Measurement, reporting and verification: taking stock after Durban

Considerable progress was made on enhancing the measurement, reporting and verification provisions of the UN climate change convention at the Durban climate change conference last December. The new measurement, reporting and verification (MRV) provisions reflect broader trends in the UN climate change regime, such as a growing focus on actions to reduce greenhouse gas (GHG) emissions in developing countries and the scaling-up of financial flows from industrialised countries to developing countries for climate-related activities.

Effective MRV is important because it provides answers to key questions such as 'what are countries doing to tackle climate change?', 'how much progress is being made?' and 'how do we know that the information provided is reliable?' The principal purpose of the MRV system is to provide confidence that countries are meeting their commitments under the UN climate change convention and to build trust between countries—more of which is urgently needed in the current international climate change negotiations.

A central feature of the UN climate change convention is that it categorises all countries as either 'industrialised' (listed in Annex I to the convention) or 'developing' (non-Annex I countries). These two groups of countries have different commitments under the convention including on their MRV requirements. The new MRV provisions represent a significant step up for developing countries. However, undertaking more frequent and comprehensive MRV comes with a price tag attached in terms of human and financial resources at the national and international level. The MRV system will also need to be flexible and continue to evolve in order to remain fit-for-purpose in the future climate regime.

In this issue

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The outcome of Durban

The Durban climate change conference—which included the 17th session of the Conference of the Parties (COP 17) to the convention and the 7th meeting of the Conference of the Parties serving as the Meeting of Parties to the Kyoto Protocol (CMP 7)—took place between 28 November and 11 December 2011. In the run-up to the conference, the spotlight was on the future of the Kyoto Protocol, since it remained unclear what would happen when the protocol's first commitment period ends on 31 December 2012.

The Kyoto Protocol contains legally-binding emissions reduction commitments for industrialised countries but not for developing countries. For this reason, the role of the Kyoto Protocol as a tool for mitigating climate change is a fiercely contested topic. On one hand, it is the only international agreement we currently have containing legally-binding emissions limitation commitments; on the other hand, a number of the world's largest emitters (including the USA and China) do not have quantified emissions commitments under this instrument.

The Durban conference overran by 36 nail-biting hours after the scheduled finish time. Eventually, a two-part compromise was reached. Countries agreed: (i) that there will be a second commitment period of the Kyoto Protocol starting on 1 January 2013 (although several large industrialised countries such as the USA, Japan, Russia and Canada will not participate in it); and (ii) to launch a process to develop an agreement 'with legal force' for all countries. This new strand of negotiations, called the Durban Platform for Enhanced Action, will be completed by 2015 and the new agreement is due to be implemented from 2020.

Other outcomes from COP 17 included the formal launch of a Green Climate Fund for supporting climate change mitigation and adaptation activities in developing countries, as well as the definition of a new market-based mechanism to promote cost-effective mitigation actions in these countries. In addition, countries clarified the scope of a review of the long-term goal to limit the increase in global average temperature to below 2 degrees celsius above pre-industrial levels that had previously been agreed at COP 15 and COP 16.

In terms of MRV, negotiators succeeded in putting meat on the bones of the new MRV system previously agreed at COP 16 in Cancun in December 2010. At COP 16, countries agreed that industrialised countries shall submit biennial reports in addition to enhancing reporting in annual GHG inventories and periodic national communications. It was also agreed that developing countries should submit biennial update reports ('consistent with capabilities and the level of support provided for reporting') in addition to national communications every four years (premised on the prompt provision of financial support).

In addition, countries agreed at COP 16 to undertake two new verification processes: 'international assessment and review' (IAR) for industrialised countries and 'international consultations and analysis' (ICA) for developing countries.

The new MRV provisions for developing countries represent a significant step up for this group, as their information is currently reported on an irregular basis and not verified.

The most significant MRV developments at COP 17 were the adoption of reporting guidelines for biennial reports and biennial update reports—hereafter referred to collectively as 'biennial (update) reports'—as well as further clarification on how the IAR and ICA processes will work.

New reporting guidelines for industrialised countries

Countries clarified at COP 17 that the aim of biennial reports from industrialised countries is to provide 'consistent, transparent, comparable, accurate and complete' information, although they did not define these terms. Biennial reports are to focus on progress made towards emissions reduction targets and support provided to developing countries. The first biennial reports are due in under two years' time (on 1 January 2014).

The COP 17 decision text also specified that biennial reports from industrialised countries shall contain information on the GHG inventory; the emissions reduction target; mitigation actions and their effects; use of GHG units from market mechanisms and land use and forestry activities; updated emissions projections for 2020 and 2030; and finance, tech-

nology and capacity-building provided to developing countries. The guidelines stipulate that information on the provision of finance to developing countries will be reported using common templates, which is a step forward since the previous system had no such templates for financial support provided.

New reporting guidelines for developing countries

COP 17 clarified that the aim of biennial update reports from developing countries is to provide 'consistent, transparent, complete, accurate and timely' information focusing on mitigation actions and their effects as well as financial support, technology and capacity building received from industrialised countries. The initial biennial update reports are due almost a year after the first biennial reports from developed countries (December 2014). Least-developed countries and small island developing states can, however, submit reports at their discretion due to their comparatively limited capacity and resources.

The reporting guidelines also specify that biennial update reports from developing countries should contain an update to the previous national communication of the GHG inventory, information on mitigation actions and their effects, and support received and needed. Recognising that it will take time for developing countries to gather this kind of information, the countries agreed that, at a minimum, the initial biennial update report should contain a GHG inventory for the year 'n-4', i.e. reports submitted in 2014 should contain a GHG inventory for the year 2010. Notably, the reporting guidelines do not mention adaptation, which is a high priority for many developing countries.

Some observations on the new reporting guidelines

The absence of the word 'comparable' from the aims listed above for biennial update reports from developing countries is significant. In many cases it would be difficult for these countries to provide comparable information given their widely varying national circumstances and reporting capacities. However, if information is not comparable this could present a challenge for exercises attempting to assess the aggregate effects of mitigation actions, such as the 2013-15 review of the long-term 2°C goal.

There is a risk that the preparation of biennial (update) reports (in addition to national communications and annual GHG inventories from industrialised countries) could result in information overload for governments and other users. As of March 2012 there were 42 industrialised countries and 153 developing countries under the UN climate change convention. Simply put, unless biennial (update) reports are short and concise they are unlikely to be widely read. At the same time, they will need to contain enough information to facilitate the IAR and ICA processes and enable assessment of the implementation of commitments. Therefore a balance will need to be struck between brief reports and the provision of complete and transparent information. After the first round of biennial (update) reports it could be useful to take stock and consider whether further guidance is required regarding the length and completeness of reports.

The guidelines make it clear that the extent to which information can be provided in biennial update reports by developing countries depends on the level of support received from industrialised countries for this activity. In many cases, capacity-building in addition to financial support will be required since the preparation of such reports can take up significant human resources.

New verification process for industrialised countries

Countries previously agreed at COP 16 in Cancun that the IAR verification process for industrialised countries would assess progress made towards achieving emissions reduction targets with a view to 'promoting comparability and building confidence'. It was also agreed at COP 16 that IAR would be conducted in a 'rigorous, robust and transparent' manner.

The decision text from COP 17 roughly outlines how this IAR process will work. The process will have two steps. The first step is a technical review of biennial reports (as well as the GHG inventory and national communication where relevant) by an expert review team, resulting in a technical review report. The technical review will build on existing reviews of GHG inventories and national communications under the UN climate change convention currently carried out by expert review teams co-ordinated by the UN Secretariat. In addition to information relating to emissions reduc-

tion targets, countries clarified at COP 17 that this technical review will also consider information on financial support, technology and capacity-building provided to developing countries.

The second step is a 'multilateral assessment' based on the biennial report and its technical review report (as well as other relevant documents). The multilateral assessment will include an exchange of written questions and answers between other countries and the country under review, as well as an oral presentation by the country concerned followed by a question and answer session. The scope of the multilateral assessment includes progress made towards mitigation targets but excludes support provided to developing countries—which means that there will continue to be no formal dedicated space for exchanging views between countries on this issue.

The output of the multilateral assessment will be a record containing the technical review report, the written questions and answers, the proceedings of the question and answer session and any further comments submitted by the country under review. The conclusions will be forwarded to 'relevant bodies' under the UN climate change convention.

New verification process for developing countries

Verification of developing countries' reports will be a new venture since this activity has to date only been undertaken for developed countries. It was previously agreed at COP 16 in Cancun that the objective of the ICA process for developing countries would be to 'increase the transparency of mitigation actions and their effects'. The information to be considered included the national GHG inventory, mitigation actions and financial support, technology and capacity-building received from developed countries. It was also agreed at COP 16 that the ICA process would be 'non-intrusive, non-punitive and respectful of national sovereignty'.

Countries clarified at COP 17 that ICA, like IAR, will be a two-step process. The first step is a technical analysis of the biennial update report by a team of technical experts, resulting in a summary report. The guidelines stress that the country concerned will be consulted extensively during the preparation of the summary report. The second step is a 'facilitative sharing of views' in a workshop setting, based on the biennial update report and its summary report. Other countries will have an opportunity to submit written questions in advance of the workshop. The workshop will include an oral presentation by the country concerned followed by a question and answer session. The output will be the summary report and a record of the workshop. The summary report is to be 'noted' by a body under the UN climate change convention and made publicly available. Table 1 summarises the similarities and differences between the IAR process for industrialised countries and the ICA process for developing countries. While there is a degree of symmetry between the shape of the IAR and ICA processes, the language used to describe each aspect is different and reflects the common but differentiated responsibilities of industrialised and developing countries under the UN climate change convention.

Some observations on the new verification processes

IAR will be undertaken individually for all biennial reports from all industrialised countries. ICA is to be conducted for all developing countries that have submitted a biennial update report, with the objective of 'universal participation'. While the 'facilitative sharing of views' step may be conducted for a group of up to five countries at once, the time required at UN climate change conferences to undertake these workshops could be considerable. The organisation of these events, together with technical reviews and analyses of reports (in addition to continuing reviews of GHG inventories and national communications for industrialised countries) could have significant resource implications for the UNFCCC Secretariat and its roster of experts.

It remains to be seen how transparent the IAR and ICA processes will be. All summary reports will be made publicly available on the UNFCCC website. However, only other country governments are invited to ask questions and there are no formal channels for participation by non-government stakeholders. The transparency of the IAR and ICA processes could be further enhanced if countries decide to make the multilateral assessments and workshops open to observers, rather than holding them behind closed doors.

Some of the details for how IAR and ICA will work in practice remain unclear. For example, it is not clear whether technical reviews and analyses will include in-country visits (as they currently do for reviews of industrialised countries' national communications and some of their GHG inventory reviews) or will be purely desk-based and conducted by technical experts at the UN Secretariat or in their home countries. Further clarification is also needed on how the composition of technical expert teams will be decided and what 'relevant bodies' the conclusions will be forwarded to under the IAR process.

Notably, the IAR and ICA processes do not contain any compliance provisions. Instead, the new IAR and ICA processes appear to be intended as facilitative exercises employing international peer pressure to urge countries to improve their performance and reporting over time. In this sense they could be similar in spirit to the Environmental Performance Reviews of environmental policies conducted by the OECD and In-Depth Energy Policy Reviews conducted by the International Energy Agency.

There is, however, already a compliance mechanism included in the Kyoto Protocol and this is likely to continue to apply to industrialised countries with commitments under the second commitment period. Under the Kyoto Protocol compliance mechanism, a 'question of implementation' may be raised by an expert review team or another country in relation to the implementation of a country's commitments under the Kyoto Protocol (including in relation to implementation of its emissions targets or the adequacy of its national measurement and reporting system). The question of implementation is considered by a Compliance Committee and if the country concerned is deemed to be in non-compliance then potential penalties include adjustments to the GHG inventory, corrections to holdings of GHG units, suspension of

Table 1	IAR (for industrialised)	ICA (for developing countries)
Objective	To promote comparability and build confidence	To increase the transparency of mitigation actions and their effects
Manner	Rigorous, robust and transparent	Non-intrusive, non-punitive and respectful of national sovereignty
Scope	GHG inventory and GHG units Mitigation targets Support provided	GHG inventory Mitigation actions Support received
Inputs	Biennial report GHG inventory Any further technical information provided by the country concerned	Biennial update report including GHG inventory - Any further technical information provided by the country concerned
Process	Step 1: technical review Step 2: multilateral assessment	Step 1: technical analysis Step 2: facilitative sharing of views
Frequency	Every two years	Depends on capability and level of support provided
Outputs	In-depth review report Summary of multilateral assessment Written questions and answers Any further observations from country concerned	Summary analysis report Summary of facilitative sharing of views Written questions and answers Any further observations from country concerned
Use of outputs	Conclusions forwarded to 'relevant bodies' under the UN climate change convention	'Noted' by a body under the UN climate change convention

eligibility to participate in climate market mechanisms or a reduction of the country's GHG allowance for the subsequent commitment period.

Although a compliance mechanism has not been included in the IAR and ICA processes outlined at COP 17, it is possible that some sort of compliance mechanism could feature as part of the post-2020 Durban Platform that will be agreed by 2015. This will depend in part on how countries decide to interpret the concept of an agreement 'with legal force'.

MRV and the bigger picture

The improvements currently being made to the MRV system in terms of increased scope, frequency and wider country participation reflect broader emerging trends in the UN climate change regime. One such trend is a growing recognition that significant action on mitigation is required in developing countries as well as industrialised countries in order to have a chance of limiting the global average temperature rise to below 2°C. To this end, many developing countries have recently proposed voluntary mitigation actions under the UN climate change convention, some of which are backed up by domestic legislation. A wide variety of different actions have been proposed, such as to reduce GHG emissions per unit GDP, to achieve a deviation from the business-as-usual emissions pathway, to increase the share of renewables in the electricity supply mix or to increase forest cover. The increased frequency of reporting for developing countries, together with the ICA process, will help to keep other countries abreast of progress made in implementing these actions.

Another trend is the scaling-up of financial flows from industrialised to developing countries for climate-related activities, including bilateral, multilateral and private sector flows. Developed countries have committed to jointly mobilise USD 100 billion per year of climate finance by 2020 for mitigation and adaption activities in developing countries. While the definition of what counts as 'climate finance' has not yet been agreed and will be challenging to resolve, it is clear that improved tracking of climate finance flows from industrialised countries will be required and this is reflected in the focus of developed country biennial reports and IAR.

It is important that MRV provisions continue to take into account the national circumstances and limited capacities of developing countries. The list of industrialised countries in Annex I of the UN climate change convention has remained almost unchanged since the convention entered into force in 1994.

This presents a challenge for MRV, since the ever expanding range of reporting capabilities within the group of developing countries (ranging from large countries with relatively high institutional capacities to least-developed countries and small island developing states) is making it increasingly difficult to develop a single prescriptive set of reporting guidelines or a single verification process that can cater to the diverse needs of these countries.

These broad trends highlight that a comprehensive yet flexible MRV system is required. The decision text from COP 17 contains explicit provisions for the revision of the IAR and ICA processes by 2016 and 2017 respectively. This flexibility will enable lessons learned from the first round of IAR and ICA to be incorporated. It will also provide an opportunity to modify the verification processes once further details of the post-2020 Durban Platform agreement 'with legal force' have emerged•

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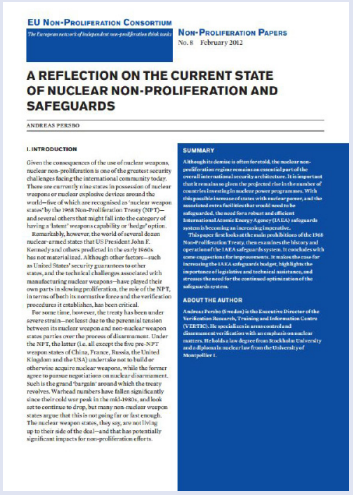
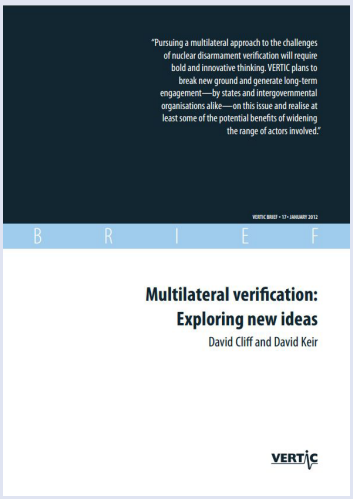
New on the website, Q1 2012


EU NON-PROLIFERATION CONSORTIUM
NON-PROLIFERATION PAPERS
No. 8 February 2012
A REFLECTION ON THE CURRENT STATE OF NUCLEAR NON-PROLIFERATION AND SAFEGUARDS
ANDREAS PERSBO

Non-Proliferation Paper No. 8, 'A reflection on the current state of nuclear non-proliferation and safeguards'

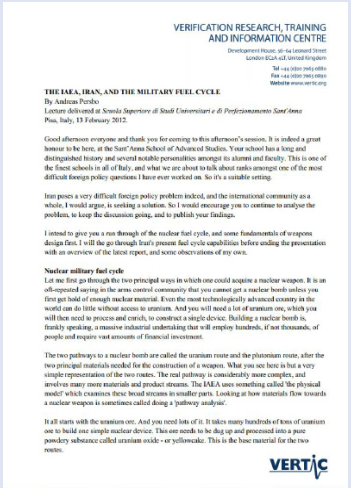
Although its demise is often foretold, the nuclear non-proliferation regime remains an essential part of the overall international security architecture. It is important that it remains so given the projected rise in the number of countries investing in nuclear power programmes. With this possible increase of states with nuclear power, and the associated extra facilities that would need to be safeguarded, the need for a robust and efficient International Atomic Energy Agency (IAEA) safeguards system is becoming an increasing imperative. This paper first looks at the main prohibitions of the 1968 Nuclear Non-Proliferation Treaty, then examines the history and operation of the IAEA safeguards system. It concludes with some suggestions for improvements. It makes the case for increasing the IAEA safeguards budget, highlights the importance of legislative and technical assistance, and stresses the need for the continued optimization of the safeguards system.


"Pursuing a multilateral approach to the challenges of nuclear disarmament verification will require bold and innovative thinking. VERTIC plans to break new ground and generate long-term engagement—by states and intergovernmental organisations alike—on this issue and realise at least some of the potential benefits of widening the range of actors involved."
B R I E F
Multilateral verification: Exploring new ideas
David Cliff and David Keir
VERTIC

VERTIC Brief No. 17, 'Multilateral verification: Exploring new ideas'

This paper, by David Cliff and David Keir, outlines new thinking in the realm of multilateral disarmament verification and considers the arguments for incorporating multilateralism into future verified disarmament processes.

The paper stems from VERTIC's engagement in a new project that seeks to explore the next steps in multilateral arms control verification for nuclear weapons. In March 2012, VERTIC, in partnership with the African Institute for Security Studies, convened a first meeting in South Africa to discuss ways forward in a selection of important areas. The meeting consisted of experts from several nuclear and non-nuclear-weapon states, as well as intergovernmental organisation representatives. It is seen as the first stage in what will hopefully become a multi-year project with work-streams of direct relevance to forwarding the multilateral disarmament agenda.


VERIFICATION RESEARCH, TRAINING AND INFORMATION CENTRE
THE IAEA, IRAN, AND THE MILITARY FUEL CYCLE
By Andreas Persbo
Lecture delivered at Scuola Superiore di Studi Universitari e di Perfezionamento Sant'Anna Pisa, Italy, 13 February 2012.
VERTIC

The IAEA, Iran, and the military fuel cycle

This presentation by Andreas Persbo argues that Iran poses 'very difficult foreign policy problem' to which 'the international community as a whole is seeking a solution'. It reviews the nuclear military fuel cycle, discusses design choices, and applies this analysis to Iran's fuel cycle. It also discusses the present application of safeguards in Iran, and possible military dimensions to the country's nuclear programme. Finally, it offers some thoughts on the future.

Robotics in nuclear disarmament verification?

Could robotics be used to verify nuclear warhead dismantlement in a future arms control agreement? This author believes it to be an idea worth investigating.

Many robotic systems are currently used in a wide range of tasks—some which we probably don't notice in everyday life, while others are more obvious and recognised.

Some of the more striking applications are the result of projects on which vast sums of money have been spent. Examples include NASA's Mars Rovers, Honda's humanoid ASIMO and the Boston Dynamics BIGDOG which can run, climb slopes, jump and keep itself on its feet even after violent shoves. Semi-robotic human replacement limbs and other medical devices are also becoming more affordable and increasingly common.

At the other end of the cost scale are robotic vacuum cleaners and the like. According to Professor Noel Sharkey, Sheffield University's expert in Robotics and Artificial Intelligence, there is now one robot for every five humans in the Japanese industrial workforce. Professor Sharkey has further stated that, because of technological advances and the ready availability of cheap components, robots are 90 per cent cheaper to make than they were in 1990. Many of the more successful robots are now coming from the Far East and the USA.

In the military sphere, there is a new generation of semi-autonomous drones. Other, fully-robotic systems are in development, such as the US Army's Battlefield Extraction Robot (BEAR) which can recover injured troops from hostile environments. There are also research projects in development on more advanced, self-organising and 'swarming' micro-robots (that is, a group of units with inter-communication and shared decision-making abilities) with a variety of applications in mind. An example is the European Commission-funded 'Swarmanoid' project under the Future and Emerging Technologies (FET-OPEN) initiative.

But are any of the advances in robotics relevant to the task of verification in a nuclear arms control context? The following sections explore the pressing issues in arms control verification and try to address this question.

Verification challenges and the NPT

There is a legally-binding prohibition on signatory countries to the 1968 Nuclear Non-Proliferation Treaty (NPT) concerning the transfer of weapons-related information and items. Articles I and II of the NPT are key:

Article I

Each nuclear-weapon State Party to the Treaty undertakes not to transfer to any recipient whatsoever nuclear weapons or other nuclear explosive devices or control over such weapons or explosive devices directly, or indirectly; and not in any way to assist, encourage, or induce any non-nuclear weapon State to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices, or control over such weapons or explosive devices.

Article II

Each non-nuclear-weapon State Party to the Treaty undertakes not to receive the transfer from any transferor whatsoever of nuclear weapons or other nuclear explosive devices or of control over such weapons or explosive devices directly, or indirectly; not to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices; and not to seek or receive any assistance in the manufacture of nuclear weapons or other nuclear explosive devices.

If non-nuclear-weapon states (NNWS) are involved in verifying the dismantlement of nuclear weapons by a nuclear-weapon state (NWS), the potential for violations of the NPT exists—whether unintentional or deliberate—in the form of information leakage. Data concerning nuclear warhead or component design, mass or any other physical parameters would be highly proliferative if leaked. This would particularly be the case if it were proposed that an individual from

a NNWS were to form part of the inspector team, or were to access any information gleaned by that inspector team. That, of course, is routinely the case for civilian safeguards inspections; but the case of nuclear weapons is very different.

There is a fundamental tension here because:

- a state that possesses nuclear weapons wants to convince third parties (some of whom do not have them) that they have truly dismantled, or otherwise put beyond use, the number of weapons that they have declared as part of a disarmament agreement; and
- the very information that would be required to provide proof of that action, is likely to be inherently proliferative.

This is an extremely difficult situation and, hitherto, most research in this area has sought to develop ways in which sufficient information is released to provide an inspector party with confidence that the declared dismantlement has occurred, whilst at the same time restricting sensitive information from inspector party access.

However, the whole basis of a treaty or agreement that calls for the reduction in numbers of nuclear weapons hinges on the fissile material in those weapons being removed from the military arsenal of the host country (the dismantler).

So, it really comes down to a mass-accountancy issue—but without the possibility of the mass being declared by the host, or measured by the inspector. Furthermore, the identity of the fissile material is a key factor in the disarmament equation; and once again, the true isotopics of the fissile material may well be something that has to be withheld from inspectors. If the fissile material belonged to the Russian state, for example, it most certainly would be withheld. If it were US property, they would be likely to reveal some details about the isotopics.

This tension, between the inspector requiring detailed information for verification purposes and the owner being unable to release it, seems like an impasse and a potential showstopper for NNWS involvement—until we dig a little deeper.

In fact, the verifying party does not really need to know what mass or what isotopics are associated with a given nuclear weapon undergoing dismantlement. What they actually require is absolute assurance that the weapons have been dismantled and that all the fissile material from those weapons is safely removed from the military arsenal of the dismantling state.

This means that they must know:

- that each object presented to inspectors as a declared warhead of 'type x' is actually such an object;
- that all the fissile material is removed from that warhead during dismantlement;
- that none of that fissile material is diverted back into military use; and
- that all of the fissile material presented for monitored storage (e.g. safeguards) or further processing (e.g. blend-down) is sourced from the weapons declared to be dismantled.

Thus, the information the verifying state or party requires is ultimately logical (yes or no) rather than quantitative (mass and isotopic make-up). But the yes/no information must be authentic and trusted as such with the highest possible confidence.

The proposition then is, if the yes/no decision cannot be provided by a human inspector who has had sight of the relevant classified data, can it be provided by a robot that does have sight of the classified data—but is never allowed to reveal that data?

Information barriers

There are examples of prototype hardware-based 'information barriers' which are starting to address some of these problems. Up to now, however, none have progressed beyond the prototype stage and none use robotics principles.

The author feels that there is a real prospect of resolving the impasse presented by the fundamental tension discussed earlier, by using a specially-designed robot. How that might be achieved is explored in a preliminary way here. As is the

case for any complex equipment used in bilateral or multilateral verification measurements, the issue of trust in the equipment applies—and will be returned to later. But first, what is a robot? And how could it be designed and built to carry out verification duties that a human inspector may not be allowed to due to non-proliferation and national security concerns?

Definition of a robot

As stated in the 2007 MIT Robotics Primer, the definition of a robot is: 'an autonomous system which exists in the physical world, can sense its environment, and can act on it to achieve some goals.' Furthermore, as an autonomous system, a robot has the ability to:

- gain information about the environment;
- work for an extended period without human intervention;
- move either all or part of itself throughout its operating environment without human assistance; and
- avoid situations that are harmful to people, property, or itself unless those are part of its design specifications.

A robot may also learn or gain new capabilities like adjusting strategies for accomplishing its task(s) or adapting to changing surroundings. Robots, even though autonomous by these definitions, do currently still require regular maintenance, as do other machines.

Concepts in robotics

There are two important concepts in robotics:

1. Exteroception; and
2. Proprioperception.

Exteroceptive sensors are used to gather information about the environment that the robot is operating in and, thus enable it to perform functions appropriately. Common exteroceptive sensors will use or measure:

- the electro-magnetic spectrum
- sound
- tactile properties (surfaces)
- chemical species in the air
- temperature
- range to objects in the environment
- attitude (inclination)

The first requirement for complete physical autonomy is the ability for a robot to take care of itself. Many of the battery-powered robots on the market today can find and connect to a charging station, and some robotic toys, like Sony's 'Aibo', are capable of self-docking to charge their batteries. Self-maintenance is based on proprioception, or sensing one's own internal status. In the battery-charging example, the robot can proprioceptively notice that its batteries are low and then seek a charger. Another common proprioceptive sensor is for heat monitoring. Increased proprioception will be required for robots to work autonomously near people and in harsh environments.

Verification without proliferation and the potential of robotics to help

To re-phrase the thrust of this article into three key questions:

1. What added value would using a robot bring towards achieving a successful verification mission, beyond current methods under consideration, such as information barriers?
2. Is it possible to design and build a robot capable of being deployed in a realistic scenario, collecting the relevant data, processing it securely, making the verification decisions and outputting only logical results—such as a red or green light?
3. How can it be ensured that the classified information collected and processed by such a robot never escapes, either during the verification activity or at any time thereafter?
4. Is it possible to design and build such a robot so that it will be trusted by both host and inspector states and its decision will be similarly trusted?

Considering question 1, verification of nuclear warhead dismantlement will take place in a highly security-protected facility. Both the dismantlement process itself and the area where it takes place is highly classified and unlikely to be

made accessible to human inspectors. So, it may be very useful for parties involved in verification missions if a robot could be designed that could operate in these areas and take the necessary measurements,

Looking at question 2, robots in fact already exist that can monitor themselves, take steps to maintain their functionality and carry sensors, like the exteroceptive sensors listed above, with which they collect data. But what would be the essential sensors and data-handling capability of a nuclear dismantlement verification robot?

The key process of exposing and dismantling of the central physics package of a nuclear warhead—where the explosive components are separated from the fissile components—is the point at which potentially the most valuable data could be collected to verify, to a high degree of confidence, that the declared object being dismantled was truly a nuclear warhead. This is also the process stage where it could be verified that the revealed and extracted fissile component(s) were truly representative of nuclear warhead components, if only an inspector were allowed to witness the process and make some radiation measurements.

Unfortunately, a NNWS inspector will not be allowed access to this type of activity.

If human inspectors, tasked with making a yes/no decision, were allowed to make verification measurements at this stage, it is likely that they would want to estimate the mass, physical size and configuration of the fissile object(s) removed from the physics package. They would also want to see a high-resolution gamma spectrum of the fissile component(s) and they may also want to process that data in a computer model to determine the presence of key radioisotopes (and even the isotopic ratios).

This would mean visual contact, possible use of physical dimension measuring devices, and maybe a thermal camera to confirm heat sources.
Most importantly, with currently available Non-Destructive Assay technologies, they would require a high-purity germanium detector linked to a multi-channel analyser for gamma spectrometry, a neutron detector set up to process neutron counts into a multiplicity estimate and a computer loaded with modelling software to carry out a data fusion analysis. They would then have a good basis for a decisional yes or no answer to the verification question posed by the team leader (and by the negotiated declarations).

How difficult would it be, then, to develop a robotic version of this human inspector that was also restricted from divulging any proliferative or otherwise sensitive information it might acquire, as highlighted in question three above?

On the face of it, since the NDA measurement devices, the analytical software and the hardware already exist individually, it would not appear to be prohibitively difficult to integrate them all into a semi-autonomous robot inspector. The possibility of using neural networks to train the system could also be explored.

In this way, human inspectors need never enter the sensitive area, need never get anywhere near the classified data and the robot (or at least its core processing module) which may be said to have been contaminated with classified data, need never leave—or, at least, not in one piece.

Certification and authentication

However, when addressing question four, the issues of authentication (proving to both host and inspector parties that the system does what it is intended to do, no more and no less), loom particularly large for such a complex proposed system. So too does the issue of certification (that is, the safety and security approval of the system for entry into a nuclear explosives area).

The larger problem of the two, authentication, requires that the party using a given piece of equipment needs to be fully satisfied that the equipment in question:

1. is what it purports to be and has not been switched for something else;
2. does what it has been designed and built to do, fully and accurately and consistently and does nothing else;
3. has not been modified or tampered with in any way since

they last has custody of it; and

4. cannot be falsely manipulated by external agencies such as through radio-frequency signals.

At this stage, it is only possible to state that any conceptual or design-stage robotic system intended for use in verification activities must be designed with this issue, and the related issue of certification, very much in mind. Indeed, these issues have not been satisfactorily addressed even for the (much less complex) information barriers already in development.

It is not possible to go much further in this article towards answering the question posed by the title, but the author believes that the time is ripe for more investigation into the possibilities of designing and testing a prototype device in the next few years. This would probably be best undertaken as a partnership between experts in nuclear disarmament verification—such as a US national weapons laboratory group, or the VERTIC Arms Control and Disarmament Programme—and experts in designing, specifying and building high-quality robotic systems, such as NASA or a UK industrial robotics company•

DAVID KEIR

Originally a research chemist in academia, David Keir joined the nuclear industry in the 1980s, as part of a UKAEA team, analysing nuclear reactor accidents and their environmental consequences worldwide.

Subsequently he headed a group looking at chemical and biological risks, and developing assessment methods for release of genetically modified organisms. He provided technical reportage for the European Union on member state implementation of GMO directives, as well as developing risk assessments for legacy anthrax and other biohazards.

Returning to nuclear issues in the late nineties, he then acted as a safety consultant in the UK nuclear weapons field, specialising in nuclear safety cases and environmental management systems. From 2001 to September 2011 he was a key member of the Arms Control Verification Research programme, based at Aldermaston. David joined VERTIC in September 2011•

National implementation evolves

Years before national implementation of the 1972 Biological Weapons Convention (BWC) was being systematically addressed by organisations such as VERTIC, the Office of Legal Affairs at the International Atomic Energy Agency (IAEA) was providing legislative assistance to IAEA member states to assist them with the implementation of the nuclear treaties. These efforts included the publication of the Handbook on Nuclear Law in 2003 and the Handbook on Nuclear Law: Implementing Legislation in 2010.

Similarly, work on national implementation of the 1993 Chemical Weapons Convention (CWC) started shortly after the entry into force of the convention in 1997. Initial steps included surveys of national legislation in 1998 and 2001, workshops on legislative issues in 2000 and 2001, and legislation checklists and questionnaires in 2002 and 2004. Work to assist national implementation originated in the Office of the Legal Adviser (LAO), a unit in the Organisation for the Prohibition of Chemical Weapons (OPCW), and continues to be carried out by the LAO to this day, in co-ordination with the Implementation Support Branch in the OPCW's International Co-operation and Assistance Division.

LAO's work gained momentum after the adoption of a Plan of Action Regarding the Implementation of Article VII Obligations by the CWC's Eighth Conference of States Parties, in October 2003. The Article VII Action Plan, as it is known, set the stage for a dramatic expansion of LAO's engagement with CWC member states, to help them draft and enact laws and regulations to give effect to various requirements contained in the convention. The plan included four main elements: identification of problems and needs; resources for implementation support; overall time-frame, intermediate steps and target date; and oversight by the Executive Council and the Conference of the States Parties. It was no coincidence that the plan coincided with the adoption of a universality action plan, which energized expansion of the OPCW's membership to 188 states parties today.

The Article VII Action Plan led to a number of initiatives emerging from the LAO, including a National Legislation Implementation Kit, which I developed during my time at the OPCW. LAO staff also started travelling around the world at an increased and sometimes hectic pace, particularly in 2005 and 2006, working with countries in all regions to amend existing legislation or prepare new laws for the effective implementation of the CWC. This international co-operation and assistance produced results: the proportion of CWC states parties making an Article VII, paragraph 5 submission on measures that they had taken to implement the convention rose from 61 to 68 per cent between 2003 and 2009. The comprehensiveness of CWC implementing legislation increased from 33 per cent in 2003 to 46 per cent in 2009, the year for which the most recent data is publicly available.

Notably, there was great resistance from some countries to the idea of model legislation and technical assistance visits in the early years, but this resistance eventually broke down as state after state passed tailored laws which drew from the materials produced by LAO and its direct work with government officials responsible for getting their national legislation in order.

National implementation of the BWC—green shoots

Though BWC implementation was not nearly as advanced as the IAEA and OPCW's programmes in 2003, green shoots were nonetheless starting to emerge. That year saw VERTIC produce 'Time to Lay Down the Law', a report that, for the first time, gave a broad overview of BWC implementing legislation in states parties around the world. And the very first set of BWC intersessional meetings in 2003, after the BWC's Fifth Review Conference, addressed national implementation.

Other activities were underway as well. In 2004, the UN Security Council adopted Resolution 1540, under which a Committee and a group of experts were established to co-ordinate assistance to UN member states to implement the resolution. Resolution 1540 was recently extended by Resolution 1977 to the year 2021. Under this resolution, all UN member states are required to adopt measures to prevent and

prohibit non-state actors from engaging in any activities involving nuclear, biological and chemical weapons, as well as to establish adequate and effective measures to account for and secure related materials.

In 2005, VERTIC and the International Committee of the Red Cross (ICRC) developed a model law to implement the BWC. And in 2006, the Sixth Review Conference of the BWC reaffirmed both 'the commitment of States Parties to take the necessary national measures under Article [IV]' and also 'that the enactment and implementation of necessary national measures under this Article would strengthen the effectiveness of the Convention.' That same year, Interpol started its Biocriminalization Project (I was hired as the Project Manager), which aimed to analyze laws and regulations for preventing bioterrorism and also work with states to improve their legislation to prevent biological weapons proliferation. VERTIC and Interpol also jointly developed a more comprehensive model for implementation of the BWC, with biosecurity and transfer control measures and enforcement mechanisms included. This model has since evolved into VERTIC's Sample Act for National Implementation of the 1972 Biological and Toxin Weapons Convention and Related Requirements of UN Security Council Resolution 1540 (available on VERTIC's website).

In 2007, the Meeting of the States Parties to the BWC 'agreed on the fundamental importance of effective national measures in implementing the obligations of the Convention.' That same year, VERTIC staff co-operated with the ICRC and the first European Union Joint Action for the BWC—implemented by the Bioweapons Prevention Project (BWPP)—for legislation assistance activities in Peru and Nigeria. VERTIC's participation in this work was part of a pilot project, which preceded the current National Implementation Measures Programme, discussed next.

VERTIC's National Implementation Measures Programme

Owing to a lack of staff capacity and time, the surveys of legislation for implementation of the CWC that the OPCW had carried out in 1998 and 2001, discussed above, did not continue. Instead, the OPCW's Office of the Legal Adviser relied on self-reporting by states through a legislation questionnaire released in 2002, but their answers were not always very detailed, nor necessarily accurate. Moreover, the Technical Secretariat of the OPCW—and this fell largely to LAO—was tasked by the Eighth Conference of the States Parties in 2003, under the Article VII Action Plan, to begin drafting outreach fairly quickly.

While at Interpol, I decided that it would be useful to carry out a systematic gap analysis of laws and regulations related to the BWC—such as those carried out at the OPCW between 1998 and 2001—before moving towards working with states on legislative drafting. This included looking at definitions, criminal offences, jurisdiction, control lists, biosecurity and biosafety measures, transfer controls and enforcement. Two years later, in 2008, this work would continue and expand at VERTIC under a new National Implementation Measures (NIM) Programme, after a successful two-year pilot project.

VERTIC's NIM Programme has so far completed 136 analyses of countries' national laws and regulations to implement the BWC. These analyses are carried out through legislation surveys based on a template with 96 criteria covering the areas noted above. The results of this data collection and analysis have enabled VERTIC to provide direct legislative assistance to over 30 countries in all regions of the world, with several draft laws currently under inter-ministerial review or being considered by national assemblies. And VERTIC has developed a comprehensive 'BWC legislation toolkit', including the legislation models noted earlier and a publicly-available database of over 2,000 BWC-related laws and regulations in a range of languages.

In an interesting twist, NIM Programme staff have found that it is quite effective and relatively easy to undertake outreach on universality of the BWC, by adding a ratification or accession package to our legislation survey packages for non-states parties, in national languages. These have gone out to ten non-states parties in the past two years and will go to several more in 2012. This universality-cum-legislative assistance activity echoes the steps called for in the CWC action plans from 2003.

Emerging developments in international co-operation and assistance

I have briefly laid out the activities undertaken by the IAEA and OPCW, and the convergence of activities, actors and methodologies for implementation of the BWC since 2003. I would now like to turn to where I think we are headed: a convergence of activities, actors and methodologies for international assistance and co-operation across the CBRN regimes. I will direct my remaining comments to this convergence in relation to legislative assistance, and there is a lot of good news.

Those of us in the field have become a lot better at what we are doing. For instance, models and guidelines have been developed for states to develop laws and regulations across the CBRN spectrum and most of these are now in several languages, including less common ones such as Dari and Georgian. We all, more or less, know each other in the assistance community and communicate informally on a regular basis, or at least bring each another up to date on our work during conferences and workshops. In this way, we are also learning how to avoid duplication of effort and ensuring that we are not stepping on one another's toes.

Where we have not been able to make as much progress, however, is in joint legislative drafting missions. Despite this, there is another trend emerging, which in my mind is a positive one. We of course continue to co-ordinate our efforts with the OPCW and the IAEA, as well as with the Implementation Support Unit (ISU) and European Union (EU) Joint Action for the BWC—in matters related to the CWC, nuclear weapons treaties and BWC, as I alluded to above. But, increasingly, we are co-ordinating and co-operating on assistance directly related to comprehensive implementation of Resolution 1540 with the 1540 Committee itself and its experts, the Organisation for Security and Cooperation in Europe (OSCE), the Caribbean Community (CARICOM) and the Central American Integration System (SICA), which are the regional trade and integration organisations for the Caribbean and Central America, as well as the EU CBRN Centres of Excellence, the UN Office of Drugs and Crime and the UN Office of Disarmament Affairs. This development comes at a time when VERTIC is expanding its National Implementation Measures Programme to include legislative drafting support for Resolution 1540, for those states interested in this approach. Towards this objective, a report on the legislative framework for controlling nuclear and other radioactive materials, with a particular focus on illicit trafficking, is nearly complete. And a rollout is underway with tools in development (legislation survey template, modular sample act, etc.) to work with states on comprehensive implementation of Resolution 1540.

Why is this important? In the past couple of years, we have noticed during our outreach efforts that states are increasingly reconsidering how best to implement their obligations under the BWC, CWC, the nuclear weapons treaties and Resolution 1540. In some cases, they have communicated that they would like to draft CBRN implementing legislation and establish CBRN National Authorities. VERTIC believes that for many states, this would make a lot of sense as it centralises resources and streamlines implementation of 1540 at the national level. We have already worked with one country, Chile, through this approach. A Balkan state has also indicated recently at a workshop that it envisages taking this approach, and there is marked interest in the Pacific, Central America and the Caribbean in moving forward on comprehensive 1540/CBRN legislation. Indeed, CARICOM and SICA have appointed 1540 implementation co-ordinators in their secretariats. This form of outreach is also helpful in drawing in the remaining non-states parties to the conventions, especially those which have not joined for political reasons.

This evolution towards comprehensive 1540 legislation has been complicated, however, by the way assistance has been structured. The international organisations providing assistance in the CBRN area, including both the OPCW and the IAEA, but also ones such as the UNODC and the ICRC, are restricted in their mandates as to what kind of legislative assistance they can provide, and as I noted before there have been no or rare joint drafting missions involving more than one assistance-providing organisation. Moreover, the 1540 Committee and its experts serve as a clearinghouse for assistance activities related to CBRN legislation, but they cannot provide drafting assistance themselves.

States can, of course, continue to choose from a menu of legislative assistance providers across the CBRN spectrum, including the IAEA, OPCW, and VERTIC, and can mix and match assistance to implement their remaining obligations under the CBRN treaty regimes and Resolution 1540. Now, however, if states are interested in working on comprehensive Resolution 1540-implementing legislation at once, including dealing with the illicit trafficking of nuclear and other radioactive material, VERTIC will be in a good position to do this with its expanded National Implementation Measures Programme. Indeed, VERTIC was recently identified as a legislative assistance provider in the UN Counter-Terrorism Implementation Task Force's Report of the Working Group on Preventing and Responding to Weapons of Mass Destruction Attacks: Interagency Coordination in the Event of a Terrorist Attack Using Chemical or Biological Weapons or Materials•

SCOTT SPENCE

Scott is the Senior Legal Officer at VERTIC, where he co-ordinates the strategic vision and technical implementation of the National Implementation Measures (NIM) Programme. The NIM Programme works with interested governments on comprehensive national implementation of the Biological and Chemical Weapons Conventions as well as UN Security Council Resolution 1540. This includes awareness-raising activities, promoting universal membership in the conventions and legislative drafting assistance. Scott is currently laying the groundwork for the expansion of the NIM Programme to encompass the legislative response to the illicit trafficking of nuclear and other radioactive materials. Scott is also a Key Legal Expert, on behalf of VERTIC, for the EU CBRN Centres of Excellence.

In December 2011, he spoke in Geneva on the evolution of national implementation of the international legal regime to control Chemical, Biological, Radiological and Nuclear (CBRN) weapons and materials. In his address, Scott presented his views on ways forward for strengthening national implementation in this field. The full version is available on the VERTIC website•

VERTIC blogs, January-March 2012

'Reflections on the Durban climate change conference'
Hugh Chalmers, 22 December

'Is a step towards laser enrichment a step back for nuclear non-proliferation?'
Gabriele Loche, 12 January

'Building confidence in the BWC'
Nibras Hadi, 20 January

'The Biological Weapons Convention and the recipe for avian superflu'
Yasemin Balci, 26 January

'Nuclear verification issues and priorities in Iran'
David Cliff, 3 February

'The New START treaty: going well, as far as it goes'
David Cliff, 7 February

'Promising plastics and neutron detection'
Hugh Chalmers, 16 February

'Europe's emissions trading scheme expands to new heights'
Grete Luxbacher, 24 February

'An illuminating look into black carbon'
Hugh Chalmers, 1 March

'Yongbyon redux'
Ariane Tabatabai, 9 March

'Chinese emissions monitoring put to the test'
Hugh Chalmers, 15 March

'Returning to the recipe for avian superflu'
Yasemin Balci, 24 March

Verification Watch

Europe's emissions trading scheme expands to new heights

As of 1 January this year, aircraft operators with flights originating or terminating at airports within the EU must participate in the European Greenhouse Gas Emission Allowance Trading Scheme (EU ETS). Instituted in 2005, the ETS is an EU-wide carbon market, covering around 11,000 industrial installations located in the EU, which account for approximately 50 per cent of the EU's carbon dioxide (CO_2) emissions. The scheme aims to reduce emissions by eight per cent from 1990 levels during the 2008-2012 period by establishing emission caps. Emissions allowances (where one allowance is equivalent to one tonne of CO_2) are allocated to individual installations: if an installation emits more CO_2 than their allowances cover, they must buy surplus allowances from others on the carbon market to make up the difference.

The EU ETS is now the first market-based trading scheme to include emissions from aviation activities. But since the expansion covers all incoming and outgoing flights, non-EU states have begun questioning its international legitimacy.

Currently, aviation emissions account for approximately three per cent of the EU's greenhouse gas (GHG) emissions. However, while most other emissions have decreased, aviation emissions have experienced a rapid increase, having doubled from 1990 levels. Consequently, the EU, which is currently on track to meet its emission reduction targets, added aviation activities to its ETS. The first trading period to include aviation emissions began at the start of this year and will end in 2013; it aims to reduce aviation emissions by three per cent compared to the average 2005-2006 levels.

Under the EU ETS rules, aircraft operators must monitor their planes' annual GHG emissions according to a plan approved by their member state's competent authority. Aircraft operators headquartered outside the EU are assigned an administering member state, to which they will report. Each aircraft operator must submit an annual report detailing activities and emissions by 31 March of the following year. This report needs to have been verified by an independent EU-accredited verifier prior to submission. Once verification is complete, aircraft operators have until 30 April to surrender allowances. Throughout the verification process, the verifier considers the national laws and legal framework of the administering member state—not those of the state in which the aircraft operator is based.

Several countries outside the European Union have spoken out against the EU ETS expansion, arguing instead for a solution through the International Civil Aviation Organization. A major concern for these countries is the fact that the emissions from the entire flight are counted, not just those emitted in EU airspace. Some non-EU countries have argued that this amounts to an infringement of sovereignty since the EU, they claim, is seeking to impose its laws beyond its own borders.

With speculation as to the possibility of a trade war between EU and non-EU countries, events came to a head when 23 non-EU countries met in Moscow. They issued a declaration detailing potential actions including prohibiting companies from participating in the scheme, a review of the open sky agreements, and possible fees for EU airlines when flying in non-EU airspace.

Despite the controversy, the EU has stood by its assertion that the addition of aviation emissions to the EU ETS is not only legal, but is currently the most cost-efficient and environmentally-beneficial solution•

Grete Luxbacher, London

The New START treaty: going well, as far as it goes

A little over a year has now passed since the US-Russian 'New START' agreement on strategic offensive nuclear arms came into effect. The pact was approved by the US Senate in December 2010 and by the Russian Parliament in January 2011. The following month, the two countries exchanged the relevant instruments of ratification and the active life of the treaty began.

New START requires each party to ensure that no later than seven years after entry into force they hold no more than 1,550 deployed strategic nuclear warheads apiece. The treaty also sets each party a limit of 700 deployed intercontinental ballistic missiles (ICBMs), submarine-launched ballistic missiles (SLBMs) and heavy bombers. A further limit, of 800, on deployed and non-deployed heavy bombers, ICBM launchers and SLBM launchers also applies.

So how has the treaty fared over its first year? On 22 December 2011, Rose Gottemoeller—the chief US negotiator for the New START treaty—wrote an article featured in *The Hill*, a Washington-based newspaper, in which she noted that the implementation of New START was 'going very well.' Since the treaty came into force over 1,700 notifications, which help to 'track movement and changes in the status of weapon systems', had been exchanged between the two parties. As Ms Gottemoeller explained, the US is 'constantly in communication with the Russians'.

These information exchanges have also been verified through two types of permitted inspection. Each party is offered ten 'Type 1' inspections and eight 'Type 2' inspections annually. In her article, Ms Gottemoeller announced that the US had at that point hosted 17 such inspections, allowing groups of inspectors into sensitive facilities, such as ICBM bases, to indirectly observe individual delivery systems and any warheads upon them. In return, Russia has hosted 16 inspections. The US experience so far, Ms Gottemoeller said, was demonstrating 'that the New START treaty is enhancing [US] national security by building predictability and stability between the United States and Russia'.

In an implementation update released by the US State Department on the one-year anniversary of New START's entry into force, it was revealed that both sides had by then conducted their full annual quota of 18 inspections, and that over 1,800 notifications had been exchanged over the past year.

The US State Department also noted that three 'exhibitions' have been carried out since 5 February 2011: one by the Russians and two by the US. The Russians exhibited their RS-24 mobile ICBM and launcher; the US exhibited its B-2A heavy bomber and demonstrated that its B-1B heavy bombers are no longer capable of carrying nuclear armaments. B-1B aircraft will thus no longer count toward the limits of the treaty.

Data released on 1 December 2011 revealed that as of 1 September 2011 the United States held 1,790 deployed strategic warheads and the Russian arsenal consisted of 1,566. (Earlier data released on 1 June 2011 revealed that in February 2011, Russia held 1,537 deployed warheads, meaning that Russia in fact *increased* its number of deployed warheads between February and September of last year.)

As far as delivery systems are concerned, as of 1 September 2011 the US reportedly held 822 deployed ICBMs, SLBMs and heavy bombers against the treaty limit of 700, while Russia had 516. When non-deployed delivery systems are included, which increases the total delivery system limit to 800, the US total stood at 1,043 while Russia's was then at 871•

David Cliff, London

Puffer fish toxin use thwarted

A federal criminal court in the United States is scheduled to sentence a man from Illinois, Mr Bachner, at the end of May for possession of a toxin with intent to use it as a weapon. The court found that Bachner had acted in contravention of the 1989 Biological Weapons Anti-Terrorism Act by ordering and receiving Tetrodotoxin (TTX), a highly deadly toxin, to poison his wife and claim millions of dollars in life-insurance pay-outs. TTX has no known antidote and is found naturally in puffer fish. Mr. Bachner could face life in prison and a fine up to $750,000.

This case highlights the importance of national implementation of the 1972 Biological and Toxin Weapons Convention (BWC). It demonstrates how implementation of the convention in domestic legislation, awareness of its applicability among private companies and its enforcement by suitably trained police investigators can prevent the use of biological weapons.

In Section 175, the 1989 Biological Weapons Anti-Terrorism Act criminalizes activities such as the acquisition, possession and retention of biological agents and toxins for use as a weapon. It also makes punishable the possession of biological agents and toxins of a type or in a quantity not justifiable for prophylactic, protective, bona fide research or other peaceful purposes. 'Section 175 was clearly legislation implementing the BWC' according to a judge of the court. Since Mr. Bachner possessed TTX in quantities for which he had no peaceful purpose and his intent was to kill his wife, these offences applied to his case.

TTX is also a legally-controlled substance. It appears on the US 'Select Agents and Toxins List', which requires persons who possess, use or transfer biological agents and toxins mentioned on the list to be registered with the Federal Centers for Disease Control and Prevention (CDC). However, an exemption from such registration applies if the amount of TTX is less than 100 milligrams. Mr. Bachner, posing as 'Dr. Backer,' placed an order of 98 milligrams of TTX for 'marine antitoxin research purposes.' While the amount of his order did not require him to register with the CDC, it was unusual enough to raise suspicion at the chemical distribution company where he had placed his online order. Since most purchases of TTX consisted of only two milligrams and his exceeded the company's single purchase maximum, the company notified the Federal Bureau of Investigation (FBI) and did not process his order.

Following the notification, agents from the FBI's Joint Terrorism Task Force, specialized in investigating offences related to weapons of mass destruction, organised a special delivery of the TTX to Mr Bachner by undercover agents. After he had taken possession of the box containing the TTX, he was taken into custody. This occurred within two weeks of the chemical company's initial notification. Mr. Bachner pleaded guilty to the charges in August 2011 and his sentencing hearing is scheduled to take place on 30 May 2012•

Yasemin Balci, London

Russia and the use of incapacitating chemical agents

The Russian Federation ratified the 1993 Chemical Weapons Convention (CWC) in November 1997. Around five years later, in response to a takeover of the Dubrovka Centre theatre in Moscow by a group of Chechen separatists, it pumped an unspecified gas, widely believed to be a derivate of an opiate fentanyl, into the theatre, in a bid to free the over 900 hostages. However, at least 125 hostages died and 700 were poisoned from exposure to the gas, as the investigation by the European Court of Human Rights (ECHR) found.

The Russian government claimed that the deaths were a result of natural causes and that the gas had, at most, minor direct effects, which had been aggravated by the victims' personal health problems. The surviving hostages and relatives of the deceased, however, considered the use of gas during the attack a violation of the right to life, as protected in Article 2 of the 1950 European Convention on Human Rights. They submitted the case (Finogenov and others v. Russia) to the European Court of Human Rights (ECHR), which has recently issued its verdict. The Court unanimously held that the inadequate preparation of the

rescue and evacuation operation and the lack of an effective investigation after the incident amounted to violations of Article 2. However, the use of gas during the theatre siege itself was considered a justifiable interference with the right to life.

Though the judgments of the ECHR are based on the 1950 European Convention on Human Rights, it could have taken other relevant international law—the CWC—into account. The decision by the ECHR not refer to the CWC may possibly result from the divergent interpretations among parties to the CWC over the treaty's provisions on toxic chemicals used for law enforcement. While the use of toxic chemicals for law enforcement, including domestic riot control is a 'purpose not prohibited' under the convention, there is some debate in CWC-related forums about whether incapacitating chemical agents, such as the one used during the Russian siege, are covered by this exemption.

The ECHR held that the use of the gas during the attack was not a disproportionate measure, and therefore not a violation of the right to life. The gas was dangerous and potentially lethal, but considering the 'real, serious, and immediate risk of mass human losses', the use of the gas, while putting lives at risk, had created a significant chance of survival. The gas had been pumped in with the intention of disabling the terrorists and evacuating the hostages.

The ruling that the use of gas was justifiable will be relevant for future judgments, though the outcome will always depend on the particulars of the case. Given the vast scale and complexity of this case, Russia was given a wide margin of appreciation. This means that, in deciding whether an act amounts to violation of a right, the Court grants the authorities some leeway.

Both the applicants and the government had three months from the date the decision was issue to appeal the verdict of the Court. This period expired this month and no notice of any appeal could be found•

Nayive Corzo, London

DPRK: study causes testing debate, new deal agreed

A forthcoming study by Swedish researcher Lars-Erik De Greer, reported in February 2012 in the journal *Nature*, suggests that North Korea may have carried out two nuclear tests in 2010. The trigger for De Greer's analysis was a small detection of radioactive xenon by South Korean scientists in May 2010, around the same time that North Korea made a (widely-dismissed) claim to have achieved nuclear fusion. Using radioisotope data from monitoring stations in Japan, South Korea and Russia—as well as meteorological reports from the time—De Greer concludes that the DPRK may have conducted nuclear tests in April and May of that year.

North Korea is currently known to have conducted nuclear tests in 2006 and 2009. And there is far from any consensus opinion behind these new findings. Rather, De Greer's analysis, which is to be fully-published in the April/May edition of *Science and Global Security*, has been met with a number of sceptical voices. Jeffrey Lewis of the Monterey Institute of International Studies in California, for instance, notes that there is nothing to suggest that another kind of nuclear incident, such as a reactor incident somewhere in the region, wasn't the cause of the radioisotopes that have led De Greer to his conclusions. Ola Dahlman, an ex-geophysicist who for many years was involved with the monitoring system of the Comprehensive Nuclear-Test-Ban Treaty (CTBT), also questions the lack of any supporting seismic evidence of a nuclear explosion. For its part, the organisation responsible for the CTBT has never officially analysed the data, despite the fact that some of its sensors were those used by De Greer in his analysis. Formal analyses are only conducted by the CTBTO if requested by the organisation's member states, and none have yet made such a request. As Lassina Zerbo, the head of the CTBTO's International Data Centre, has noted though, De Greer's work may encourage member states to re-examine the data and possibly ask the CTBTO to look into the issue more closely.

Early 2012 also saw a significant new deal reached. On 29 February, the DPRK agreed to a moratorium on nuclear testing and long-range missile launches, as well as agreeing

to halt uranium enrichment at its Yongbyon nuclear site. The so-called Leap Day deal—reached following bilateral talks between the DPRK and the US—also provided for IAEA access to Yongbyon to monitor the enrichment freeze and to confirm the disablement of North Korea's 5MWe reactor (shut down in 2007). In return for these actions, the US announced its intention to provide an initial 240,000 metric tons of food aid, 'with the prospect of additional assistance based on continued need.'

The return of IAEA inspectors to North Korea would represent a significant development for efforts to improve relations between the DPRK and the West—and potentially for efforts to secure the renunciation of nuclear weapons by the regime in Pyongyang altogether. IAEA inspectors were ejected from North Korea in April 2009. On 16 March 2012, the IAEA announced that it had received an invitation from North Korea to request their return. But that same day, the DPRK *also* announced that in mid-April it planned a satellite launch that many see as cover for a long-range missile test of the kind that on 29 February it said it would stop.

The planned launch—set for 15 April and timed to mark the 100th anniversary of the birth of North Korean founder Kim Il-sung—has cast a dark shadow over the implementation of the Leap Day deal. The US has already suspended the planned food aid in response to the impending launch. The last such satellite launch by North Korea, in 2009, was condemned by the UN Security Council and led to both North Korea's withdrawal from the six-party talks process, the aforementioned ejection of IAEA inspectors and a second North Korean nuclear test. As Mark Fitzpatrick of the International Institute for Strategic Studies wrote recently: 'It is easy to see events now playing out as they did three years ago. The 15 April test launch will undoubtedly provoke a similar rebuke [by the UN]. Given the symbolism of the satellite launch on Kim Il-sung's birthday, that rebuke will not be worn lightly. It would not be too surprising if Pyongyang then abrogated the Leap Day deal and set off another nuclear explosion.'•

David Cliff and Ariane Tabatabai, London

Verification Quotes

The science of measurement is essential in underpinning the transition to a low carbon economy. As the UK is a world leader in both measurement science and the centre of the global carbon market it is only right that we develop the right infrastructure to support this transition. The Centre for Carbon Measurement at NPL is designed to do this, to provide reliable measurements with a sound scientific and technical basis that will improve the understanding of the global climate, support policies for mitigating climate change, and accelerate the development of low-carbon technologies' —David Willetts, UK Minister for Universities and Science, 26 March 2012, speaking about the opening of the Centre for Carbon Measurement at the National Physical Laboratory in London.

Data from ground based stations and satellites is fed into climate models, and they spit out conclusions on things like sea level rise and other climate impacts. So the better data we have, the better we can make the models' —Jane Burston, head of the Centre for Carbon Measurement (CCM), 26 March 2012, explaining why their work matters. The CCM will, among other things, improve the computer models that are just about the only tools scientists have to project the future of our warming planet.

This milestone is yet another demonstration of the shared commitment of the OPCW, its states parties and the global chemical industry to ensuring that chemistry is only used for peaceful purposes. By increasing the number of OCPF inspections in the coming years, we will improve our capacity to verify compliance with the provisions of the Chemical Weapons Convention and thereby raise the level of confidence among all our stakeholders'—OPCW Director-General Ahmet Üzümcü, 15 March 2012, speaking on the occasion of the 1,000th audit of an 'Other Chemical Production Facility' (OPCF). These are plants that could be converted to the production of chemical warfare agents.

Science & Technology Scan

The helium-3 shortage and its verification impact

Over the past decade, a resource crisis has been brewing within nuclear safeguards and national border control agencies. Since the attacks of September 11th, the demand for fissile material detectors has skyrocketed. Consequently, supplies of helium-3, a core component of such detectors, have plummeted. The situation has become so severe that in one case the price of helium-3 was seen to jump by approximately 2000 per cent over one year. As this shortage worsens, small nations hoping to install effective fissile material detectors at their borders may soon find themselves priced out of the market.

While regular helium is the second most common element in the universe, the helium-3 isotope is extremely rare. The vast majority of helium-3 is actually sourced from stocks of aging nuclear weapons. As these weapons age, the tritium contained in their neutron initiators gradually decays into helium-3, which has to be extracted to preserve the weapon's reliability. But this decay is not particularly rapid. It takes over 12 years for one kilogram of tritium to produce only 500 grams of helium-3. According to a 2010 price estimate from a physicist at the European Organization for Nuclear Research (CERN), 500 grams of helium-3 could cost upwards of USD8 million.

According to rough calculations by Geoffrey Forden, formerly of MIT, a typical portable neutron detector could require approximately 93 grams of helium-3. So, although this quantity will last a lifetime, it is becoming prohibitively expensive to acquire in the first place. Considering the above price estimate, the helium-3 required for one detector could cost as much as USD1.4 million. Thankfully, efforts have been undertaken by the US Department of Energy (DoE), the dominant international supplier of helium-3, to direct its sale to areas of priority. An interagency policy committee has made the supply of helium-3 to programmes for detecting fissile material at foreign and domestic borders and ports a high priority, second only to research programmes that rely exclusively on helium-3.

While this prioritisation has enabled the border control and safeguards communities to continue acquiring helium-3-based neutron detectors, it has hit many scientific institutions hard. It is also uncertain how sustainable such controlled distribution is in the long run. At the start of this year, the DoE was releasing on average 14,000 litres of gaseous helium-3 to markets per year, while producing only approximately 9,000 litres.

Despite efforts from the US Government Accountability Office and the Congressional Research Service, there seems to be no clear and immediate remedy to this problem. Increasing domestic production of tritium, and consequently helium-3, would have little effect in the near-term due to the long decay time of tritium. Importing helium-3 is similarly problematic. Russia has frozen exports and few alternative sources remain. As helium-3 can be simply converted back into tritium, a key component in modern nuclear weapons, some states have a blanket ban on exports.

Unless this deficit is addressed, it is highly likely that the price of helium-3 will continue to rise for those outside the perceived interests of the suppliers. Under UN Security Council Resolution 1540, all states are required to 'develop and maintain appropriate effective border controls and law enforcement efforts to detect, deter, prevent and combat the illicit trafficking of [nuclear materials]'. Fissile material detectors will inevitably play a key role in this. Indeed, 15 of the 40 requests for technical assistance to the 1540 Committee mention explicitly the provision of nuclear materials detection equipment. As this shortage worsens, it is unlikely that the US-led provision of technical assistance in this area will be able to compete with the domestic demand for helium-3. And like the struggling scientific institutions, states may soon have to put elements of their 1540 implementation on hold for lack of resources•

Hugh Chalmers, London

Promising plastics

Scientists in the US have recently developed a material that can help sift through the large quantity of radioactive materials observed both during nuclear safeguards inspections and national border screenings, identifying any that might be of concern. The team, from Lawrence Livermore National Laboratory (LLNL), have designed a new plastic that emits a characteristic glow when exposed to atomic particles known as neutrons. These miniscule, electrically-neutral particles are radiated from materials by the same fission process which, when forced into a chain reaction, creates a nuclear explosion.

Unlike other forms of radiation, such as gamma rays, significant quantities of neutrons are a convincing indication of the presence of fissile, rather than simply radioactive, materials. As such, neutron detectors are used extensively throughout the international nuclear safeguards regime, the verification protocol of the New START agreement and at large ports and border crossings. These detectors can vary considerably in size, shape and operating technique, depending on the task at hand. For example, the IAEA manual on safeguards techniques and equipment lists over 30 different neutron detectors for measuring both fresh and irradiated nuclear fuel in its various forms.

The vast majority of these detectors currently utilise the same physical principles and require the same material, namely gaseous helium-3. When held under pressure within an electric field, this gas produces a detectable electric signal when exposed to neutrons. Unfortunately the design and production of these neutron detectors is restricted by the required operating conditions of the gas and by the scarcity of helium-3 (see previous article). While thought to be highly abundant on the surface of the moon, this isotope of helium is rarely found naturally on Earth.

Other effective detectors have been developed that do not rely on helium-3, but instead rely on a process called 'scintillation'. Scintillating materials emit characteristic pulses of light when exposed to various forms of radiation. If these pulses are both detectable and distinguishable these materials can serve as neutron detectors. Until recently only a few such discriminatory scintillators were known. Stilbene, an organic crystal, is typically considered the best scintillator for neutron detection, but growing crystals to practical shapes and sizes is both costly and time-consuming. Liquid scintillators are known to exist, but practical application is also hampered by their toxicity, flammability and sensitivity to external factors.

Scientists have therefore been looking to cheaper, more reliable materials such as plastics for suitable scintillators. Unlike organic crystals, plastics are cheap to produce and can be easily fashioned into various shapes. While a number of scintillating plastics have been produced, until now none were capable of discriminating between neutrons and gamma rays. After experimenting with a variety of plastic dyes, the LLNL scientists have hit upon a winning combination. By embedding a compound called polyvinyltoluene (PVT) with a scintillating dye named 2.5-diphenyloxazole (PPO), they were able to achieve an efficient and usable level of neutron-gamma ray discrimination.

At this early stage of development, it is hard to determine exactly what impact this advance will have on the use of neutron detectors in the international nuclear safeguards regime. However their results, published in *Nuclear Instruments and Methods in Physics Research*, show a great deal of promise. Their plastic is cheap and easy to fabricate into any number of shapes and sizes, making it applicable for fissile material detection at all scales, from small IAEA safeguards inspections to large fixed cargo monitors. Indeed, plastic scintillators could grow to play a vital role in national border monitoring activities as states pursue cheap and effective implementation of their commitments under UN Security Council Resolution 1540•

Hugh Chalmers, London

VERTIC News & Events

National Implementation Measures Programme

The NIM team ended the first quarter of 2012 having completed six legislation surveys on implementation of the Biological and Toxin Weapons Convention (BWC), two technical assistance visits and comments on three draft bills. The team has also started work on expanding the programme to include a legislative response to the illicit trafficking of radioactive and nuclear materials. This expansion has necessitated a major restructuring of the NIM Programme's data management and information-sharing systems, as well as updates to the programme's web pages. Programme staff have also been working closely with the VERTIC Arms Control and Disarmament Programme to finalize a pilot project report on the illicit trafficking of nuclear and other radioactive materials. For more information, see the article 'The international legal regime to control CBRN weapons and materials: national implementation evolves' on page 13 of this edition of *Trust & Verify*.

On 19 January, the NIM team met Mrs Grace Asirwatham, Deputy Director-General of the Organisation for the Prohibition of Chemical Weapons, during an NGO meeting in London. On 23 January, NIM staff attended an International Working Group discussion entitled 'Global Partnership—2012 and Beyond' in Washington, DC.

NIM staff also discussed the outcomes of the BWC Seventh Review Conference, organized by the Harvard Sussex Program and the Foreign and Commonwealth Office in Brighton, UK, on 8 March. And from 12-14 March, NIM staff presented on national implementation at a seminar in Bogota, Colombia on UN Security Council Resolution 1540 implementation in the Andes Region, which was organized jointly by the Stimson Center, the Stanley Foundation and the Colombian Ministry of Foreign Affairs. In addition, the NIM Programme sent a legal expert to the CBRN Centres of Excellence meetings in Southeast Asia and, at the end of March, NIM staff also participated in the Wilton Park Conference on the future of the Australia Group•

Arms Control and Disarmament Programme

The past three months have been as busy as ever for the VERTIC Arms Control and Disarmament Programme. In January, the programme released a new briefing paper on 'Multilateral verification: Exploring new ideas', by David Cliff and David Keir, which aims to present some of VERTIC's thinking on the potential role and benefits of intergovernmental organizations in verifying nuclear disarmament. The paper is publicly available for download on the VERTIC website.

February then saw programme staff travel to Brussels, Belgium, to take part in the EU Non-Proliferation and Disarmament Conference. At the meeting, Andreas Persbo chaired a panel discussion on the 'Proliferation Case Studies' of North Korea, Pakistan and Syria. February also saw the programme deliver a lecture at the Scuola Sant'Anna,

Italy, on the Iranian nuclear programme. An article on the same topic—written by David Cliff—will appear in the magazine of the Scuola Sant'Anna, *International Commentary*, in early April.

In addition, February saw the VERTIC ACD programme host Dr John Walker of the UK Foreign and Commonwealth Office, whose book *Britain and Disarmament* has recently been released by Ashgate Publishing. The book considers the UK's nuclear, biological and chemical weapons programmes between the years of 1956 and 1975, and represents the product of meticulous and extensive research by Dr Walker.

In March, programme staff travelled to New York City in the USA to participate in a seminar on CTBT verification organised jointly by VERTIC and the EastWest Institute. The seminar saw Jenifer Mackby of CSIS in Washington and Edward Ifft of Georgetown University speak on the International Monitoring System of the CTBT and the treaty's on-site inspection provisions respectively. The event was well-attended with representatives from UN missions, academic institutions and non-governmental organisations. VERTIC is grateful to Jacqueline Miller and her staff at EastWest for all their assistance and support in organizing this meeting, as well as to Ms Mackby and Dr Ifft for participating.

Also in March, the ACD team travelled to Johannesburg, South Africa, for a meeting it had organised under its project on intergovernmental involvement in disarmament verification. This meeting, which involved participants from a number of non-nuclear-weapon states as well as an intergovernmental organization, generated insightful and practical discussions as well as future work plans. VERTIC wishes to express its thanks to all those who contributed.

March also saw the programme represented in a SIPRI seminar on nuclear security in Stockholm, Sweden, as well as in an IISS-run meeting on 'Fostering International Dialogue on Korean Security' in London. In addition, Mr Persbo presented on the Iranian nuclear issue at an International Law Association meeting on arms control law. Finally, March saw the ACD team and VERTIC's NIM team collaborating in a meeting with the United Nations Office on Drugs and Crime to finalise VERTIC's report on the illicit trafficking of nuclear and radioactive materials•

Environment Programme

During this quarter the Environment programme continued its initial research into Arctic affairs by reviewing the Arctic Nations' High North policy and investigating Indigenous Peoples' Rights, as well as the effects of climate change. Further research was also completed on the production and trade of commodities associated with deforestation.

Over the last three months the VERTIC blog has had several environment articles including on emissions monitoring in China, the UN climate change conference in Durban, the EU emissions trading system and black carbon•

VERTIC Reflections

At VERTIC, we saw the first quarter of 2012 pass by in a flurry of activity. It is almost hard to believe that we already are publishing another edition of *Trust & Verify*. My own personal highlight this quarter was being given the honour of chairing a panel at the first ever European Union Non-Proliferation Conference in Brussels. But I also enjoyed travelling to Pisa, Italy, to deliver a lecture at the stunningly beautiful Scuola Superiore Sant'Anna.

Many other activities have been happening around the organisation as well, as the staff news section of this edition attest. We have been busy not only delivering on projects, but also with the conceptualisation of new ones. So, we may have some very interesting announcements in the coming months. For instance, our pilot work on the illicit trafficking of nuclear and radioactive material is almost completed, and a very substantial research report on the implementation framework is undergoing final revisions. We may also make some big announcements on a new assistance programme on the Additional Protocol. There are many exciting things are on the horizon.

But many changes are also happening internally. Our Board of Trustees have also undergone a transition. On 21 February, Dr Edwina Moreton took over the reigns from Owen Greene and Sir Hugh Beach. A new chair is always an exciting time, and one that often heralds new ideas and fresh opportunities. So we will have many things to discuss and decide at our upcoming Strategic Review, scheduled for June 2012•

Andreas Persbo, Executive Director

Grants and Administration

This quarter, VERTIC focused on project delivery and the implementation of existing grants. We also secured a grant from the US Department of State, Federal Assistance Award, for our National Implementation Measures (NIM) work. VERTIC is grateful to its funders for their continued support.

VERTIC held its Annual General Meeting on 21 February 2012. The Board of Trustees selected Dr Edwina Moreton to be the new Chair of the Charity. Andreas Persbo, Executive Director, thanked Sir Hugh Beach and Owen Greene for their work as co-chairs and noted that he was looking forward to Edwina Moreton's contribution to the charity as chair. The Board also selected Sir Hugh Beach as President of the Charity. Andreas Persbo said that VERTIC has been honoured to have Sir Hugh serve on the board for almost two decades, and welcomed him to his new role. All existing trustees who had served more than three years on the board resigned and were re-appointed under our current Articles of Association.

VERTIC's internship programme continues to thrive and attract strong applicants. We currently have Ariane Tabatabai supporting the Arms Control and Disarmament Programme and both Ghada Awad and Nayive Corzo supporting the National Implementation Measures Programme. Finally, we would like to thank Gabriele Loche, Grete Luxbacher, Nibras Hadi and Ryoji Sakai for their contributions to VERTIC•

VERTIC Social Media

If you don't already, be sure to check the VERTIC Facebook page regularly for news updates, new and forthcoming publications and new posts on the VERTIC blog. And 'like' us to receive updates direct to your own News Feed. If you're on Twitter, you can also follow VERTIC this way to stay fully up-to-date with all our activities. VERTIC tweets regularly about what we're up to in our offices in London and around the world, and from international conferences that we attend—including treaty review meetings and the IAEA General Conference.

Facebook:
http://www.facebook.com/pages/VERTIC/133964093289150

VERTIC's Facebook page (pictured left) features updates on news and events at the organisation. We regularly add to the feed with VERTIC blog posts, publications, news and other goings-on here in London and in all the other locations that VERTIC staff operate.

'Like' our page to see notifications of VERTIC activities on your own Facebook feed.

Twitter:
@vertic_org

You can also stay up-to-date with what's going on at VERTIC, and in the issues that we work on, via our Twitter page (see left).

Here, we also post updates from other organisations and sites on items and events relevant to all VERTIC activities.

In memoriam: Brian Jones, 1944-2012

VERTIC's staff were saddened to learn of the death of verification practitioner, Dr Brian Jones, on 10 February 2012 and offer their sincere condolences to his family, friends and colleagues. A trained metallurgist, Dr Jones researched structural materials for nuclear reactors, submarines, helicopters and jets in various posts before joining the Defence Intelligence Staff of the UK Ministry of Defence in 1987, where he worked until his early retirement in 2003. Unable to redress the unsubstantiated claims about Iraq's weapons of mass destruction capabilities in the British government's flawed dossier before its release, particularly the assertion that Iraq could launch chemical weapons within 45 minutes of an order to do so, in his role as a Defence Intelligence Analyst, he was able to put the record straight in his evidence to the Hutton inquiry into the death of Iraqi weapons inspector Dr David Kelly after he had left the MoD. It was around this time, when he returned to academia to research and lecture on WMD intelligence issues, that Dr Jones became involved in VERTIC's work. He wrote an insightful chapter on 'Intelligence, verification and Iraq's WMD', which discusses the relationship between compliance verification and intelligence assessments in the context of Iraq's WMD programme, for our Verification Yearbook 2004 and gave a presentation on this topic at the Yearbook launch event. His words ring as true today as they did eight years ago: 'The onus must therefore be on the verification organization to continuously review the quality of intelligence advice on the basis of direct experience and to consider this as a factor in making its assessments.'

He is survived by his wife, Linda, and two sons•

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building trust through verification

VERTIC is an independent, not-for-profit nongovernmental organization. Our mission is to support the development, implementation and effectiveness of international agreements and related regional and national initiatives. We focus on agreements and initiatives in the areas of arms control, disarmament and the environment, with particular attention to issues of monitoring, review and verification. We conduct research and analysis and provide expert advice an information to governments and other stakeholders. We also provide support through capacity building, training, legislative assistance and cooperation.

PERSONNEL Andreas Persbo, *Executive Director*; Angela Woodward, *Programme Director*; David Keir, *Senior Researcher*; Larry MacFaul, *Senior Researcher*; Scott Spence, *Senior Legal Officer*; Hassan Elbahtimy, *Researcher*; Rocío Escauriaza Leal, *Legal Officer*; Yasemin Balci, *Associate Legal Officer*; David Cliff, *Researcher*; Unini Tobun, *Administrator*; Hugh Chalmers, *Consultant* (2011-12); Sonia Drobysz, *Consultant* (2010-11); Ghada Awad, *Intern* (March-June 2012) Nayive Somaira Corzo *Intern* (February-May 2012); Grete Luxbacher, *Intern* (November 2011-April 2012); Ariane Tabatabai, *Intern* (February-May 2012).

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