There is evidence that certain lipophilic toxins are chronically toxic and may serve as tumour promoters.

The marine toxins are divided into various groups, one approach distinguishes between lipophilic and hydrophilic types, the other categorisation is based on their effect on humans:

- Amnesic shellfish poisoning (ASP) = form with the effect of amnesia
- Diarrhetic shellfish poisoning (DSP) = form causing diarrhoea
- Paralytic shellfish poisoning (PSP) = form causing paralysis

The number of annual poisoning cases that can be traced back to marine toxins has clearly decreased thanks to better monitoring of seafood production than in the past. But the danger has not been completely banned yet. Thus, after a warning was issued by the French Government in 2010, a major food contractor

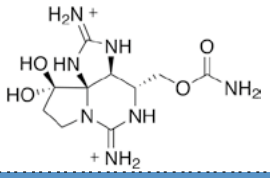
was obliged to withdraw large amounts of blue mussels from the market [4]. This measure was taken within the context of an increase in diarrhetic disorders (DSP as cause) relating to products of Spanish origin.

Saxitoxin belongs to the group of PSP toxins [5]. It was the first toxin to be isolated in 1957 from the round clam Saxidomus giganteus endemic to Alaska and received its name from it. However only in 1975 did researchers succeed in determining the molecular formula of the compound by calculating its crystalline structure and characterising it as a heterocyclic tetrahydropurine alkaloid.

The structure of the 57 remaining PSP toxins isolated to date can be derived from saxitoxin [6]. Saxitoxin is a very powerful neurotoxin. Its main effect lies in blocking the outer face of the electric potential dependent sodium channels of nerve cells, which inhibits neural transmission and can result in severe paralysis. Saxitoxin is similarly toxic as synthetic neurotoxins. With the exception of a few proteins (ricin, botulinum toxin etc.) it is, therefore, one of the most toxic chemical substances. Humans respond relatively sensitively to PSP toxins, so that a dose of approx. 1–2 mg saxitoxin can be lethal for a human adult. To protect consumers, the Federal Office of Public Health has defined an upper limit (sum of PSP toxins) for Switzerland of 0.8 mg/kg mussels.

Analytics of marine toxins

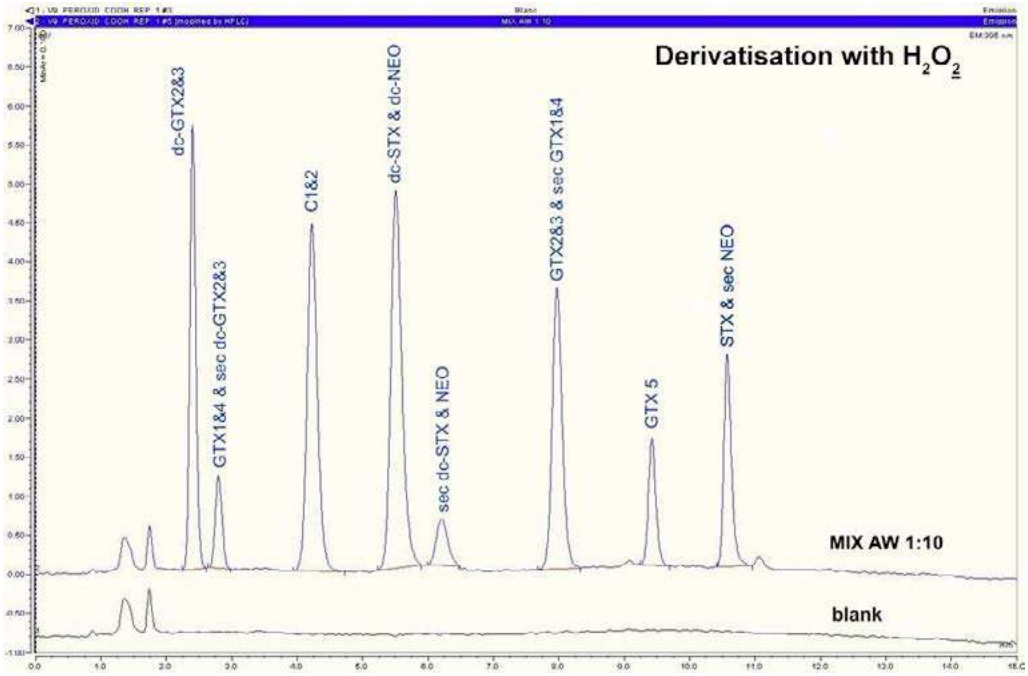
A variety of biological, biochemical and chemical procedures are available for analysing marine toxins. These are usually divided into chromatographic and non-chromatographic detection methods. Non-chromatographic procedures that include bio assays and immune assays provide only summary detection of several PSP toxins (overall toxicity). To obtain information on individual toxin components, chromatographic procedures have been developed over the last decades that allow us to sensitively and selectively detect individual compounds. The high pressure liquid chromatography (HPLC) with fluorescence detection has prevailed as standard procedure.

Structural formula	
	
General	
Name	Saxitoxin
Other names	STX PSP
Molecular formula	$C_{10}H_{17}N_7O_4$
CAS number	35523-89-8
Properties	
Molecular mass	299,29 g·mol^{-1}
Solubility	Soluble in water and methanol, less soluble in ethanol [1]

The following procedures are used at SPIEZ LABORATORY:

- HPLC with fluorescence detection (derivatisation prior to the column according to former DIN EN 14‘526) as accredited method of the STS 054 testing agency ‘detection of biological agents’ (Fig. 3) [7, 8]
- LC-MS/MS in collaboration with the Organic Analytics section of SPIEZ LABORATORY [9]
- ELISA (RIDASCREEN FAST saxitoxin; R-Biopharm) und lateral flow assays (JELLETT Ltd.; Rapid test for PSP)

The extension of analytics to a variety of marine toxins has led to mass spectrometric methods being introduced across the board. Since a few years, well-functioning lateral flow essays (LFA) are also available for the rapid detection of PSP and ASP [10].



HPLC-Chromatogram of various PSP-toxins

Examination of real samples

The Toxology section is interested in real samples so that it can regularly train the established and partly accredited detection methods. For this reason, mussel samples are regularly examined at SPIEZ LABORATORY for traces of marine toxins by Swiss Armed Forces NBC specialists as part of their training. The samples are usually taken from major food contractors in connection with random test validation of their supplier certificates. Time and again, samples are found that show traces of marine toxins (focus on PSP) Until now, however, their concentrations have always been well below the legal limits (<10 %).

Another training option consists in collaboration as partner in the Toxinology section within the EQuATox [11] research project of the EU. Apart from optimising detection procedures for toxins, the core activities of this project encompass four proficiency tests for the detection of ricin, saxitoxin (PSP), staphylococci enterotoxin B and botulinum neurotoxins.

With respect to the analytics of marine toxins, SPIEZ LABORATORY has contacts with two cantonal laboratories that have been active in this field for longer. One aspect of these contacts is the intention to jointly serve as national reference laboratory for the analysis of marine toxins. Thus, SPIEZ LABORATORY has the opportunity to extend its food safety capacity as part of its civil protection services.

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Envisat Medium Resolution Imaging Spectrometer (MERIS) satellite image acquired July 11, 2010 shows blue-green algae blooms in the Baltic Sea

Members of the the scientific advisory board of the OPCW

Remarks by the Chair

Report of the OPCW SAB on developments in Science and Technology for the Third Review Conference of the Chemical Weapons Convention

Stefan Mogl SPIEZ LABORATORY, Switzerland, Chair OPCW Scientific Advisory Board

The Scientific Advisory Board (SAB) of the Organisation for the Prohibition of Chemical Weapons (OPCW) provides specialized advice in relation to science and technology to the OPCW Director-General. Every five years OPCW member states conduct a review of the operation of the Chemical Weapons Convention (CWC, Convention) – a Review Conference – for the third time in April 2013. The SAB supports this review process with an analysis of developments in science and technology. Following the practice for the previous review conferences, the SAB prepared a report for the Third Review Conference, taking into account a variety of sources, including a dedicated workshop organized by the International Union of Pure and Applied Chemistry (IUPAC), the National Academy of Sciences and the OPCW at SPIEZ LABORATORY in Switzerland, in February 2012.

Convergence of Chemistry and Biology

The convergence of the sciences and in particular the convergence of chemistry and biology combined with rapid advances in the life sciences affect the implementation of the Convention in different areas. The commercial production of chemicals, for example, is increasingly employing biologically mediated processes. Other new technologies make the chemical synthesis of simple organisms and the design or redesign of biological systems possible, which may simplify the production of certain classes of chemicals including toxins and bioregulators. The SAB considers it unlikely that these technological developments will be applied to the production of classic chemical warfare agents such as blistering agents and nerve agents for which proven methods exist. Instead, the Board expects from convergence, benefits in the protection against chemical weapons. However, toxins and bioregulators fall between the CWC and the Biological Weapons Convention (BWC) and the SAB therefore proposes to strengthen the cooperation between the experts on the two treaties and to keep the convergence of the sciences under review.

Accelerated Discovery of Chemicals

Concerns were raised in the past about the accelerated discovery of new biologically active chemicals as a result of new approaches and methods in drug design – such as combinatorial and other forms of parallel multi-compound synthesis – that could lead to the discovery of prototypes for new toxic chemicals.

The SAB does not negate that among the millions of compounds being screened today potential, candidates for toxic chemicals can be discovered but it emphasizes that these new methods generate data based on in vitro screening that may not actually reflect toxicity in vivo. This is in contrast to the animal testing that was used in the development programs for toxic chemicals during the 1950s-1970s on a much smaller number of compounds. The Board concludes that today's large in-house databases in pharmaceutical companies and related institutions pose no greater risk to the Convention than the much smaller databases – based mainly on in vivo testing – that existed prior to the Convention's entry into force in 1997.

Nanotechnology
The SAB expects that advances in nanotechnology will help improve countermeasures against chemical-warfare agents in detection, diagnostics, physical protection and decontamination. The Board cannot confirm concerns about enhanced acute toxicity of nano-size materials because too little is known today. In the view of the SAB nanotechnology is unlikely to provide a dramatic improvement in the military utility of existing chemical agents, but it could be exploited in the development of new agents and advanced delivery systems. For example, nanomaterials are investigated for the smart delivery of therapeutic agents (see below).

Technologies for the Delivery of Toxic Chemicals and Drugs
The pharmaceutical industry is developing methods to administer drugs for medical purposes via the respiratory system through inhalation. A potential growth area is the use of porous nanoparticles acting as carriers. In the form of a particulate aerosol nanoparticles deliver the drug into the alveolar regions of the lungs from where they are absorbed into the blood. Advancements further include engineering of nanomaterials for controlled drug release, enhanced penetration of the blood-brain barrier and targeting specific organs or cells. The SAB will keep this technology under review.

In relation to the classic delivery of toxic chemicals by munitions the SAB noted with some concern isolated reports of the commercial availability of munitions that apparently were designed to deliver large amounts of riot control agents over long distances. A range of other devices that might be attractive for the dissemination of chemical weapons and biological-weapons agents by non-State actors continue to receive attention from observers.

Production Technologies
Technological advances in production methods for industrial chemicals are relevant to the CWC because they could be utilized for the production of toxic chemicals. Microreactors and small-scale flow reactors have been mentioned in the past as a potentially critical development for the implementation of the Convention. The technology has made significant advances in the past five years and such reactors have become more prevalent in research and development laboratories. They are however not yet widely used in industry and their integration into industrial scale production has been slower than some observers predicted. In the view of the SAB, microreactors, at this point in time, are not generic reactors for an easy "off-the-shelf" solution to chemical production and they show particular limitation for handling solids. While microreactors offer many technical advantages for certain types of reactions, utilizing them for a particular process requires experience and technical expertise. In the view of the SAB, the technology continues to require monitoring in order to assess the impact it may have on the verification regime of the Convention.

Schedules of Chemicals
The CWC contains in the Annex on Chemicals three schedules listing the chemicals which fall under routine verification by the OPCW. The SAB made no specific recommendation regarding a review or an amendment of these schedules as has been proposed by some observers. It emphasized that the definition of toxic chemicals in the Convention would cover all potential candidate chemicals that might be utilized as chemical weapons. Regarding new toxic chemicals not listed in the Annex on Chemicals but which may nevertheless pose a risk to the Convention, the SAB makes reference to "Novichoks". The name "Novichok" is used in a publication of a former Soviet Scientist who reported investigating a new class of nerve agents suitable for use as binary chemical weapons. The SAB states that it has insufficient information to comment on the existence or properties of "Novichoks".

In relation to Schedule 1 chemicals the SAB alerts Member States that certain schedule 1 chemicals – the chemical warfare agents sulfur and nitrogen mustard – may be present in industrial processes under certain conditions. Literature studies indicate that nitrogen mustards and sulfur mustards are utilized as captive intermediates in multi step synthesis more frequently than previously thought. Based on the same study the SAB concluded furthermore that if starting materials in industrial processes contain the respective precursor chem-

icals of nitrogen and sulfur mustards, both groups of schedule 1 chemicals may be formed as impurities when chlorinating agents are present. In the view of the SAB such mixtures pose no threat to the object and purpose of the Convention but may have to be addressed from a policy perspective.
The SAB has been following the discussions on chemical incapacitants for law enforcement purposes and is aware of concerns that have been raised about the possibility of such agents being used for purposes prohibited by the Convention. The Board discussed some of the scientific aspects and emphasized that labeling such chemicals as "non-lethal" is inappropriate, as toxicity is a matter of dosage for all chemicals. There also seem to be pronounced differences between animal species in the response to certain type of incapacitants. The SAB recalled some of the technical complexities regarding the safe use of such agents that have been reported in expert meetings. These findings include the variability in human response to potential incapacitants, which is due to a number of factors (age, gender, medical precondition etc.), as well as the problem of uneven dissemination during field use of any agent and the resulting difficulty to predict an actual dose for people exposed. Because incapacitants could become the subject of an investigation of alleged use, the SAB recommends that the OPCW should develop the necessary analytical capability to verify such toxic chemicals.

Verification Technology
The OPCW undertakes analysis of samples onsite as part of its inspection activities. In the view of the SAB the organization has demonstrated in the past five years that equipment and procedures are fit for purpose. Samples were collected and analysed regularly during chemical industry inspections. Further progress in sample preparation as well as analysis methods will reduce analysis time and increase the number of samples that can be analysed within the time constraints of an inspection. Analysis results are based on the OPCW Central Analytical Database (OCAD), which serves as the OPCW's reference library. The SAB is pleased that the contents of the OCAD have grown significantly in the past five years, extending the group of chemicals that can be identified during onsite analysis. However, the SAB emphasizes that strictly limiting the OCAD to the scheduled chemicals listed in the Annex on Chemicals may prevent inspectors from detecting other toxic chemicals with weapons potential, which may become necessary for example during an investigation of alleged use of chemical weapons.

Currently 22 laboratories are certified by the OPCW for the verification analysis of chemical weapons related samples. These designated laboratories would receive samples from an OPCW inspection where offsite analysis is considered appropriate, or in cases of investigations into alleged use of chemical weapons. They must provide analytical evidence for the presence or absence of chemicals that may be the subject of a potential violation of the Convention. Significant progress has been achieved in establishing analytical methods and identification criteria for the two schedules 1 toxins listed in the Annex on Chemicals, ricin and saxitoxin. In the view of the SAB, attention should be given also to the identification of non-scheduled or novel toxic chemicals. The SAB recommends preparing for scenarios, where there might be evidence of prohibited use of toxic chemicals but no scheduled chemicals can be found. In this context, the SAB considers the increasing availability of high-resolution mass spectrometers (HRMS) an important recent development. The ability to perform accurate mass measurements will assist substantially the analysis of new toxic chemicals that are not contained in analytical databases such as the OCAD.

The SAB is satisfied with the changes the OPCW made after the Second Review Conference to the annual proficiency testing that designated laboratories must undergo to keep their certification. The modified test format now accurately reflects samples that might be submitted for offsite analysis and addresses the concerns raised previously by the SAB. The Board however emphasizes that the logistics of offsite analysis – sending chemical weapons samples from an inspection anywhere in the world to designated laboratories whilst maintaining full chain of custody – should be exercised by the OPCW more regularly.

Another area of sampling and analysis is the analysis of biomedical samples. The Convention stipulates that for an investigation of alleged use samples should be collected from human and animal casualties. The OPCW has conducted three confidence building exercises since the Second Review Conference and worldwide capabilities for biomedical sample analysis have risen significantly. One key issue is criteria for trace level analysis: the target chemicals in biomedical samples may be present only in trace amounts and the evaluation of analysis results for such samples will require adaptations to the current acceptance criteria that were established for OPCW proficiency testing.

Regarding chemical forensics the SAB notes that only a small number of OPCW laboratories have undertaken activities in this area. The capability to identify attribution signatures to connect a toxic chemical or precursor to a particular source or production route has so far not been a focus of OPCW offsite analysis. In the view of the SAB extensive collaboration between institutions would be required to establish such a capability for the OPCW.

The SAB concludes that maintaining the designated laboratory network for offsite analysis has been successful, but is costly as well as resource intensive. Considering the developments raised in the four paragraphs above, the Board recommends a comprehensive review of the system to allow for an adaptation to new requirements and to ensure the OPCW's offsite analysis capability remains effective.

Assistance and Protection

Research is advancing in all areas of chemical defence but development and acceptance of robust and fieldable new methods and devices is generally slow. While there have been advances in relation to assistance and protection against chemical weapons, many challenges still remain. In addition to traditional developments, the last decade has seen a focus on first responder equipment. Because of an increasing concern that non-State actors may employ toxic chemicals, additional technical challenges have arisen in relation to detection, medical countermeasures, and decontamination.

The first line of defence against chemical weapons is detection, whereas depending on the measuring objective a device must have different characteristics (to warn of a toxic hazard, identify the chemical, monitor the extent of contamination, check the adequacy of decontamination, etc.). Detectors have generally become smaller and more selective and sensitive in the detection of toxic chemicals but there is still room for improvements in this regard as well as in ease of operation.

Developments in the field of medical countermeasures against nerve agents have been slow in the search of a broad spectrum reactivator of nerve agent inhibited acetylcholinesterase. An alternative approach has been the use of a scavenger to detoxify the nerve agent before it reaches its biochemical target, for which different methods have been investigated.

Improvements have been sought in physical protection against chemical warfare agents, notably in protective suits and respirators that exert lower physiological stress and which utilize nanomaterials for enhanced protection. New formulations for decontaminants have been tested, including the use of enzymes for detoxification. However, there is limited knowledge available regarding the efficacy of methods for the decontamination of public urban environments, and, systems and technologies developed for military use are not always fully transferable. The SAB recommends sharing of best practices in the protection against chemical weapons as part of OPCW international cooperation and assistance activities.

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Education and Outreach in Science and Techology

Education and outreach in science and technology is important to the Convention's future implementation. In the view of the SAB it is a critical element in preventing the re-emergence of chemical weapons and the misuse of toxic chemicals. Education and outreach serves a number of purposes, such as raising awareness about the Convention among the global scientific community, relevant industry, as well as civil society. The SAB stresses the importance of targeting professional bodies and academic institutions and recommends that outreach activities should consider the particular requirements of a region. The SAB furthermore recommends that education and outreach should be strengthened in the national implementation of the Convention through concerted partnership efforts by all stakeholders, coordinated and supported through National Authorities.

International courses of the Emergency Response Team of the DDPS

Dr. Beat Aebi

11 chemistry specialists of the Emergency Response Team of the DDPS (C-EEVBS) attend multi-day courses at regular intervals at the NBC and Self-Defence Academy of the German Bundeswehr in Sonthofen (ABC/SeS, Allgäu, D) . The exercises enable the simulation of various scenarios, e.g. a transport accident with dangerous chemicals or an illegal chemical warfare agent laboratory.

After the Sarin attack of the Japanese Aum sect in 1995, the Federal Council ordered that a specialist unit be raised. A disastrous attack like the one in Tokyo has fortunately not been repeated since. Current reports from areas of crisis , however, leave no doubt: time and again, terrorists do use chemicals to attack the population. In order to be able to respond rapidly and correctly, an intensive exchange of information is important with partners from both Switzerland and abroad. From a practical angle, regular training with realistic scenarios and efficient equipment stand to the fore.

Training of the C-EEVBS in Sonthofen

In October 2011, the C-EEVBS was able to participate in a course at the NBC Defence and Self-Protection School of the German Bundeswehr in Sonthofen (D, Allgäu). This training was organised by the German Federal Office of Civil Protection and Disaster Assistance BBK. It is responsible for equipment and training of the German NBC specialist unit called Analytical Task Force (ATF). The ATF forms the German counterpart to the cantonal NBC bases of the fire brigades in Switzerland. The chemistry specialists from Spiez were able to attend several exercises with the ATF. They were able to effectively apply their expertise and special detection equipment for chemical warfare agents and thus support the ATF. Because of this positive experience a further training week in Sonthofen was arranged. Here measuring techniques were extensively practised and perfected: A variety of dangerous substances and irritants were contained In 12 plastic tubes. Participants had to try to identify

Exercise with a mock illegal laboratory for synthesizing chemical agents

the unknown substances with the detection devices of the C-EEVBS. Sampling (gaseous, liquid and solid samples) was also practised in the open air at the depot for hazardous substances.
Several exercises followed at the Bodelsberg military training area, a former Pershing missile base. At the former guardhouse all anticipated installations for illegal production and dissemination of chemical warfare agents had been perfectly copied. A large number of open and closed chemicals, glassware, transport containers, written documents and other evidence of criminal activities constituted a daunting task for the participants. They had to swiftly gain an overview of the situation, localise the final products of the synthesis, take several samples of these and pack and label them safely too. Their actions were recorded in writing, photographed or video filmed.

Furthermore, an operational exercise was conducted at Bodelsberg in the open air. A tilted truck and its surroundings (25m x 100m) had to be examined and tested for the presence of chemical warfare agents. No chemical warfare agents could be used for this exercise. To ensure that the exercise could still be carried out realistically, small amounts of chemically related pesticides were used. Participants were able to locate and test all contaminated spots quickly. The training options at Sonthofen for C-EEVBS training are outstanding. Under the operational lead of Lieutenant Colonel Matthias Arnold and the scientific lead of Government Director Dr. Manfred Metzulat as well as the support of the staff the training weeks could be successfully conducted. Because of these advantageous circumstances another training session in Sonthofen is planned for 2013.

Preparing for a mission

EEVBS

The C-DDPS Operations Team is operational since January 1st 2010. It originated from the DDPS Operations Team which has existed for 10 years andconsists of some 20 voluntary specialists from SPIEZ LABORATORY and the NBC-EOD Competence Centre of the armed forces. The operational concept of the unit is aimed at giving the local task forces support as rapidly and efficiently as possible. Task forces include chemical hazard, fire, police and ambulance services.

The team is alerted by the National Emergency Operations Centre of the FOCP and is available around the clock. An expert adviser is able to consult operations management by telephone. On location the team leader can support the operations management as required. The measuring and sampling team consists of three specialists and can begin operations in the contaminated area within a few minutes.

The radiological response team (A-team) brings together the existing emergency response organizations of SPIEZ LABORATORY and the NBC-Centre of Competence. The biological response team (B-team) will be at the ready once the new biosafety laboratory BSL4 in Spiez is operational.

Personnel and material of the DDPS Emergency Response Team can be deployed with modular vehicles, equipped with advanced measuring and communication equipment.

IUPAC-workshop in Spiez

Dr. Beat Schmidt

From 20 - 23 February 2012, the international IUPAC Workshop on Developments in Science and Technology was held at the NBC Centre in Spiez. 80 experts from 25 countries discussed challenges that could have an influence on the Chemical Weapons Convention (CWC), e.g. the convergence of chemistry and biology, advances in synthetic and analytic chemistry or the advances in chemical safety.

Cause for the IUPAC International Union of Pure and Applied Chemistry Conference was the coming CWC Revision Conference (RevCon) in April 2013. The workshop programme was compiled by the National Research Council of the National Academies (NAS) as commissioned by the IUPAC in cooperation with the OPCW and SPIEZ LABORATORY.

For the CWC member states the RevCon provides an excellent opportunity to fundamentally evaluate and, if necessary, reinforce the treaty. A particular emphasis is laid on new scientific and technological threats, and suitable measures are passed if required. As these are political decisions that have to be made by the consensus of the 188 state parties to the CWC, it is a struggle for small advances. For the RevCon to be successful it is therefore essential, that new technological challenges are presented in a concise and well-founded manner. The report from the IUPAC workshop is an important instrument for the OPCW and its member states for channelling the decisions of the authorities in the right direction. It is in the interest of Switzerland that as an organisation the OPCW emerges strengthened from these negotiations, as all forms of chemical weapons should remain banned in the future too.

In his opening speech, the director general of the OPCW, Ambassador Ahmet Üzümcü underlined the importance of the RevCon for the future focus of his organisation. 70 % of reported chemical weapons stocks had been destroyed since the beginning of the CWC agreement. To keep the organisation fit for the future, a total world-wide ban on chemical weapons would have to remain assured. But precisely the emerging disciplines in science and technology might lead to the renewed misuse of the toxicity of chemicals.

From the workshop discussions it became clear that advances in science and technology present a clear threat, but that humanity also benefits from the new achievements. New findings in synthetic and analytical chemistry, the global change in chemical industry and the advances in chemical safety are generally to be welcomed. But at the same time, structures must be improved so that these advances are accessible and usable for all regions.

In November 2012, the revised final report of the IUPAC-workshop in Spiez could be handed out to all CWC delegations at the seventeenth State Conference in the Hague.

Participants and organizers of the IUPAC-Workshop in Spiez

Integral testing of C protection suits (ICP)

Dr. Patrick Wick

For over ten years, SPIEZ LABORATORY has been integrally testing C protective clothing. This established method helps to select suitable C protective clothing and demonstrates their performance. In 2012 four C protection suits were tested: the over 20-year old Cesar chemical protection suit (CH), the new C protection suit for the chemical safety laboratory in Spiez, the new Zodiak decontamination suit as well as a complete EOD system with integrated C protection.

As part of the individual protection equipment (IPE) a chemical protection suit consists of several components. The protective effect of the entire gear is determined by the quality of the individual protection components, but also by their interaction. It is thus indispensable, that apart from checking the individual elements, to test the overall system integrally too.

For several years, SPIEZ LABORATORY has had at its disposal a corresponding test installation (MIST chamber) and offers, in addition to the classical gas test, a corresponding aerosol test. This method was originally developed for permeable protective clothing that absorbs harmful substances with activated carbon. Impermeable protective clothing, however, can also be tested.

In 2012, four different types of suits were tested that differ greatly in their technology, application and manufacturing date.

Cesar chemical protection suit
The Cesar chemical protection suit consists of two parts that are still lined with activated carbon foam – it is the predecessor of the CSA 90 chemical protection suit currently used by the Swiss Armed Forces. After storage for more than 20 years, it had to be established whether the suit still satisfies current requirements and can be used for operations. At the time when the Cesar chemical protection suit was fielded, integral testing had not been available yet. That made it all the more interesting to compare it with the CSA 90 model.

Integral testing as well as the examination of material samples on the new installation in Spiez for combat agent resilience testing (YPAP21) provided gratifying results. Resilience of the suit to chemicals and thus its protective performance showed no significant change. Therefore, the operational capability of the Ce-

Members of a police Explosive Ordnance Disposal (EOD) team talk in front of a model aircraft during an explosive disposal training exercise with a U.S. Army EOD team at Kimpo Airport in Seoul May 16, 2007.

sar suit is still assured even after prolonged storage. In comparison with the CSA 90 the Cesar chemical protection suit was only slightly inferior. Its disadvantages lie in the greater thermal insulation by activated carbon foam and the minor wear comfort due to the rigid material.

Chemical protection suit for the safety laboratory

A new chemical protection suit (CSA HT) for highly toxic compounds that is to replace the CSA 90 was evaluated for use at the chemistry laboratory in Spiez. It is based on a similar technology as the CSA 90 (Saratoga®). Comparison with the CSA 90, however, clearly revealed the technical advances of the past 20 years: The new model is also a two-piece, consisting of jacket and trousers which can, if needed, be connected with a 'sand/aerosol stopper'. The suit is designed for warm climate zones and is, therefore, easy to wear.

The overall protection factor is ten times higher than that of the CSA 90. For the first time, a suit was tested twice over a three-hour period. The test method destroys permeable suits as their activated carbon is increasingly saturated. The second measurement reproduced the overall result very well, but also clearly demonstrated the local variations. The Individual Protection section has worked out an evaluation method that will in the future allow us to obtain significant results even at low material costs.

Zodiak decontamination suit

Two systems were tested in collaboration with the Military Science Institute for Defence Technologies - NBC Protection (WIS) in Munster. Zodiak is used by the German Bundeswehr as decontamination suit. Revision of the system to adapt it to the new M2000 respirator necessitated a test. This impermeable two-piece suit without activated carbon is practically airtight due to a sophisticated sealing system and, therefore, suitable for the test.

Both systems show surprisingly high overall protection factors, although the new system turned out to be significantly better. The protection factors are comparable to that of an active carbon lined permeable suit. That it is merely a practically airtight suit was clearly evident from the distribution of the measured values. As expected, the measurements gave lower protection factors at the jacket-trousers and mask-suit interfaces.

EOD system

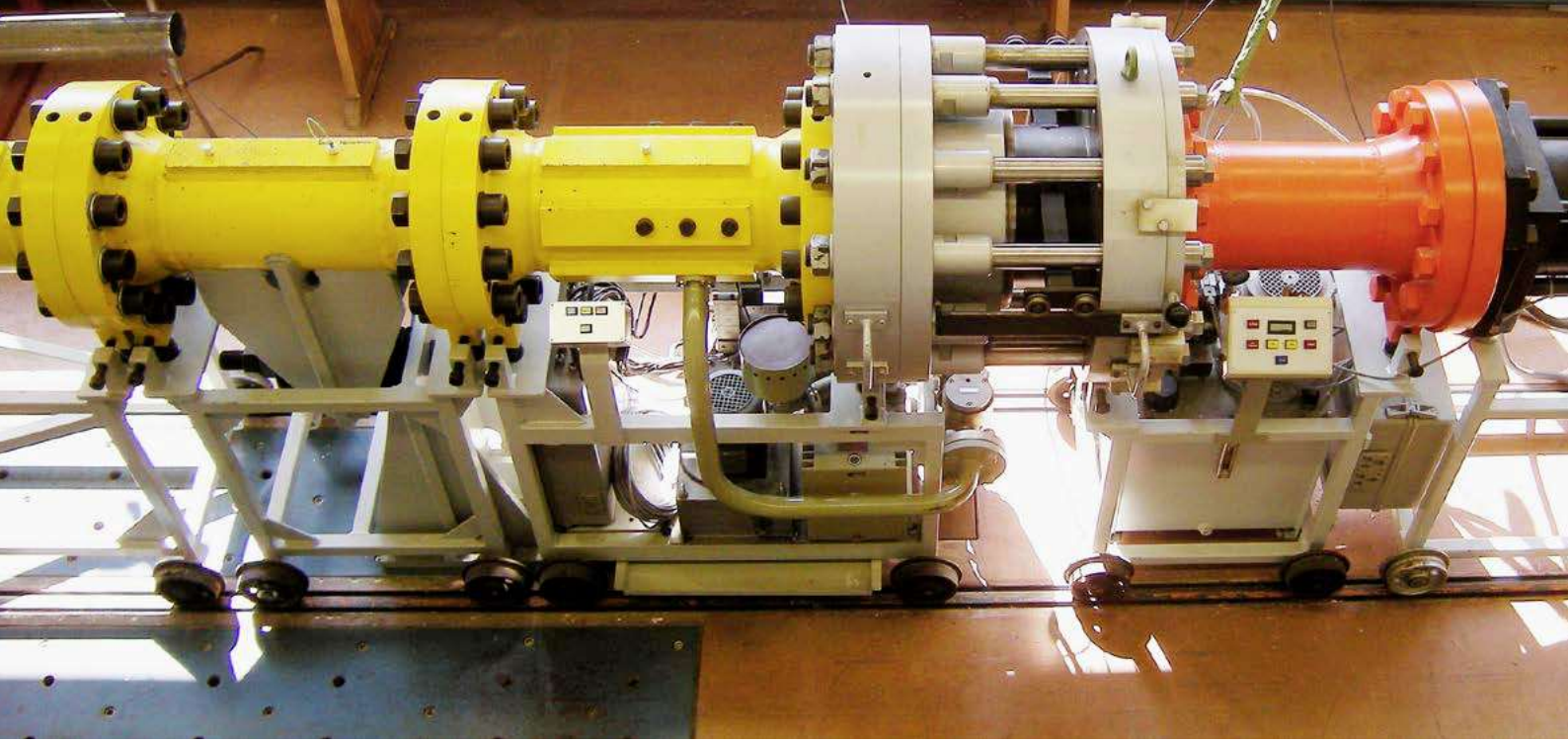
As innovation, explosive ordinance disposal staff are not only to be protected against the effects of an explosion but also against combat agents. The German Bundeswehr is procuring a new EOD system (explosive ordnance disposal), which is newly is equipped with C protection (undergarment) and is carried with a filter fan device.

If possible integral testing should duplicate field conditions. Therefore, the standard movement programme for test persons incorporated various activities such as walking, climbing, crawling and resting. The movement programme had to be adapted for this special test. It reproduces approaching, exposing and defusing a bomb:

- Mounting and descending a step (5')
- Shovelling sand and gravel (10')
- Sitting down, ballpoint pen at hand to the left and the right of test person, picking it up and setting it down (5')
- Conduct of washer test (5')
- Laying it on the ground (5')

For metrological reasons a two-hour programme had to be conducted. This is considerably longer than the usual duration of a mission and stretches the physiological limit of a test person. Although breathing is supported with ventilation, the heavy equipment in conjunction with the reduced thermal exchange almost completely exhausted the test person. With these the measurements, however, it was possible to demonstrate the impressive effectiveness of this C protection EOD system well.

EOD protective suit



Air Blast Simulation

Establishing an air blast-profile database on the research shock tube

André Zahnd

Over the years, a large amount of data and information has accumulated on air blast profiles that could be generated with the research shock tube. This data has been reorganised as a database to ensure swift service of clients in the future and to demonstrate in a simple fashion the manifold air blast simulation options SPIEZ LABORATORY has at its disposal.

The study of the consequences of weapon impact, namely the mechanical effects of explosions, has a long tradition in SPIEZ LABORATORY. It began in the sixties, when the nuclear weapons threat appeared to be omnipresent. In a first step, a theoretical basis was established, followed by the capacity to carry out mechanical simulations with shock tubes and finally computer simulations. SPIEZ LABORATORY repeatedly adapted its activities to the changing requirements. Thus, the research shock tube installation was developed and realised in 1980. It is a modular shock tube which can be used for simulating a correspondingly wide range of air blast situations. Until the end of the nineties, it was used for various research projects, for example investigations into the propagation of air blasts through tunnel systems or in the ground .

In the mid-nineties, work began on simulating conventional air blasts and the installation has been used since for testing NBC protection components. The air blast profiles generated here range from 0.25 to 80 bar peak reflected overpressure and result in correspondingly positive pressure impulse density of 0.3 to 220 bar*ms. To date, demands in this field are increasing continuously and this trend will continue, in particular due to the changing operational possibilities of certain products. These new requirements call for a centralised collection and management of data of the air blast profiles that have been established up to now.

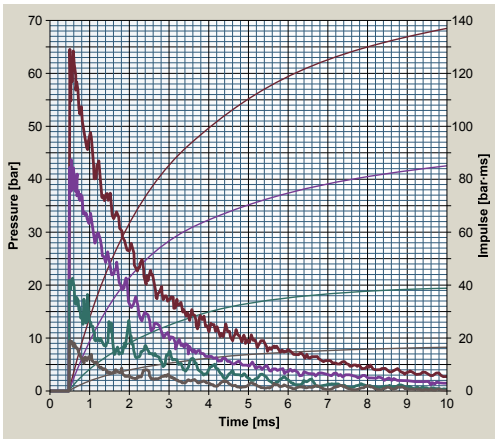
To establish the database, all particulars existing in paper were collected, reviewed and sorted. The interpretation and allocation of individual data proved to be relatively difficult as quite a lot of expertise could only be reconstructed with difficulty due to the absence of former personnel. Based on individual enquiries to some clients, it it was possible to clarify the points of departure and close gaps in the

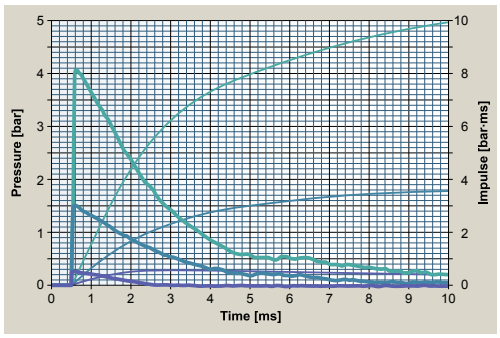
Propagation tube, locking device and driver tube of the shock tube

documentation. After more than 20 different air blast profiles were evaluated, the configurations for the simulation of the air blasts could be implemented into the database. On the basis of relevant requirements, each of which describes a certain blast profile with a minimum peak reflected overpressure at the shock front and a minimum positive impulse, the precise shock tube configuration was established or evaluated. Through this process detailed sketches were made that provide information such as tube configuration, length of driver-tube, diaphragm material, alignment and position of pressure gauges for both calibration shotsand test composition. Measurements were evaluated anew for all profiles and experiments were repeated to validate existing data or to close certain gaps.

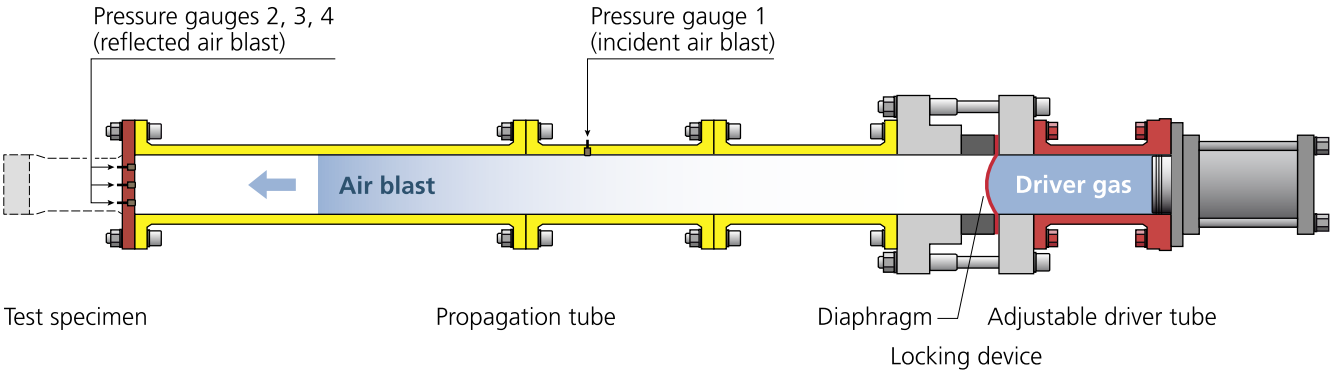
Today the Collective Protection section has an instrument at its disposal that documents all recurrent air blast profiles of the research shock tube to date and will be able to integrate future new profiles efficiently. Each air blast profile provides information on technical requirements, components used, valid basic experiments, the latest experimental evaluation of the calibration shots, etc.

The new air blast profile database enables a swift mode of operation for serving clients and documents our present expertise. Future blast profiles will be augmented and their extent of documentation is clearly defined. Furthermore, it will be possible for control systems and measuring software to adopt and use existing data in the future.





Air blast profiles generated by the research shock tube



Testing and quality assurance of polymers

Christian Krebs

Moulded parts or semi-finished parts consisting of polymers are delivered by the manufacturers with factory certification. It has become evident that these factory certificates have to be checked. Although most companies have certified their produce, it is important to test both series and specimen parts. The purchaser must already lay down the specifications and test plans when ordering the merchandise. The problem is that the buyer does not know what has to be prescribed. The following explanations reveal what should be done in the respective case and what options exist in the field of polymers.

The manufacturers of moulded parts and semi-parts consisting of polymers (thermoplastics, thermoplastic elastomers, duromers and elastomers) are increasingly under financial and time pressure. During a debate in November 2012 at the Swisstech in Basel, various entrepreneurs made the following statement: 'In a time of diminishing margins and tough price negotiations, it is important to offer high quality niche products, as there is no air left for unnecessary expenditures'. So it is obvious that no additional tests are planned for polymer products that are delivered by certified manufacturers. On the other hand, high-quality niche products are to be produced. This can be achieved with polymers by correctly applied quality assurance during and after production.

The characteristics of polymers are greatly affected by how they are processed. The production of moulded parts and semi-parts consisting of polymers is subject to strong economic pressure today. The agent processing the material has to buy the raw material (granules or rubber mixture) at a fixed price. In most cases, the tools required are very expensive. So an agent can only enhance earnings through processing, by keeping the cycle time as short as possible and thus being able to produce more parts within a certain unit of time. He is able to reduce the length of the cycle for instance by more rapidly cooling a thermoplastic. More rapid cooling, however, generates internal stress in the mould part. Too high internal stress may cause fissures and thus weaken the material in practical use. A reduction of the cycle time may spell insufficient vulcanisation in the case of elastomers. Insufficiently vulcanised elastomers may lead to less operational suitability. Thermoplastics can be severely damaged by inadequate processing; when

too high processing temperatures are applied, the material being moulded remains in the cylinder for too long (syringe volume too large for dedicated mould) or the selected injection speed is too high.

The destruction of macromolecules or high internal stress in the moulded part can usually not be perceived externally and damage cannot be detected by checking the weight of the moulded part or measuring its hardness.

It is therefore indispensible to continually monitor the quality of the produced moulded parts while processing polymers and that recipients or processing agents apply respective tests to each batch.

Testing for optimum processing means:

Thermoplastics/TPE: Determining melting index difference between moulded part and semi-finished part to moulding compound (granules). Moulded part and granules are not allowed to differ by more than 5 %. Moulded part and granules must be taken from the same batch. Furthermore, it must be established that the moulded part has no internal stress (internal stress test, however, only for themoplastics)
Duromers: Verification of optimum hardening process by determining the glass transmission temperature Tg. Possibly mechanical features.
Elastomers: Verification of optimum vulcanisation by determining the compression set.

Furthermore it should be established for every lot that the same material or the same mixture (in the case of elastomers with thermo analysis TGA) was always used.

The buyer of moulded parts and semi-parts should also take note whether the processing agent, when purchasing his moulding compound, does a minimum input check by subjecting the delivered moulding compound to respective tests. As in many cases, the moulding compound (granules) can no longer be directly purchased from the manufacturer, but via intermediaries, supplies may be confused. In medical technology products the factory certificates have to be verified by the manufacturer of the moulding compound by having an accredited laboratory test the delivered granules.

If these examinations or analyses are applied to every lot or consignment it is warranted that mould parts or semi-parts have been optimally processed and their practical use is guaranteed or that always the same high-quality material was delivered throughout the production process.

In order for a product to be traceable, it is also very important that the moulded parts and semi-products are durably marked with manufacturing date, material abbreviation and manufacturer's code.

The processing agent is obliged to register his processing parameters and to archive these for at least ten years. In the case of thermoplastics it is important that a respective sample of every moulding compound lot is kept for ten years. This makes it possible to retrace the product (e.g. in the event of damage.

It is also worthwhile to conduct minimum tests on commercial consignments of moulded parts consisting of plastics or elastomers to ensure that they have been processed optimally and consist of the right material. Especially in the case of elastomers optimum vulcanisation should be metrically verified.

The material testing working group at SPIEZ LABORORATORY has the respective knowledge and experience to consult the procurement and technology agencies of federal offices in quality assurance when procuring moulded parts, semi-parts and modules consisting of plastics and elastomers. If all required quality assurance measures are formulated prior to any order and communicated to the supplier, it is possible to obtain without difficulty plastic and elastomer products in the required and constant quality throughout the entire production period. A corresponding example was the procurement of the NBC 90 protection gear (masks, gloves, over-boots and C protection suit) in the nineteen-nineties.

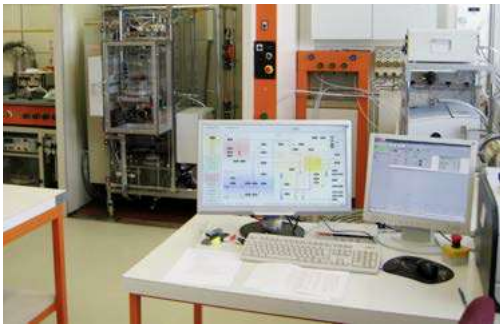
Testing the absorption capacity of respirator filters to protect against harmful industrial gases

Andres Wittwer and Roland Liebi

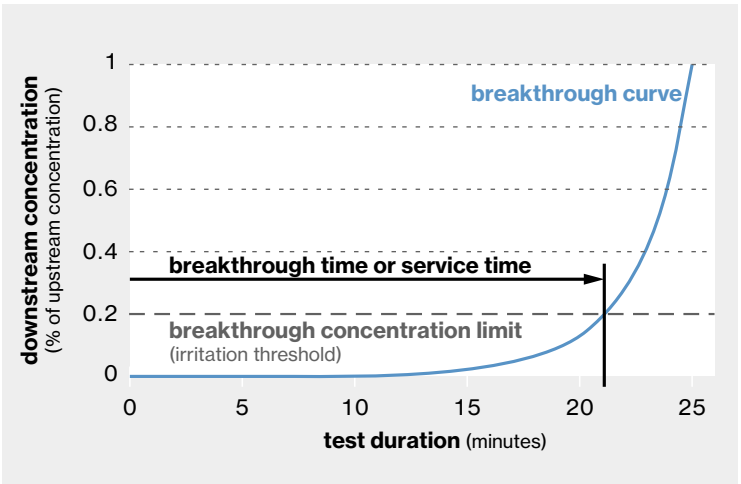
The demand for test options for respirator filters has been increasing for years in parallel to greater safety and work hygiene requirements with regard to various harmful substances. SPIEZ LABORORATORY has revised and expanded its test facility and is able to fully satisfy present customer requirements.

Within the context of comprehensive civil protection the focus is on the protective effect of respirator filters against a large number of air pollutants that exceed the range of military NBC protection (combat agents). Because of the greater demands as regards safety, work hygiene and environmental protection as well as the new corresponding standards, testing the absorption capacity of respirator filters to protect against harmful industrial pollutants is in higher demand than ever before. The number of test laboratories capable of performing such tests, is decreasing.

After more than 20 years of operation, the enlarged and with regard to automation extensively renovated test facility could enter service at the end of May 2012 under the designation of 'TICSA' (toxic industrial chemicals absorption apparatus).



Expanded facility for testing respirator filters



The filter testing principle is quite simple: acclimatised air, polluted with a test gas, is drawn through the filter that is to be tested. After the air has passed through the filter, measurements are made to establish how long it takes for the test gas to breach the filter and reach a concentration that presents a health hazard.

Unfortunately, there is no equally simple answer to the question ' how long does such a filter provide protection?'. Rather, the following further questions arise:

- against what substance, what concentration?
- rate of air flow (rate of breathing, physical performance, type of mission)?
- Climate: Air temperature and humidity?
- Filter type, class, product?

Therefore, the test facility must allow a precise setting of all these parameters in order to obtain reliable results or establish dependencies. It should also be possible to work with all conceivable, possibly even highly toxic, inflammable and corrosive test gases (air pollutants).

Accordingly, suitable materials had to be used, safety elements integrated and safety concepts realised for revising the filter test facility. All instruments suitable for controlling the dosage of the test substance and its detection had to be integrated. Finally, the new installation also offers a comprehensive and secure data recording system which enhances test evaluation.

Testing of NBC respirators – comparative measurements

Dr. Patrick Wick

Overall leakage of NBC respirators can be determined with various methods. SPIEZ LABORATORY uses Helium as test gas, the WIS/Munster uses a sodium chloride aerosol as test substance. Both methods do not satisfy the industrial norm for determining overall leakage of integral masks and were compared in parallel measurements, during which one protective mask was examined that had a pre-defined leak. The results were surprisingly congruent.

The objective of the examination was to compare various test methods to determine leakage of NBC respirator masks in collaboration with the WIS/Munster and possibly detect differences between a method that uses gas from one that is based on aerosol.

SPIEZ LABORATORY uses helium as test gas which is measured by mass spectrograph (see 2009 annual report). This method corresponds to no standardised method according to EN136, but in setup and procedure corresponds to the norm. The EN136 standard prescribes the use of sulphur hexafluoride (SF6) or a sodium chloride (NaCl) aerosol.

WIS/Munster uses a NaCl aerosol for its measurements. For determining the concentration it has recently used a particle counter (FMT) contrary to EN136 requirements. Apart from this, both institutes use PortaCounts®, which are used to adjust the protective mask to the individual carrier. It is a device that counts the number of particles in the air.

The test structure entails connecting a Sheffield test head and an artificial lung that has a breathing volume of 2l and 20 breaths per minute. The test mask, a German M65, was hermetically sealed to the head with putty. Holes of varying diameter had been drilled into the eyeglasses of the masks enabling the comparison of a wide range of protection factors. Prior to measurement, the test setup was checked with the PortaCount® in order to exclude systematic deviations between the two laboratories.

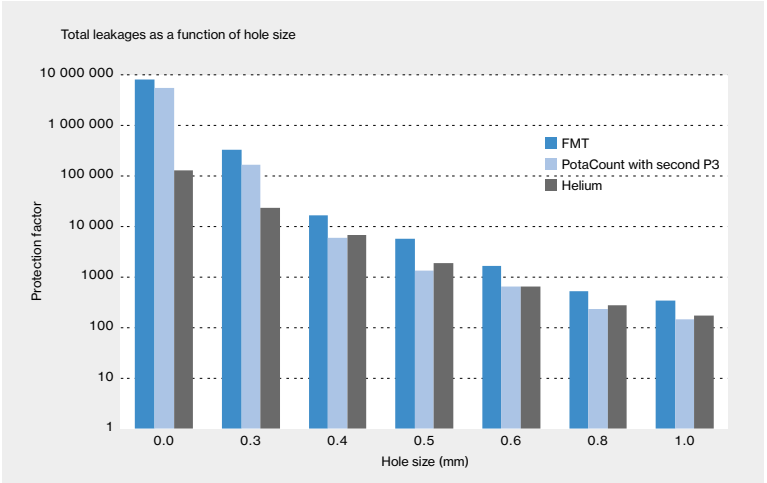
The results showed a very good agreement between the various methods. With helium, however, much lower protective factors were measured than with an aerosol. This applies particularly to higher protective factors. The

Determining the overall leakage of NBC-respirators

difference was clear with the mask that had been hermetically sealed with putty. While the aerosol method reaches the limit of its performance capacity, as only individual particles are measured, appreciable amounts of helium can still be detected in the mask with the helium method.

Where this divergence comes from is presently unclear and the object of further investigations. For respirators that must satisfy EN136 standards this deviation is irrelevant, as the minimum protective factor is 2,000x and the methods correlate well in this range. In the military realm, however, a much higher protection performance is demanded, in particular where aerosols are concerned. It could become evident that for high performance respirators a new distinction will have to be introduced, whether the protective factor measured serves to protect against an aerosol (B threat) or a gas (C threat).

Calculated protection factors measured by the different methods for the same hole diameters



Revision of NBCN reference scenarios

Dr. Andreas Bucher

Since 2006 the reference scenarios developed by SPIEZ LABORATORY have been serving as foundation for implementing the 'National NBC Project' and the 'NBC Protection Switzerland' strategy. As innovation the scenarios also serve the Federal NBCN Crisis Management Board as a precautionary planning instrument. In 2012, the existing catalogue was augmented with further scenarios and subjected to a systematic risk assessment procedure. This allowed a uniform assessment of the entire range of dangers in Switzerland.

Scenarios that serve as a risk-based foundation for planning have to be evaluated regularly. They are developed to supply a current overview of the sequence of an incident and to provide substantial information on what effects are to be expected as regards health, environment, infrastructure, economy and society. Within the context of a comprehensive revision, the 2012 NBC scenario catalogue has been extended and augmented with selected scenarios relating to natural dangers (N). The catalogue now comprises the following scenarios: (see table left)

A1	Nuclear power plant accident*
A2	Radiological bomb
A3	Nuclear weapon explosion close to the Swiss border
A4	Attack against a transport with highly radioactive waste *
B1	Attack with B toxin
B2	Attack with pathogen viruses
B3	Attack with anthrax
B4	Pandemic – new yet unknown germ
B5	Pandemic – influenza
B6	Animal disease – outbreak of FMD in Switzerland
C1	Attack/accident against/during transport
C2	Accident in stationary installation of chemical plant
C3	Attack with toxic chemicals
C4	Attack with C combat agent
C5	C-weapon attack against Switzerland
N1	Earthquake
N2	Storm
N3	Flood

*as of end of 2012: Scenarios A1 and A4 are still being elaborated by the Swiss Federal Nuclear Inspectorate ENSI

At the request of the cantons, a uniform risk assessment was made for all scenarios. The method applied was developed by the Risk Foundations section and the Research Coordination agency of the Federal Office for Civil Protection FOCP in collaboration with Ernst Basler + Partner Ltd (Switzerland). It is based on former threat analyses relating to civil protection, i.e. KATANOS (FOCD, 1995) and KATARISK (FOCP, 2003). In addition, comparable studies from other states were taken into account (e.g. BBK, 2010; Cabinet Office, 2012; Department of Homeland Security, 2011).

Risk assessment is based on a method that allows us to determine different threats through a uniform procedure and to compare them in a comprehensible manner. The comparison of threats is a useful working basis for civil protection as it faces a variety of dangers and is obliged to efficiently deploy its limited resources.

For risk assessment, the probability of occurrence is established for each scenario (W) and its effects (A) are determined. By multiplying W with A, you obtain the specific risk (R) for the respective scenario. Transferring the values for

the individual scenarios into a common risk matrix allows comparison of the various scenarios and the probability of their occurrence. This comparison also serves as basis for prioritising threats: The Federal NBCN Crisis Management Board is not able to address all existing scenarios simultaneously, but has to set priorities. In its 2012-2016 prevention cycle the Federal NBCN Crisis Management Board will address the following scenarios: 1. earthquake, 2. nuclear power plant accident, 3. dirty bomb, 4. pandemic.

Information on the frequency of occurrence and the impacts of scenarios is based on incident analyses, statistics, literature, other scenarios etc. Where information is lacking – for instance, the considerable uncertainties as regards the extent of effects or the frequency of occurrence or plausibility of scenarios – such issues are assessed in group debates by experts. These expert panels follow a modified form of the Delphi questioning procedure that enables efficient approximation and consolidation of estimates. In the case of natural or technological dangers the probability or frequency of a scenario occurring is determined as precisely as possible on the basis of statistics or expert estimates. Where estimation by points is impossible, the probability of occurrence is allocated to a logarithmic class.

Intentionally caused incidents (e.g. attacks) cannot be described in terms of frequency. Here the plausibility of occurrence within the next ten years is estimated on the basis of subjective probabilities (technical feasibility of an attack, effects attained, likelihood of success from the viewpoint of the attacker, precedent cases etc.). In analogy to the probability and frequency classes, intentional incidents are allocated to a plausibility class.

The aggregated extent of damage results from adding up the effects of an incident in monetary value across all indicators. For this, a monetary value is allocated to each indicator unit. The cost limit is determined for each indicator, i.e. the amount in money that society is willing to invest for reducing an indicator's extent of damage by one unit (KATARISK 2003). In this way, the entire damage extent of an incident can be portrayed in the matrix:

- Persons (BV Art. 10, 57, 58, 61)
- Environment (BV Art. 2, 76-79, 104)
- Economy (BV Art. 26, 54, 61, 100-102)
- Society (BV Art. 2, 5, 7-36, 41, 52-53, 57-58, 69, 78)

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The number of reference scenarios has deliberately been limited. Never the less, they do well to cover the range of threats and dangers from accidents and natural disasters to terror / sabotage and incidents related to political power play.

FOCP (2003) KATARISK. Disasters and emergencies in Switzerland. A risk assessment from the viewpoint of civil protection, Federal Office for Civil Protection (FOCP), Bern.

FOCP (2010) Risk aversion: a contribution to systematic risk assessment. Federal Office for Civil Protection (FOCP), Bern.

FOCP (2012) KATAPLAN guidelines – Cantonal threat analysis and emergency precautions (in preparation).

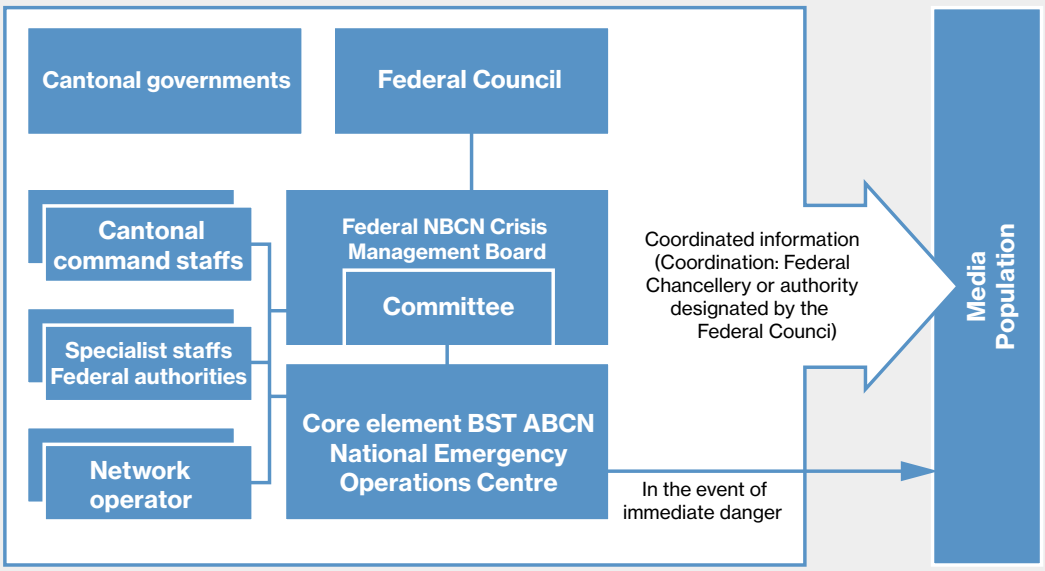
BZS (1995) KATANOS - Disasters and emergencies in Switzerland. A comparative overview. Federal Office for Civil Protection (FOCD), Bern.

Cabinet Office UK (2012) National Risk Register for Civil Emergencies, 2012 Edition.

Cabinet Office UK (2012) National risk register for civil emergencies, 2012 edition.

Department of Homeland Security (2011) Strategic national risk assessment. The strategic national risk assessment in support of PPD 8: a comprehensive risk-based approach toward a secure and resilient nation.

Emergency organisation in the event of NBCN incidents with national implications



The organisation of national NBC protection

Dr. Marc Kenzelmann

Within the context of implementing the Swiss NBC protection strategy new actors involved in national NBC precaution and incident management have emerged with coordinating and over-riding tasks. This has also changed the national profile of all organisations involved.

By prescribing the implementation of certain aspects of the 'National NBC Protection Project' or the 'Swiss NBC Protection Strategy', the Federal Council has laid foundations for uniform and goal-oriented NBC incident management in Switzerland. These Federal Council decisions are also supported and implemented by the cantons. The prescribed or recommended structures for implementing national NBC protection were created in 2007 and are, while taking current developments into account, correspondingly being realised. The Security Policy 2010 Report (SIPOL 2010) also takes the federal character of competencies in Switzerland's security areas into account, in that it demands the creation of a body, whose structure entails equal representation, in the form of the Consultation and Coordination Mechanism of the Swiss Security Network (KKM SVS).

Afterwards, two essentially new actors for NBC precaution were established in 2011 and 2012:

1. The Federal NBCN Crisis Management Board (BST ABCN), that according to the NBCN Operations Ordinance of 1 January 2011, Art. 5, assumes the following duties in NBC precaution: it provides scenarios for precautionary planning, coordinates precautionary planning for managing NBCN incidents with national implications, coordinates training for managing NBCN incidents and checks operational readiness through regular exercises. The BST ABCN is thus the strategic-operational body for Swiss NBC precaution. The NBC Precaution organisation, as part of the BST ABCN, is directed by the National Emergency Operations Centre (NEOC) as its permanent core element and also has structures that entail equal representation (delegates from both Confederation and cantons).

2. The KKM SVS, in service since June 2012, also maintains a permanent NBCN expert group consisting of representatives from the

Federal Committee for NBC Protection (KomABC), the NBC coordination platform of the cantons (KPABC), the BST ABCN and the Steering Committee for Interventions Relating to Natural Dangers (LAINAT). This strategic expert group does not convene frequently, follows the operational work relating to precaution of Confederation and cantons and serves as 'access window' to the KKM SVS for issues that have to be addressed at the political level between Confederation and cantons. Therefore, the KKM SVS provides politico-strategic supervision in NBCN matters and addresses, in particular, questions relating to the financing of posted and passed measures. Correspondingly, it is drafting a decision to be passed at the level of Federal Council and cantonal government conferences.

The KomABC thus has gained the following new role within the current structure of NBC precaution:

As independent advisory committee of the Federal Council that unites representatives from Confederation, cantons, research, industry and civil protection task force organisations, the KomABC is a specialist committee whose task consists in supporting (with experts) and, if necessary, revising the precaution process. In particular, the KomABC is permanently represented in the 'NBCN Precaution Cell' of the BST ABCN as well as in the NBCN expert group of the KKM SVS. As advisory committee of the Federal Council, the KomABC is also tasked to observe the interaction of all actors and to draw attention to any weak points.

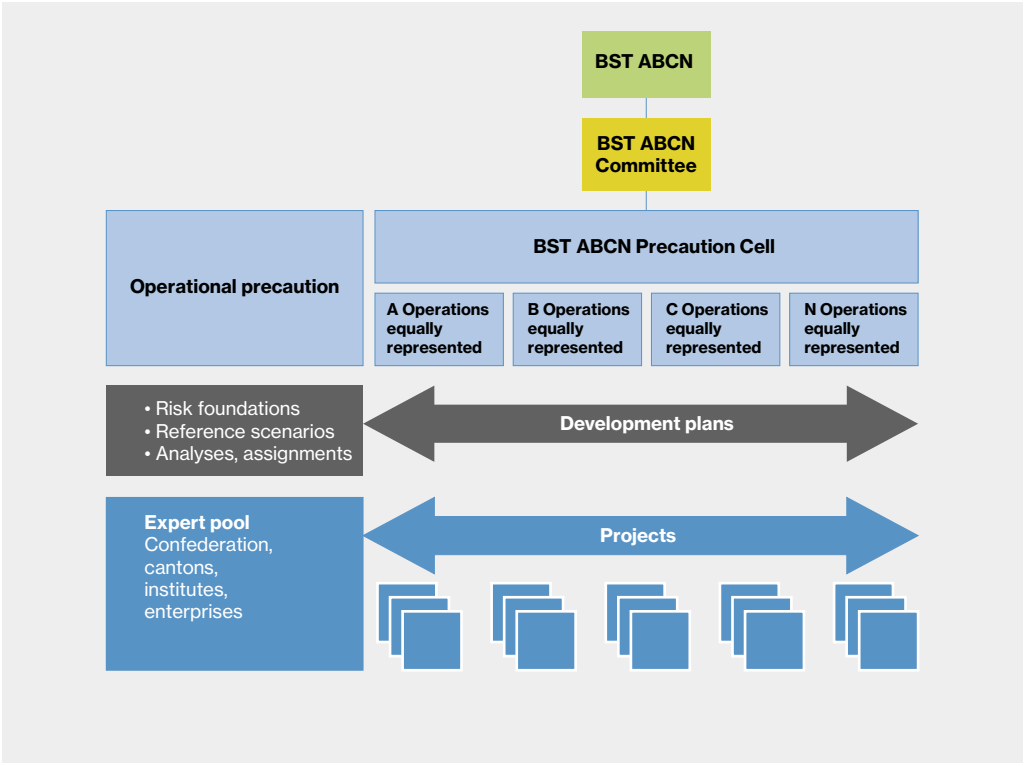
The established, operational as well as specialist contacts and cooperation relating to NBC and N continue to exist. They constitute what are known as technical service bodies and means.

Current challenges

The newly established structure of national NBC protection will be greatly promoted in the years to come. It will be obliged to coordinate and efficiently implement the measures prescribed by the Federal Council from the following reports, while the KomABC will monitor this work closely:

- Report of the Inter-Departmental Working Group for the Revision of Emergency Protection Measures in the Event of Extreme Events (IDA NOMEX),
- Report of the KomABC on Precaution and Management of NBC Incidents (consensus paper),
- Report of the Federal Council on the 2015+ Civil Protection and Civil Defence Strategy as Regards NBC Relevant Topics.

The 2013 ODYSSEUS national emergency exercise (GNU) will provide a first opportunity to test the interaction of all actors. The exercise comprises the joint management of an incident by all actors at all levels after radioactivity has escaped from one of the Swiss nuclear power plants.



Precautionary planning within the Federal NBCN Crisis Management Board (BST ABCN)

Staff

SPIEZ LABORATORY
Director: Dr. Marc Cadisch[2)]

Secretariat: Irma Lehnherr
Staff: 2/Stellen: 2

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Dr. Béatrice Balsiger
François Byrde
Dr. José Corcho
Dr. Emmanuel Egger
Ruth Holzer
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André Pignolet
Dr. Stefan Röllin
Hans Sahli
Thomas Sarbach
Marc Stauffer
Dr. Christoph Wirz

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Dr. Daniel Kümin
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Jasmine Portmann
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Fritz Wüthrich

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Dr. Walter Aue
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Fausto Guidetti
Roland Kurzo
Dr. Urs Meier
Benjamin Menzi
Dr. Martin Schär
Dr. Beat Schmidt
Andreas Schorer
Dr. Peter Siegenthaler
Andreas Zaugg

NBC PROTECTION TECHNOLOGY SECTION
Staff: 12/FTE: 12
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Thomas Friedrich
Markus Gurtner
Lukas Gyseler
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Angelo Seitz
Dr. Patrick Wick
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André Zahnd

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Head: Mauro Zanni[2)]
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Remo Bigler
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Lisa Brüggemann
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Pia Feuz
Béatrice Gurtner Kolly
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Katharina Imobersteg
Felicitas Jegher
Hans-Ulrich Kaderli
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Nelly Kupferschmid
Beat Lörtscher
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Miranda Müller
Klaus-Nestor Perrollaz
Eveline Rogenmoser-Nguthu
Nicole Rothenbühler
René Scherz
Hans Schmid
Isabelle Strasser
Marianne Tadmoute
Roger Tschirky
Marianne Walther-Leiser
Alexander Werlen[2)]
Marianne Wittwer
Rosmarie Zahnd

STRATEGY AND COMMUNICATION
Staff: 1/FTE: 1
Dr. Andreas Bucher[2)]

DDPS RADIATION PROTECTION TECHNOLOGY
Staff: 1/FTE: 1
Markus Zürcher

NATIONAL NBC PROTECTION AND COORDINATION OFFICE
Staff: 1/FTE: 1
Dr. Marc Kenzelmann[2)]

TRAINEES
Staff: 7/FTE: 7
Simon Burn
Yannick von Känel
Miriam Champion
Roger Noti
Leonie Gfeller
Bruno Lengacher
Dominik Stettler

NOTES
Staff: Total number of employees
FTE: Number of paid full-time-equivalent posts

[1)] Deputy Director Spiez Laboratory
[2)] Member of SPIEZ LABORATORY executive management team

Organisation

Accredited activities

ISO/IEC 17025 accredited laboratories		No. of reports 2012
STS 019	Testing laboratory for the analysis of samples for chem. Warfare agents and related compounds	4
STS 022	Testing laboratory for adsorbents and respiratory protective filters	46
STS 028	Testing laboratory for the determination of radionuclide concentrations	26
STS 036	Testing laboratory for polymers and rubber	206
STS 054	Testing laboratory for the detection of biological agents	245
STS 055	Testing laboratory for NBC protection material	97
STS 101	Testing laboratory for the determination of main and trace elements, their compounds and selected air pollutants.	50
Total reports		**674**

Visits

Visits provide a valuable opportunity to share knowledge and expertise. Below are some of the groups we received in 2012. The list is not exhaustive.

Date	Thema
18.12.2012	Organic Chemistry Group, FOPH Bern
14.12.2012	Laboratory of Organic Chemistry ETH Zürich
04.12.2012	General Secretariat DDPS
04.12.2012	Pharma Tox Institute University of Zürich
27.11.2012	Round Table 35 Worb
19.11.2012	R+B Engineering AG, Bern
01.11.2012	Fachschaftstag Biologie- und ChemielehrerInnen Gymnasien Kt. Bern
24.10.2012	Geneva Centre for Security Policy (GCSP) Middle East Course
24.10.2012	GCSP Middle East Course
17.10.2012	Ambassadors accredited to Switzerland (FDFA-Event)
05.10.2012	Ernst Basler + Partner AG, Zürich
21.09.2012	Naturwissenschaftliche Gesellschaft Thun
20.09.2012	EOC - Electronic Operations Centre
17.09.2012	Academy of Military Medical Sciences, Beijing
30.08.2012	Senatoren LBA
20.08.2012	fedpol, Bereich Biometrie
13.07.2012	Agency for Defense Development (ADD), Republic of Korea
05.07.2012	Geneva Centre for Secuirty Policy (GCSP) Disarmament Programme
05.07.2012	Department of Biochemistry, University of Zürich
03.07.2012	Switzerland Armed Forces Staff 180
03.07.2012	Amt für Bevölkerungsschutz und Armee Kt. Thurgau
21.06.2012	Zentrum Elektronische Medien, LBA
07.06.2012	Deutschschweizer Physik Kommission
30.05.2012	Polizeischule 64/65 Kantonspolizei Bern
30.05.2012	Laboratory for Waste Management, Paul Scherrer Institute, Villigen
25.05.2012	Heeresstab FGG 3/5/9
11.04.2012	DGA Maîtrise NRBC, Paris
30.01.2012	Psychologischer Dienst der Armee
18.01.2012	Cantonal police forces, Canton of Neuchâtel

Presentations

Our scientists attend and actively contribute to conferences and offer their input to training courses dealing with NBC protection issues. Below are some of the presentations, given by our specialists during 2012.

Date	Thema
14.02.2012	Dr. Nadia Schürch: Approaches and experiences in the first External Quality Exercise, QUAND-HIP-Meeting, Budapest
23.02.2012	Dr. Beat Aebi: Rapid Response Team EEVBS, IUPAC Meeting, Spiez
23.02.2012	Dr. Matthias Wittwer: MALDI-TOF MS: a universal fingerprinting tool, IUPAC Meeting, Spiez
24.02.2012	Dr. Beat Aebi: LABOR SPIEZ und Einsatzequipe VBS, Institut für Rechtsmedizin, Basel
24.04.2012	Stefan Mogl: Incapacitating Agents – „Good to Know“, ICRC Expert Meeting, Montreux
25.05.2012	Dr. Nadia Schürch: Approaches and experiences in the first External Quality Exercise, QUAND-HIP-Meeting, Budapest
09.05.2012	Dr. Beat Aebi: Rapid Response Team EEVBS, CBMTS IX Meeting, Spiez
09.05.2012	Dr. Matthias Wittwer: MALDI-TOF MS for the identification of highly pathogenic Bacteria, CBMTS IX Meeting, Spiez
05.06.2012	Dr. Peter Siegenthaler: OPCW Proficiency Testing and QC Measures in the Testing Laboratory for CW Agents, Laboratory of Toxicant Analysis, Academy of Military Medical Science (AMMS), Beijing
05.06.2012	Dr. Peter Siegenthaler: The Swiss Response to CBRN Threats: Incident Response Team and CBRN Sample Handling, Laboratory of Toxicant Analysis, Academy of Military Medical Science (AMMS), Beijing
05.06.2012	Dr. Peter Siegenthaler: The Swiss Response to CBRN Threats: Incident Response Team and CBRN Sample Handling, Laboratory of Toxicant Analysis, Academy of Military Medical Science (AMMS), Beijing
12.06.2012	Dr. Daniel Kümin: Description of an Accident due to Increasing Pressure in an Air-Tight Room – Lessons Learned, Jahreskonferenz EBSA, Manchester
19.06.2012	Dr. Cédric Invernizzi: Bedeutung von und Bedrohung durch neue Krankheitserreger, KomABC, Bubendorf
20.06.2012	Dr. Cédric Invernizzi: Geburt eines Virus: Gefahr Bioterrorismus, BVET, Bern
03.08.2012	Stefan Mogl: Third Review Conference and Beyond, Wilton Park, Westinghouse UK
26.09.2012	Stefan Mogl: Nicht letale chemische Kampfstoffe, ABC-Schutzkonferenz, Bern
22.10.2012	Dr. Daniel Kümin: How to Choose a Suit for a BSL-4 Laboratory – The Approach Taken at SPIEZ LAB, Jahresvers. ABSA, Orlando
23.10.2012	Prof. Dr. Stephen Leib: ZNS Infektionen - Therapieansätze aus experimentellen Modellen, Universität Basel
31.10.2012	Stefan Mogl: OPCW Open Ended Working Group for RevCon: SAB Report to Developments in Science and Technology, OPCW, Den Haag
01.11.2012	Dr. Nadia Schürch: Biologische Bedrohungen, Blockkurs Katastrophenmedizin, Universität Zürich
15.11.2012	Dr. Matthias Wittwer: Pathogenesis and Evolution of Infectious Diseases, Uni Bern
23.11.2012	Dr. Nadia Schürch: B-Dekontamination, 3. Symposium der ABC Suisse, KompZen ABC-KAMIR, Spiez

Publications and Lab-Reports 2012

The list is not exhaustive. Some of the reports are classified.

Physics Section

Laboratory Note LN-2012-02
In Situ Exercise Geneva
François Byrde, Hans Sahli Hans, Dr. Christoph Wirz

Environmental radioactivity and dose – FOPH Annual Report
Distribution of Natural and Artificial Radionuclides in Prealpine Lake Sediments
S.Röllin, R. Holzer, H. Sahli, M. Astner, F. Byrde, M. Burger, E. Klemt, V. Putyrskaya

Laboratory Report LS 2012-11
Large-scale Decontaminaton
Dr. Emmanuel Egger

Laboratory Note LN 2012-03
Optimization of the Method for the Separation of Phosphonic Acids by Ion Chromatography
André Pignolet, Thomas Sarbach

Biology Section

J Med Virol. 2011 May;83(5):853-63. doi: 10.1002/jmv.21993.

Phylogenetic and virulence analysis of tick-borne encephalitis virus field isolates from Switzerland

Gäumann R, Ražek D, Mühlemann K, Strasser M, Beuret CM.

Institute for Infectious Diseases, University of Bern, Bern, Switzerland. SPIEZ LABORATORY, Switzerland

Tick-borne encephalitis (TBE) is an endemic disease in Switzerland, with about 110-120 reported human cases each year. Endemic areas are found throughout the country. However, the viruses circulating in Switzerland have not been characterized so far. In this study, the complete envelope (E) protein sequences and phylogenetic classification of 72 TBE viruses found in Ixodes ricinus ticks sampled at 39 foci throughout Switzerland were analyzed. All isolates belonged to the European subtype and were highly related (mean pairwise se-quence identity of 97.8% at the nucleotide and 99.6% at the amino acid level of the E pro-tein). Sixty-four isolates were characterized in vitro with respect to their plaque phenotype. More than half (57.8%) of isolates produced a mixture of plaques of different sizes, reflecting a heterogeneous population of virus variants. Isolates consistently forming plaques of small size were associated with recently detected endemic foci with no or only sporadic reports of clinical cases. All of six virus isolates investigated in an in vivo mouse model were highly neurovirulent (100% mortality) but exhibited a relatively low level of neuroinvasiveness, with mouse survival rates ranging from 50% to 100%. Therefore, TBE viruses circulat-ing in Switzerland belong to the European subtype and are closely related. In vitro and in vivo surrogates suggest a high proportion of isolates with a relatively low level of virulence, which is in agreement with a hypothesized high proportion of subclinical or mild TBE infections.

Laboratory Report LS 2012-06

Determination of Okadaic Acid in Mussels

Werner Arnold, Dr. Martin Schär

Laboratory Note LN AW-2012-1

Immunolocical Detection (LFA) of Domoic Acid in Mussels

Werner Arnold

Sensors 2012, 12, 2324-2339; doi:10.3390/s120202324

A Bioanalytical Platform for Simultaneous Detection and Quantification of Biological Toxins

Oliver G. Weingart , Hui Gao, François Crevoisier, Friedrich Heitger, Marc-André Avondet and Hans Sigrist

Prevalent incidents support the notion that toxins, produced by bacteria, fungi,plants or animals are increasingly responsible for food poisoning or intoxication. Owing to their high toxicity some toxins are also regarded as potential biological warfare agents. Accordingly, control, detection and neutralization of toxic substances are a considerable economic burden to food safety, health care and military biodefense. The present contribution describes a new versatile instrument and related procedures for array-based simultaneous detection of bacterial and plant toxins using a bioanalytical platform which combines the specificity of covalently immobilized capture probes with a dedicated instrumentation and immuno-based microarray analytics. The bioanalytical platform consists of a microstructured polymer slide serving both as support of printed arrays and as incubation chamber. The platform further includes an easy-to-operate instrument for simultaneous slide processing at selectable assay temperature. Cy5 coupled streptavidin is used as unifying fluorescent tracer. Fluorescence image analysis and signal quantitation allow determination of the toxin's identity and concentration. The system's performance has been investigated by immunological detection of Botulinum Neurotoxin type A (BoNT/A), Staphylococcal enterotoxin B (SEB), and the plant toxin ricin. Toxins were detectable at levels as low as 0.5–1 ng·mL−1 in buffer or in raw milk.

Applied Biosafety, Vol.17, No.2,2012

First Report: Application of MALDI-TOF MS within an External Quality Assurance Exercise for the Discrimination of Highly Pathogenic Bacteria from Contaminant Flora

Matthias Wittwer, Peter Lasch, Michal Drevinek, Sabine Schmoldt, Alexander Indra, Daniela Jacob and Roland Grunow

In the present report we describe the application of Matrix Assisted Laser Desorption/Ionization Time-of-Flight (MALDI-TOF) Intact Cell Mass Spectrometry (ICMS) within a proficiency test organized by a EU funded project on the topic of Establishment of Quality Assurances for Detection of Highly Pathogenic Bacteria of Potential Bioterrorism Risk (EQADeBa). In total 15 samples with native bacteria including risk group 3 (RG3) target agents and non-RG3 bacteria as potential contaminants, were analyzed by five different labs with ICMS. Whereas the technique showed good performance in the identification of the non-RG3 contaminants the application on RG3 target agents was less successful. One reason for the limited performance is the lack of sufficient reference spectra in commercial databases resulting from the restricted access to RG3 reference strains. Another issue is the applied statistical identification approaches, which do not exploit the full potential of the technique in regard to the taxonomic resolution. Last but not least bacterial inactivation, which is mandatory for analyzing RG3 agents in a non-BSL-3 environment affects the mass spectra and thus may hamper a reliable identification.

Applied Biosafety, Vol.17, No.2,2012

First Report: Application of MALDI-TOF MS within an External Quality Assurance Exercise for the Discrimination of Highly Pathogenic Bacteria from Contaminant Flora

Matthias Wittwer, Peter Lasch, Michal Drevinek, Sabine Schmoldt, Alexander Indra, Daniela Jacob and Roland Grunow

In the present report we describe the application of Matrix Assisted Laser Desorption/Ionization Time-of-Flight (MALDI-TOF) Intact Cell Mass Spectrometry (ICMS) within a pro-ficiency test organized by a EU funded project on the topic of Establishment of Quality Assur-ances for Detection of Highly Pathogenic Bacteria of Potential Bioterrorism Risk (EQADeBa). In total 15 samples with native bacteria including risk group 3 (RG3) target agents and non-RG3 bacteria as potential contaminants, were analyzed by five different labs with ICMS. Whereas the technique showed good performance in the identification of the non-RG3 contaminants the application on RG3 target agents was less successful. One reason for the limited performance is the lack of sufficient reference spectra in commercial databases resulting from the restricted access to RG3 reference strains. Another issue is the applied statistical identification approaches, which do not exploit the full potential of the technique in regard to the taxonomic resolution. Last but not least bacterial inactivation, which is mandatory for analyzing RG3 agents in a non-BSL-3 environment affects the mass spectra and thus may hamper a reliable identification.

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Development of a high- versus low-pathogenicity model of the free-living amoeba Naegleria fowleri.

Burri DC, Gottstein B, Zumkehr B, Hemphill A, Schürch N, Wittwer M, Müller N.

Species in the genus Naegleria are free-living amoebae of the soil and warm fresh water. Although around 30 species have been recognized, Naegleria fowleri is the only one that causes primary amoebic meningoencephalitis (PAM) in humans. PAM is an acute and fast progressing disease affecting the central nervous system. Most of the patients die within 1-2 weeks of exposure to the infectious water source. The fact that N. fowleri causes such fast progressing and highly lethal infections has opened many questions regarding the relevant pathogenicity factors of the amoeba. In order to investigate the pathogenesis of N. fowleri under defined experimental conditions, we developed a novel high- versus low-pathogenicity model for this pathogen. We showed that the composition of the axenic growth media influenced growth behaviour and morphology, as well as in vitro cytotoxicity and in vivo pathogenicity of N. fowleri. Trophozoites maintained in Nelson›s medium were highly pathogenic for mice, demonstrated rapid in vitro proliferation, characteristic expression of surface membrane vesicles and a small cell diameter, and killed target mouse fibro-blasts by both contact-dependent and -independent destruction. In contrast, N. fowleri cul-tured in PYNFH medium exhibited a low pathogenicity, slower growth, increased cell size and contactdependent target cell destruction. However, cultivation of the amoeba in PYNFH medium supplemented with liver hydrolysate (LH) resulted in trophozoites that were highly pathogenic in mice, and demonstrated an intermediate proliferation rate in vitro, diminished cell diameter and contact-dependent target cell destruction. Thus, in this model, the presence of LH resulted in increased proliferation of trophozoites in vitro and enhanced pathogenicity of N. fowleri in mice. However, neither in vitro cytotoxicity mechanisms nor the presence of membrane vesicles on the surface correlated with the pathologic potential of the amoeba. This indicated that the pathogenicity of N. fowleri remains a complex interaction between as-yet-unidentified cellular mechanisms.

Environ Sci Technol. 2012 Aug 21;46(16):8952-9. doi: 10.1021/es301974m. Epub 2012 Aug 3.
Comparison of rapid methods for detection of Giardia spp. and Cryptosporidium spp. (oo) cysts using transportable instrumentation in a field deployment

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Reliable, sensitive, quantitative, and mobile rapid screening methods for pathogenic organisms are not yet readily available, but would provide a great benefit to humanitarian intervention units in disaster situations. We compared three different methods (immunofluores-cent microscopy, IFM; flow cytometry, FCM; polymerase chain reaction, PCR) for the rapid and quantitative detection of Giardia lamblia and Cryptosporidium parvum (oo)cysts in a field campaign. For this we deployed our mobile instrumentation and sampled canal water and vegetables during a 2 week field study in Thailand. For purification and concentrations of (oo)cysts, we used filtration and immunomagnetic separation. We were able to detect considerably high oo(cysts) concentrations (ranges: 15-855 and 0-240 oo(cysts)/liter for Gi-ardia and Cryptosporidium, respectively) in 85 to 300 min, with FCM being fastest, followed by PCR, and IFM being slowest due to the long analysis time per sample. FCM and IFM performed consistently well, whereas PCR reactions often failed. The recovery, established by FCM, was around 30 % for Giardia and 13 % for Cryptosporidium (oo)cysts. It was possible to track (oo)cysts from the wastewater further downstream to irrigation waters and confirm contamination of salads and water vegetables. We believe that rapid detection, in particular FCM-based methods, can substantially help in disaster management and outbreak prevention.

Chemistry Section

Laboratory Note LN 2012-01-MRU
Comparison of different NMR tubes
Dr. Urs Meier

Laboratory Note LN 2012-02-MRU
Identification of schedule 3 phosphorus containing chemicals by 31P{1H} NMR spectroscopy
Dr. Urs Meier

Laboratory Report LS 2012-01
LC-SPE-NMR techniques for the identification of CWC relevant chemicals in challenging matrices
Dr. Urs Meier

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Investigation of Hydrophilic Interaction Liquid Chromatography (HILIC) for the separation of polar compounds relevant to the CWC with an Agilent 1200-AB/MDS Sciex 3200QTrap LC/MS system
Dr. Martin Schaer

Journal of Chromatography A (accepted, 27.02.2013)

Detection and Identification of Hydrolysis Products of Sulfur Mustards at Trace Levels in Environmental Samples Using Liquid Chromatography Solid Phase Extraction combined with Off-line Nuclear Magnetic Resonance Analysis

Dr. Urs Meier

Abstract: An LC-UV-SPE NMR method for the analysis of polar hydrolysis products of the chemical warfare agents known as sulfur mustards at trace levels in environmental samples is developed. The hydrolysis products thiodiglycol (I), bis (2-hydroxyethylthio)methane (II), 1,2-bis (2-hydroxy¬ethylthio)ethane (III), 1,3-bis (2-hydroxyethylthio)propane (IV), 1,4-bis (2-hydroxy¬ethylthio) butane (V), 1,5-bis (2-hydroxyethylthio)pentane (VI), bis (2-hydroxymethyl-thioethyl)ether (VII) and bis (2-hydroxyethylthioethyl)ether (VIII) are baseline separated within 11 min by the LC gradient program and trapped on-line on SPE cartridges. After elu-tion in 2 mm o.d. NMR tubes 1H NMR spectra were recorded. Recoveries vary from 43±5 for I to 102±5 % for VI and are limited by volume breakthrough. The detection limits of the LC-SPE NMR method vary between 200 ng for V and 450 ng for I. Large volume injections are shown to be more effective than multiple trapping for the analytes I-VIII to increase the amount of material trapped on the SPE cartridges. The applicability of the developed method to the analysis of environmental samples was tested by the analysis of sample 293 provided by the 29th official OPCW (Organization for the Prohibition of Chemical Weapons) proficiency test. The chromatographic and 1H NMR data obtained by the method are highly re-producible and provide acceptable data for the identification of chemicals related to CWC (Chemical Weapons Convention) in case an off-site analysis for the verification of the CWC or OPCW proficiency tests according to the OPCW criteria for the acceptance of chromatographic and 1H NMR spectral data.

Laboratory Report LS 2012-02

Laboratory Test – Sterilization of Waste Water in the Biocontainment Laboratory

Roland Kurzo, Dr. Christophe Curty

Laboratory Report LS 2012-04

CWA – Glucose bioadducts. Towards their synthesis for use in CWA detection

Dr. Nicolas Fragnière

The presence in human body of an interesting amount of different carbohydrates, either free or bounded to macromolecules like proteins, makes them good candidates for the detection of a chemical warfare agent contamination, thanks to the possible formation of CWA - sugar adducts. In this work, it was explored if such adducts could be synthetically formed under the appropriate conditions. Even if a direct coupling on glucose seems to be difficult, it was shown that a protected glucose like 1,2:3,4-di-O-isopropylidene-D-galactopyranose reacts almost totally with CWA simulants like MPEC or IPPEC, but not with half mustard. The deprotection of the glucose was then succeeded with TFA, but a partial hydrolysis of the phosphonate was also observed, especially with the ethyl methylphosphonate compound, giving the monoalkyl phosphonic acid adduct. Moreover, the problems met for the purifica-tion did not allow to obtain the pure desired adducts.

Beside the adduct formation, it was also tried to protect the hydroxyl groups of glucose. Indeed, derivatization would allow to follow reaction on carbohydrate by GC-MS. Second, a selective protection of primary or secondary hydroxyl groups would be an interesting mean to orientate coupling reactions either on primary or secondary alcohol function. Unfortunately, neither the derivatization nor the selective protection of glucose gave useful results.

Laboratory Report LS 2012-08

Synthesis of cyclic alkylphosphonate and alkylthiophosphonate

Benjamin Menzi

Laboratory Report LS 2012-09

Serine, tyrosine and threonine – nerve agents bioadducts. Towards their synthesis for use in CWAs detection

Sebastian Dobarco

Organophosphorus nerve agents are a highly toxic type of chemical warfare agents and still represent a threat all over the world due to their potential use in terrorist purposes. Nerve agents are rapidly distributed and metabolized in vivo after exposure, forming partly covalent adducts with macromolecules such as enzymes and other proteins. These bioadducts and resulting metabolites could be used as biomarkers of nerve agent exposure.

An efficient and reliable procedure for the synthesis of phosphonylated amino acids has thus been developed, affording the desired compounds in high level of purity for the elaboration of accurate references. The phosphonylations of Cbz- and Bn-protected amino acids were performed under a new developed set of conditions, which allowed the effective installation of a broad range of organophosphorus moieties onto the hydroxyl side chains of serine, threonine and tyrosine.

The efficient removal in one step of the Cbz and Bn protecting groups by hydrogenolysis reaction provided the targeted adducts in good yields and high purities. A reliable purification procedure by precipitation was furthermore developed in order to reach highest levels of purity for the targeted phosphonylated amino acids. Procedures for the Cbz-and Bn-protections of natural amino acids, as well as the effective synthe-sis of the alkyl methylphosphonochloridates were also investigated and optimized.

Laboratory Note LN 2012-01

Impact of microreactor technology on chemical warfare chemistry: a statistical approach

Dr. Christophe Curty

Since the beginning of the 1990's, when first publications appeared reporting examples of reactions conducted in microreactors, numerous applications in many different areas of chemistry have been successfully developed using the continuous flow technique. Initially based on academic focus, the fine chemical and pharmaceutical industries are now widely investigating this technology. It has become more and more obvious that microreactor technology has begun to influence the concepts of chemical processing on both laboratory and industrial scale.

Although numerous examples of uses of microreactors are reported in the open literature to date [1], no reference has been made on the preparation of chemical warfare agents (CWAs), the chemicals scheduled in the Chemical Weapon Convention (CWC) [2] or their related products. Furthermore, the main key-reactions allowing the preparation of this category of chemicals were also not investigated.

With the aim to establish the impact of microreactors on the preparation of chemicals, the relevance of the publications referring to this technology in the open literature was determined. Furthermore, a theoretical evaluation of the compatibility of the standard working procedures for continuous microreactor processes was run at the Organic Chemistry group at SPIEZ LABORATORY.

NBC Protection Technology Section

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Finding the Optimal Recycling Solution

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