# IMS records North Korean blast and Russian meteor strike

Over a few days in February, disparate events in North Korea, on the one hand, and Russia, on the other, have shone a light on the capabilities and usefulness of the international monitoring system developed for the Comprehensive Test Ban Treaty. Detecting the first event—a nuclear explosion—is the monitoring system's raison d'être. But its assets can also be used to spot and gather data on other phenomena, such as earthquakes, and, as events in February showed, meteor strikes.

On 12 February 2013, the Democratic People's Republic of Korea (DPRK) announced that it had conducted its third nuclear weapon test. Hours before the announcement, data started to flow in from the international monitoring system indicating a seismic activity in North Korea. This gave considerable credibility to DPRK's announcement that they had indeed conducted an explosive test. The likelihood of it being independently confirmed as a nuclear test increased as data analysis indicated that the seismic event was centred on the area where the North Koreans have an established nuclear testing site.

Nuclear weapons tests can be conducted in different mediums and the international monitoring system was design to address this challenge. Such tests were once carried out above-ground—sometimes on towers and sometimes as air-bursts. These early tests yielded both very large explosions and also a great deal of environmental pollution of a radioactive nature. Beginning from the 1970s, tests were increasingly carried out underground, in boreholes or in curved horizontal tunnels, the test hole being back-filled to contain the blast and prevent or minimize fallout. Not all were successful in containing the event and the infamous Baneberry test at Nevada in the USA was a case in point. Placed some 270 m

## In this issue




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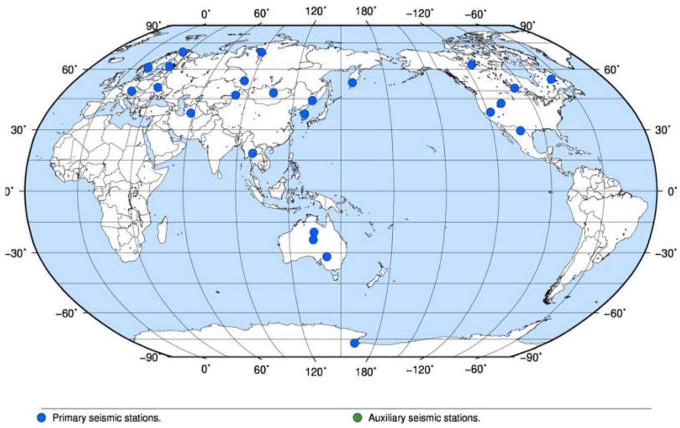
below the surface of the desert the Baneberry blast raised a plume of fallout which exposed people at the test site and beyond to unacceptable levels of contamination and radiation doses. Some of the last tests carried out by France were under the sea bed at Mururoa in the Pacific Ocean, the latest of which took place on 27 January 1996.

Nuclear explosions consist of a near-instantaneous release of a very large amount of energy that propagates through whatever medium surrounds the device, whether that is air, soil, water or a combination of these. Shockwaves produced by this sudden release of energy can be detected, in some cases very far away from the test, and collected as a stream of data in real time. This information can then be analysed further by specialists.

The international monitoring system was set up to have global coverage and consists of an array of seismic monitoring stations, infrasound detectors, hydro-acoustic detectors and radionuclide monitoring stations, situated across many countries around the world. Seismic stations are well-equipped to detect underground tests and it was through these stations that early data started to flow about the explosion in North Korea. Analysis of seismic waves can provide indicators for several characteristics of an underground explosion including its strength, location and sometimes also the depth at which it occurred.

On the 12th of February, the preparatory commission of the Comprehensive Test Ban Treaty Organisation (CTBTO)– which manages the international monitoring system—provided an initial analysis on the event based on data from 25 monitoring stations. A few days later, their analysis was updated to take account of information coming from a total of 96 monitoring stations. The organisation estimated the magnitude of the seismic activity to be 4.9 and the source of the event was confirmed to be corresponding to the location previously identified for North Korean tests in 2006 and 2009. The system's infrasound stations also detected the event.

Although the seismic strength of the tremor provides indications to the possible size (or yield) of the underground explosion, calculating a reliable estimate for this yield can be challenging. Shockwaves travel through various geological formations before they reach seismometers. These formations need to be taken into account in order to arrive at an accurate calculation of yield. This exercise is particularly challenging in the North Korean case due to the lack of sufficient information about the geology of the site and the nature of the underground cavity in which the nuclear explosive was placed. The preparatory commission of the CTBTO does not provide any estimation of nuclear yield for events since their legal mandate under the treaty does not allow them to engage in this kind of analysis. However, various independent research institutions utilised the seismic data to calculate the yield of the explosion. Their estimates range between seven and twenty kilotonnes.




First IMS seismic station detections of the North Korean test (CTBTO).

While seismic data alone can often distinguish between an earthquake and a large underground explosion, it cannot conclusively establish whether the explosion was actually nuclear or from conventional ordnance. But detonating conventional explosives instantly to give a signal comparable to a nuclear blast would be both challenging and difficult to conceal. The explosives would need to be wired in a way that ensured uniform and simultaneous detonation of the whole charge. The explosives would need to be transported to the site, requiring hundreds, possibly thousands, of truckloads. Also the material would need to be stacked into a single charge in an underground location.

So, although the seismic signature of the recent DPRK event provides important indicators, it is air samples taken for radionuclide analysis that would provide more conclusive evidence about the nature of the detected explosion and particularly whether it was a nuclear device. Particulate fission products could confirm this but advanced containment measures can prevent the escape of such particles. It is likely that such analysis would therefore focus on the noble gas fission products generated by the nuclear blast that can seep through and leak into the air. Of these xenon and krypton are of particular importance, and xenon is the more likely to be detectable given its relatively longer half-life than krypton.

Sampling of the air after previous tests by North Korea yielded mixed results. Following the North Korean test of 2006, traces of a xenon isotope above expected levels were detected by a radionuclide station in Canada. Atmospheric modelling showed that the detected xenon could be traced back to the North Korean event. However, for the 2009 test no such traces were detected and, so far, no relevant radionuclides have been detected in association with the most recent test. The CTBTO's spokesperson, Ms Annika Thunborg, was quoted by Reuters on 12 March 2013 saying that 'it is very unlikely that we will register anything at this point ... at this late stage'

In the case of a nuclear explosion, several factors can interfere with the detection of noble gas fission products. Air currents, wind and meteorological conditions more generally, will play a big role in the direction and rate of dispersal of such xenon. As radionuclides drift with the wind, the collection and analysis of this data takes much longer than seismic detection: days, or weeks is a typical lag time. In addition, although noble gases are perhaps more likely to seep through than particulate fission products, if a nuclear explosion is buried deeply and contained effectively then neither may be detectable. Conclusive evidence on the true nature and exact parameters of the test could be facilitated through direct access to the test site. But since no such access is envisioned, the international monitoring system plays the key role as an independent and credible source of information.

### *A brief history of nuclear testing*

While nuclear weapons testing had been a prominent feature of the cold war, its salience had significantly decreased by the mid-1990s. More than 2,000 nuclear weapon tests took place since 1945. Of these, the vast majority were exploded underground while about 550 were detonated in the atmosphere or underwater. By 1996, all nuclear weapons states recognised by the NPT had stopped nuclear testing. This was also the year that negotiations for the CTBT were concluded and the treaty was opened for signature. Since then a handful of countries have carried out nuclear weapon tests including India, Pakistan and North Korea.

Testing is not strictly necessary for developing a nuclear weapon. The first weapon ever used—'Little Boy'—was an untested gun-assembled design. There are other examples. According to Israeli nuclear historian Avner Cohen, Israel had developed primitive nuclear devices by 1967 and perhaps more advanced designs later. Yet, Israel probably never conducted a nuclear weapons test at this early stage. Also, a study by the US National Academy of Sciences asserts that, 'without testing, South Africa produced six modernized lighter U-235 gun-type weapons.' Sweden, while drawing up final plans for its weapons programme, decided in 1962 that nuclear testing was 'desirable', but not necessary.

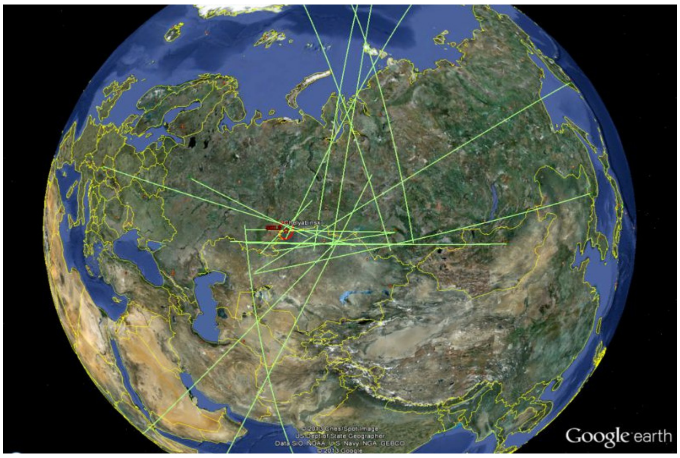
However, countries may conduct tests for different reasons. States might want to conduct both assessment trials and safety trials to develop high-yield, reliable, and lightweight nuclear weapons for missile delivery. Thus, while a state may be able to develop a functional design without testing, they may face challenges should they want a missile-deliverable weapon. And of course, military planners tend to want the highest assurance possible that a weapon will work when deployed.

## Meteor strike

A few days after the North Korean event, the international monitoring system played a prominent role in providing information on another event of a completely different nature, showing the diverse uses such a system can be put to. On the 15 February a meteoroid entered Earth's airspace and split apart over the Ural region—causing havoc and many injuries in the Russian region of Chelyabinsk. Meteoroids are space rocks that plunge toward earth at high speed. As they enter the airspace, they burn up due to friction, at which stage they are referred to as meteors, and either completely burn up before impact or hit the surface as meteorites, causing damage in line with their size.

During their journey in airspace, meteors produce shockwaves that, if strong enough, can blow out windows and shake buildings. But they also produce infrasound (sub-audible signals) which can be picked up by the international monitoring system of the CTBT.

The preparatory committee of the CTBTO announced that the infrasound network did indeed detect the signals from the Russian meteor event through 17 infrasound stations. According to a CTBTO acoustic scientist, 'the observations are some of the largest that CTBTO's infrasound stations have detected.' This superseded the bolide explosion over Sulawesi in Indonesia four years ago which was detected by 15 IMS infrasound stations.




Detections of the meteor strike by IMS infrasound stations (CTBTO).

Currently the IMS has 45 stations in operation to detect infrasound signals and events. As with seismic stations, infrasound stations provide rapid estimations of event location and can identify some of its properties. Unlike seismic stations, which were already abundant when the international monitoring system was conceived, infrasound detection stations are relatively new and most if not all had to be built from scratch. Infrasound stations include micro barometers to detect low frequency acoustic waves and transform them into electronic signals for further analysis. Because low frequency infrasound waves suffer less attenuation than sound waves, they travel far and can be detected in areas remote from their source. For example, infrasound signals from the Russian meteor were detected some 15,000 kilometers away in Antarctica.

Infrasound detection was mainly intended to monitor atmospheric or shallow underground nuclear blasts. But such signals are also produced by a variety of natural events such as volcanos and earthquakes as well as man-induced events such as chemical explosions and aircraft and missile launches, among others. Visual evidence clearly ruled out that the infrasound signals detected from the Chelyabinsk meteor were of a nuclear nature, but analysis of the signals themselves also clearly demonstrated this. As the meteor fell toward the ground it produced signals that changed direction, indicating that they did not originate from a single or fixed event like a nuclear explosion but rather from a moving object. Data provided by the international monitoring system has proved very useful for scientists around the world to analyse and gain deeper understanding of the event and will no doubt contribute to the ongoing study of meteors.

Both the North Korean test and the Chelyabinsk meteor indicate how the international monitoring system has proved itself useful as a timely and independent source of data to CTBT member states and beyond. It also shows that the slow but steady growth in the number of monitoring stations has increased the sophistication of a system capable of identifying nuclear tests, and of providing valuable data that enhances our understanding of natural events. •

Hassan Elbahtimy and David Keir

*Hassan Elbahtimy is a VERTIC researcher. David Keir heads the VERTIC Verification and Monitoring programme.*

## *New publication*

*'The Future of the CWC: implications for national implementation'* in *'The future of the CWC in the post-destruction phase'*, edited by Jean Pascal Zanders, Report No 15, EU Institute for Security Studies, March 2013. In this article, Yasemin Balci discusses the current status of national implementation of the Chemical Weapons Convention (CWC) and the implications from future developments in security, science, technology and the chemical industry on the convention and its implementation. See http://www.vertic.org/media/assets/Publications/EUISS15-The_future_of_the_CWC.pdf. •

# Verification Watch

## UN launches investigation into alleged CW use

David Cliff, London

Twenty-five years ago, on 16 March 1988, Iraqi planes attacked the Kurdish town of Halabja in northern Iraq with poison gas and nerve agents. The assault—which took place alongside a genocidal campaign then being waged by Saddam Hussein against Iraq's Kurdish minority—left some 5,000 people dead. Thousands more were injured. Today, 25 years on from Halabja, chemical weapons have allegedly been used again in the Middle East, this time as part of Syria's ongoing civil war. In mid-March, it seems that longstanding concerns—shared by Western governments and regional powers alike—over chemical weapon stockpiles in the country may have been realised in an incident in the north of the country, near Aleppo. Who is responsible for the incident remains unclear since both the Assad government and the rebel opposition have accused each other of carrying out the attack.

The Chemical Weapons Convention (CWC), which has been in force since 1997, expressly prohibits the development, production, stockpiling and use of chemical weapons. Under the CWC, states parties are subject to inspections at chemical production and stockpile facilities, to ensure that chemicals are not being made into weapons and that any stored chemical weapons are being disposed of according to the requirements of the convention. Procedures for 'clarification' and challenge inspections, which can be initiated by any CWC member state, are also included as part of its provisions in the event of alleged use.

Since it opened for signature in 1993, 188 states have joined the CWC. Syria, however, is not one of them, and is therefore not bound by its terms. However, the state remains banned from using any chemical weapons by both the 1925 Geneva Protocol, which it joined in 1968, and by the prohibition on their use under customary international law.

On 21 March the United Nations secretary-general, Ban Ki-moon, announced that in response to a request from the Syrian government he was launching an investigation into the alleged use of chemical weapons in the country, focusing in particular on Syrian government claims that rebels used chemical weapons on 19 March in the Khan al-Asal region of Aleppo province. Rebel commanders, for their part, say that chemicals were indeed used there on that day, but accuse the regime of doing it.

Speaking to reporters in New York, Mr Ban noted that the UN would be operating pursuant to General Assembly resolution 42/37 C of 1987—which provides for UN member states to report possible uses of chemical or biological weapons to the secretary-general for investigation—and Security Council resolution 620, of August 1988, which encourages the secretary-general to carry out prompt investigations in response to such allegations by member states. These instruments, which predate the CWC, are written in terms of 'upholding the authority' of the Geneva Protocol, which—as noted above—Syria is bound by. In this case, the investigation has been set in motion at the request of Syria itself, but the so-called Mechanism for Investigation of Alleged Use could have be triggered by a request from any UN member state.

The investigation is to be headed by the Swedish scientist Ake Sellstrom, with support from the Organisation for the Prohibition of Chemical Weapons, which is the implementing body for the CWC, and the World Health Organization. Little information is currently available as to what kind of team composition will be used and what reporting practices will be followed.

In addition, though, it is unclear whether (and if so, when) the investigative team will be able to get into Syria to do its work. Security there remains precarious; only last year UN personnel operating as the UN Supervision Mission in Syria were pulled out of the country as it was deemed too dangerous for them to remain.

If the use of chemical weapons is confirmed in Syria, then individuals could, in time, end up before the International Criminal Court (ICC) as suspected war criminals. According to the Rome Statute—by which the ICC was established—the use of poison or poisoned weapons, as well as 'asphyxiating, poisonous or other gases, and all other analogous liquids, materials or devices' constitute war crimes if used in international armed conflicts (see Article 8, part 2 of the statute). Syria's war is a civil conflict, of course, not an international one, but in 2010 the Rome Statute was amended so that these same provisions now constitute war crimes in the case of 'non-international armed conflicts' as well. VERTIC Brief No. 14, published in February 2011 and available on our website, provides an analysis of the Rome Statute, and its relevance to chemical and biological warfare.

Although 122 countries have now ratified or acceded to the Rome Statute, Syria (as with the CWC) has not joined. This means that the ICC has no jurisdiction there unless the Syria case is first referred to it by the UN Security Council. Should that happen, then any use of chemical weapons in Syria could potentially lead to individuals from all sides—government and rebel alike—being brought to the court in The Hague to stand trial for their actions. •

## Arms Trade Treaty passes with vast majority at UN

David Cliff, London

As *Trust & Verify* went to press, the Arms Trade Treaty—developed to establish 'the highest possible common international standards' for the global trade in conventional arms—had been adopted only a matter of days previously by a vote in the UN General Assembly. The week before that, after a ten-day period of negotiation, the adoption of the draft treaty by consensus was blocked by Iran, North Korea and Syria. As a result, the treaty was sent to the 193-member General Assembly, where a simple majority was all it required to pass. In the end, it was approved by a vote of 154-3, with 23 abstentions. Iran, North Korea and Syria were those that voted against—predictably so, given their prior moves to block the treaty. Russia and China, both major arms exporters, were among those abstaining.

The Arms Trade Treaty has been years in the making. In 2012, a long-awaited negotiating conference ended in a failure to reach agreement, but states reconvened this March in what was headed the 'Final United Nations Conference on the Arms Trade Treaty'—a last attempt to find sufficient common ground to conclude a deal.

The scope of treaty ranges from small arms and light weapons to tanks, combat aircraft and warships. Large-calibre artillery, missiles and missile launchers are covered also. Among the key provisions of the agreement are requirements for states not to transfer any conventional weaponry if it has knowledge beforehand that they would be used to commit genocide, crimes against humanity, 'grave breaches' of the 1949 Geneva Conventions, attacks against civilians, 'or other war crimes as defined by international agreements' to which the exporting state is party.

States are required by the treaty to assess the extent to which arms exports 'would contribute to or undermine peace and security' and the extent to which they could be used to commit or facilitate serious violations of international law. Exporter states need to consider whether there are any measures that could be taken—such as confidence-building steps or joint initiatives between exporter and importer—to mitigate such risks. If, after making these assessments, the exporting state 'determines that there is an overriding risk' of negative consequences, then that state is bound by the treaty not to authorise the export in question.

Now, of course, the treaty needs to be brought into force. For that to happen, 50 countries first need to sign and ratify it, meaning that the treaty has to be put before national parliaments for approval. In many countries that will likely be a smooth process. In others—such as the US for instance, where the National Rifle Association is set to bring its lobbying power to bear in opposition to it—it might not be quite so straightforward. Once ratified, countries will also need to bring in domestic implementing legislation, in particular with regard to the national regulatory systems that the treaty calls for and to ensure that the provisions of the treaty are incorporated into import and export controls.

Within a year after entry into force of the treaty, each state party is required to provide to the treaty secretariat an initial report on 'measures undertaken in order to implement [the] treaty'. The secretariat is to be established on a provisional basis pending entry into force. The report is to include measures such as national laws and control lists as well as 'other regulations and administrative measures'. States parties are also required to submit an annual report, by 31 May each year, for the preceding 12 months 'concerning authorized or actual exports and imports of conventional arms' covered by the treaty. Enforcement of the treaty falls to individual states parties, who must 'take appropriate measures to enforce national laws and regulations' to implement its provisions. •

## Verifying non-strategic nuclear weapons

Andreas Persbo, London

On 18 March 2013, Hans M. Kristensen, a writer for the Federation of American Scientists, noted that with the apparent retirement of the US nuclear Tomahawk land-attack cruise missile (TLAM/N) the US Navy appears to have got rid of the last of their non-strategic nuclear weapons (NSNWs). Mr Kristensen appears to approve, noting that 'more than two decades after the end of the Cold War, and tens of millions of dollars and countless of navy personnel hours wasted on retaining the TLAM/N, the weapon has finally been retired and the navy is out of the non-strategic nuclear weapons business altogether.' The United States, however, still base an unknown number of non-strategic weapons on European soil. The weapons are believed to number between one and five hundred. This deployment represents, some argue, a counterweight to the many hundred non-strategic weapons deployed by the Russian Federation west of the Urals.

The US infrastructure to maintain this deployment is, according to a US analyst talked to during the preparation of this article, eroding. Most governments, including the US itself, simply want to withdraw the weapons altogether. Against this, others point to their value for NATO cohesion, and object on principle against a withdrawal without the Russian Federation offering something in return. But Russia is not willing to close a deal.

Previously, in February 2013, the Polish Institute of International Affairs convened a workshop on the prospects for information sharing and confidence building on non-strategic nuclear weapons in Europe. Verification featured in some of the presentations to that workshop. One participant, for instance, noted that there are 'special verification difficulties' associated with NSNWs. Ms. Rose Gottemoeller, the US Acting Under Secretary for State for Arms Control and International Security, said that potential verification challenges included 'how to monitor nuclear warheads in storage or how to monitor their elimination.' Another participant gave background on the so-called UK-Norway Initiative, although its relevance for the non-strategic challenge was not fully explained. With the exception of a few documents, a review of the papers submitted to the conference suggests that insufficient thinking has been invested on how to verify the withdrawal of these arms.

Later in February, VERTIC attended a two-day conference on the issue organised by the Center for Strategic and International Studies and the American Physical Society. At this conference, participants were faced with a pre-determined withdrawal scenario and were simply asked to implement it. Hence, the conference did not focus on any preconditions but rather focussed on the mechanics of a specified weapons withdrawal.

While no consensus was reached, many participants (on both the US and the Russian side) focussed on a low-cost, low-intensity, low-confidence, verification arrangement if the type of withdrawal described by the conference were ordered today. This may have been a function of the present state of relations between the United States and Russia. There was agreement that the verification regime should focus on verifying the absence of deployed non-strategic weapons within the exclusion zone. This could be done by a randomised inspection regime where NATO and the Russian Federation applies an inspection-quota to visit former deployment sites or other sites of interests. Some participants argued that the regime could be supplemented by portal monitoring of centralised storage sites. Weapons kept in those sites would not count as 'deployed'. Surprisingly, though, the majority of participants (at least in one of the working groups) felt that such monitoring would likely be unnecessary, presumably since they felt that the risk that either party would cheat would be low.

What was clear, however, was that NSNWs appear to have very little military utility for the United States, and marginally more utility for the Russian Federation. If so, there would be very little incentive for either party to double-cross the other. This would explain the relative ease with which at least one of the two working groups of the CSIS/APS conference reached agreement on verification—and the relatively low level of stringency envisaged by that agreement. •

## Efforts to realise Middle East zone continue

David Keir, London

The idea of establishing a zone in the Middle East free from all weapons of mass destruction originated as far back as the 1970s. One of the key aspirations of the writers of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) was nuclear disarmament—which might be achieved geographical zone by geographical zone, as well as through mutually-agreed, bilateral disarmament treaties and multilateral efforts.

In 1995, a resolution on the Middle East was passed at the NPT Review and Extension Conference, on the initiative of Russia, the United Kingdom and the United States, which are the three depositaries of the treaty. It called for the establishment of a Middle East zone free of nuclear weapons and all other weapons of mass destruction and their means of delivery. Since 1995 no substantive progress has been achieved on the creation of such a zone, despite precedents of other zones free of nuclear weapons on both multi-state and single state bases.

In 2010, an NPT Action Plan was adopted by the member states. This included a dedicated section on the Middle East calling for an international conference on the issue. It stated that the UN Secretary General and the three depositary governments of the NPT would convene a conference on the establishment of a Middle Eastern zone free of nuclear weapons and all other weapons of mass destruction in 2012, to be attended by all states of the region and some from outside the region.

Mr Jaakko Laajava, of Finland, was appointed as the facilitator by UN Secretary General Ban Ki-moon in 2012 and Finland was selected as the host government.

Since then, Mr Laajava has held more than one hundred meetings with relevant governments. But, in December 2012, the conference was postponed because not all key participants had agreed to attend—even though the facilitator has suggested that the proposed conference '… would be a relatively brief, non-dramatic event with the aim of reaffirming the common objective for the project, deciding about follow-up steps.'

Key sticking points that brought about the failure of previous attempts to establish the zone were the diametrically-opposed positions taken by some interlocutors: on the one hand, that there must first be comprehensive peace in the region before any arms control can be attempted; and on the other, that both disarmament and peace should go together, rather than disarmament first.

The UK Foreign and Commonwealth Office reports that they continue to support the Finns in their efforts to bring about the conference in 2013 and also the intermediate step of gathering representatives of the countries of the region very soon, possibly in Geneva, to discuss arrangements for holding the conference. This seems a natural next stage from the travel-intensive efforts of the Finns to date, who have met with all countries in the region separately and also with NGOs, academics and, most recently, in Cairo with the Arab League, to discuss the matter.

Looking ahead, there is much to examine regarding what role verification mechanisms could play in the establishment of the proposed zone, especially since they may be applied to several types of weapon of mass destruction, At the moment, though, the focus is on bringing all players to the table, which can later pave the way toward a substantial discussion of the wide array of issues concerning the establishment and the implementation of the zone. •

## Science & Technology Scan

### Generation IV reactors: promises and challenges

Katherine Tajer, London

This article looks at the design choices being made for nuclear reactors, planned or under construction, and examines their implications for non-proliferation regimes. The Generation IV International Forum (GIF) will likely play a large role in developing new reactors. Founded in 2000 by the United States Department of Energy (DOE), GIF wants to create a new range of reactors that are more efficient, safer, and minimize proliferation risks by limiting the use of proliferative material and simplifying the safeguards process. The forum, consisting of representatives from 12 nations, has six concepts for reactor design, each with their own advantages and drawbacks in these three key areas:

*Super-critical water reactor*: this is a next-generation version of the light-water reactor (LWR) that has been in use since the advent of nuclear energy. Building on LWR technology, these new designs will operate at a much higher thermal efficiency. This increased temperature should simplify reactor design—reducing it to one coolant system or loop and, consequently, simplify safeguards inspections. Currently, all five design options for this type of reactor include an 'open fuel-cycle'—that is, a cycle where fissile materials are only used once and then disposed of—and some include the use of thorium. But thorium, due to its unique properties, would require a separate heavy water moderator, often considered a proliferation risk, due to the large amount of pure plutonium produced through this method.  Outside of the fuel cycle, uranium 233 (a type of weapon's grade uranium) can be extracted from thorium with standard lab equipment and therefore this process may avoid detection during traditional IAEA safeguards inspections. When used as fuel, thorium creates U233 as a by-product, presenting another proliferation risk.

*Sodium-cooled reactor*: this design also builds on previous technology and should increase fuel efficiency as well as lower actinide levels in the high-level waste, which will both improve safety and minimize proliferation risks. But using liquid sodium metal as a coolant comes with a variety of safety risks and verification challenges of its own. For one, sodium is highly reactive with both air and water, which means that the reactor would require a heavy cladding to eliminate the possibility of leakages. This construction would limit access to the first coolant loop which is necessary during safeguards inspections. Additionally, safeguards inspections would have to cope with sodium's opacity—thus requiring ultrasonic imaging. Ultrasonic imaging is both a technical challenge and requires highly specialised equipment, which is still undergoing development.

*Gas-cooled reactor*: these reactors will employ helium-cooled reactor technology. This technology lowers the current proliferation risk encountered when using enriched uranium fuel, as the Generation IV gas-cooled reactor is fed only with depleted or natural uranium and uses a 'closed fuel cycle'—which involves the reprocessing of spent fuel. This increases efficiency as it produces more energy per unit of fissile material. Gas-cooled reactors also present safety and technical challenges though, as all materials in the primary cooling loop will have to operate at 850 Celsius (while most reactors operate at a lower temperature of approximately 285 and are highly pressurised) and must withstand this high temperature over sustained periods. To date, GIF has completed 2D and 3D modelling, and by 2020, hopes to have produced a prototype reactor.

*Lead-cooled fast reactor*: using a liquid lead coolant can create a streamlined design as lead is not reactive with water or air, thus eliminating a cooling loop which would typically be required when working with other non-water coolants, such as molten salt. In addition, lead has a high boiling point which facilitates a high working temperature and allows for thermochemical production of hydrogen. Hydrogen production, if controlled and monitored correctly, can be siphoned off and serve a variety of purposes as a fuel. On the other hand, the high freezing point of lead is a safety risk and causes design difficulties, as the material may expand and cause component failures. Present technology limits this reactor's viability. For example, a better system for large-scale lead purification is needed before this reactor design can be developed. The implications for proliferation and safety, therefore, are still unclear.

*Molten salt reactor*: probably the most developed of the GIF designs, there are already molten salt running prototypes in India. However, previous examples of this reactor have proven problematic—shutting down as often as they have been run successfully. With molten salt types, fuel is dissolved into a fluoride salt, which acts as the heat transfer medium and coolant. New molten salt types can use thorium fuel or uranium. Interestingly, the development of this technology has a variety of other potential applications relating to solar energy, oil refinement and shale processing.

*Very high temperature reactor* (also known as the high temperature gas-cooled reactor): this design aims at efficiency as it involves co-generation of hydrogen and energy. Two prototypes of this reactor are already in use in Japan and China. And the DOE is planning to build a prototype for the 'Next Generation Nuclear Power Plant', which will house a very high temperature reactor and a hydrogen production facility at Idaho National Lab (INL). Once again, the high operational temperature of this reactor has created difficulties in identifying useable materials. As a result, the safety and proliferation implications are relatively unknown.

Of course, in addition to safety and proliferation considerations, cost, development timescales and the availability of alternative energy sources will be key factors in countries' strategic plans for their power sectors. With the current immense squeeze on national budgets and rising energy costs, let's hope that lessons from half a century of nuclear power have been learned and, if governments and developers decide to press ahead with this form of energy, they keep proliferation, as well as safety, as top priorities. •

# VERTIC News

## National Implementation Measures Programme

Over the past three months, NIM staff completed two legislation surveys for the Biological Weapons Convention (BWC) and two surveys related to the international legal instruments to secure nuclear and other radioactive material. They also finalized a new legislative analysis template for the Chemical Weapons Convention and related provisions in UN Security Council Resolution 1540. Surveys for two countries of their CWC implementing legislation are underway.

Scott Spence participated in and presented at the first Civil Society Forum for UN Security Council Resolution 1540, held from 8-10 January in Vienna, Austria. VERTIC was also a Steering Committee member for this Forum. Yasemin Balci presented on national implementation of the BWC at a workshop on biosafety and biosecurity held from 22-24 January in Beirut, Lebanon, which was organized by the Lebanese Ministry of Agriculture in co-operation with the International Council for the Life Sciences. The NIM Programme co-hosted the 'Workshop on National Implementation of the BWC' with the Colombian Ministry of External Relations and UNLIREC—a UN regional disarmament body—from 12-14 February in Bogota, Colombia. Mr Spence gave several presentations on the BWC and establishing a National Authority. In London, Ms Balci attended Chatham House's event 'Chemical Weapons: Lessons for the Future from Halabja' on 26 February and participated in a meeting on 1 March of the Foreign and Commonwealth Office ahead of the Third Review Conference of the Chemical Weapons Convention.

In March, Mr Spence participated in a workshop on national implementation of the BWC in Muscat, Oman. He presented on the BWC, the need to establish a national authority and the importance of biosafety and biosecurity measures. Ms Balci presented on adopting a legal framework for the BWC during the 'Uganda Biosecurity Policy Writing Workshop', organized by the Uganda National Council for Science and Technology and the NGO Global Implementation Solutions in Entebbe, Uganda from 19-21 March.

Meanwhile, Angela Woodward participated in the launch of the EU CBRN Centres of Excellence (CoE) Regional Secretariat for South East Asia in Manila, the Philippines on 6 March and subsequently in the CoE South East Asia Fifth National Focal Point Roundtable Meeting—also in Manila—on 7 March. Ms Woodward met with representatives from Cambodia, Laos, Malaysia and the Philippines to discuss VERTIC's work under a two-year CoE project to provide CBRN legislative assistance to these four states and Indonesia.

The NIM Programme said farewell to one of its team members, Rocio Escauriaza Leal, in January. Rocio formed part of our team for seven years. We have since hired two new legal officers who will assist with our nuclear and radioactive material portfolio and our EU CBRN Centres of Excellence projects. •

## Verification and Monitoring Programme

During the first quarter, the Verification and Monitoring programme has focused on implementing its projects on multilateral verification of nuclear disarmament, universalization of the IAEA Additional Protocol, and robotics in verification. VM staff members have also been engaged in developing new and follow-on projects on nuclear disarmament research, nuclear safeguards and cyber-security.

In February, Andreas Persbo travelled to Berlin, Germany, to participate in a conference on 'Creating the conditions and building the framework for a nuclear weapons-free world'. There, Mr Persbo delivered a presentation on irreversibility and verification in a world without nuclear weapons, drawing on arguments made in VERTIC's 2011 publication 'Irreversibility in Nuclear Disarmament: Practical steps against nuclear rearmament'. February also saw Mr Persbo travel to the United States, to Washington DC, to take part in a workshop meeting on non-strategic nuclear weapons, hosted by the Center for Strategic and International Studies and the Nuclear Threat Initiative. This meeting also saw Mr Persbo present on confidence and the role it plays in arms control verification.

VM Programme Director David Keir also travelled in February, but stayed closer to home—journeying to Bristol to meet with scientists and researchers at the University of Bristol's Robotics Institute and also at a commercial robotics company. This meeting formed part of VERTIC's ongoing feasibility study, on behalf of the US Department of State, on the potential role of robots in nuclear warhead dismantlement verification. In March, Dr Keir took part in a meeting organised by the International Panel on Fissile Materials, hosted at Chatham House in London, to discuss issues relating to nuclear weapon state transparency. March also saw VM programme researcher David Cliff travel to Ispra, in northern Italy, to attend a week-long course on nuclear safeguards and non-proliferation organised by the European Safeguards Research and Development Association.

In other news, the first quarter of 2013 saw new contacts made with the University of Iceland, as a result of which Dr Keir will travel to Reykjavik in June in order to present on nuclear restraint, non-proliferation and Arctic security at a meeting on security in the changing Arctic region—an event to be hosted by the University of Iceland. •

## *Verification Quotes*

*Without verification and transparency, nuclear-security agreements cannot be completed with confidence… The principle of enhanced transparency could also be applied to missile defense so long as it doesn't risk capabilities. Taking the lead in fostering greater transparency sets an important base line for all nations and can facilitate future verification of nuclear materials and weapons*—Taken from a *Wall Street Journal* op-ed, 'Next Steps in Reducing Nuclear Risks', co-authored by George Schultz, William Perry, Henry Kissinger and Sam Nunn. The article was published on 6 March 2013.

*It is not the role of this mission to apportion responsibility or blame. It's not a criminal investigation. It's looking at whether chemical weapons were used, and not by whom*— United Nations spokesman Martin Nesirky speaking at a news conference in New York on 27 March in relation to the UN's ongoing investigation into chemical weapons use in Syria.

## Grants and administration

VERTIC experienced a high degree of staff turnover this quarter. In January, we said goodbye to our legal officer, Rocio Escauriaza, after seven years of committed service to VERTIC. And last month, we saw Unini Tobun, our administrator, leave her role after seven years as well. VERTIC will greatly miss their support of the organization and dedication to their work, and wishes them well in their new posts.

In February VERTIC conducted interviews for two legal officer positions, and after a very strong response, selected two well-qualified candidates: Ms Bilqees Esmail and Dr Sonia Drobysz. Both will begin their work in the London office in the coming months, after serving out their present contracts. Sonia was previously involved with work at VERTIC as an intern and a volunteer consultant. Additionally, Katherine Tajer, a former VERTIC consultant and intern, began work as our new administrator on 11 March. Russell Moul, a former VERTIC intern, started as a consultant for the Verification and Monitoring programme this month, providing research assistance for our project on the Additional Protocol.

VERTIC has secured two grants this quarter. Our funding from the UK Foreign and Commonwealth Office—an award of £250,000—will go towards work on national implementation and the extension of our current project on the Additional Protocol. The Joseph Rowntree Charitable Trust, a long-standing supporter of VERTIC, has again provided invaluable core funding to VERTIC. This grant is valued at £105,000, and will go a long way to secure VERTIC's core activities for the next three years. •

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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, with particular attention to issues of monitoring, review, legislation and verification. We conduct research, analysis and provide expert advice and information to governments and other stakeholders. We also provide support through capacity building, training, legislative assistance and cooperation.



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