Safeguarding the front-end of the nuclear fuel cycle

In 1945, scientists involved in the development of the world's first nuclear weapon argued in the so-called 'Franck Report' that if there was unlimited trade and employment of nuclear power, the fate of every pound of uranium should be recorded. Historically, however, there has been limited international regulation at the (very) front end of the nuclear fuel cycle, specifically the production, processing and conversion of uranium ore concentrates (UOC). The rest of the fuel cycle is where uranium takes on different forms and full international safeguards have been applied, namely from the products of conversion (uranium oxides, metals, and gases). Over the past decade this has been changing. Technological advances in the uranium industry, coupled with persistent proliferation threats, have increased concerns over the introduction of undeclared uranium (or other source materials) into the nuclear fuel cycle through conversion, fuel fabrication or enrichment plants. Today, seven decades after the publication of the Franck report, international safeguards are capturing more material upstream, such as source materials. The Iran deal also marks the first non-proliferation agreement that will monitor a state's uranium production and inventory in detail.

The starting point of IAEA Safeguards

Non-Nuclear Weapon States (NNWS) with a Comprehensive Safeguards Agreement (CSA) with the International Atomic Energy Agency (IAEA) must report any imports or exports of source material to the Agency. Under a CSA, (based on INFCIRC/153), Paragraph 34 (a) states: a state shall inform the Agency 'when any material uranium or thorium […] is exported to a non-nuclear weapon state…unless the material is exported for specifically non-nuclear purposes'. Paragraph 34(b) mirrors the same language for imports. This includes material containing even trace quantities of uranium or thorium (such as phosphates, mineral sands, coal and rare earth elements) if such material is to be used eventually in a nu-

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clear reactor. If such material is not destined for nuclear purposes (such as for ceramics), then it is exempt from the requirement to report. The IAEA checks that reports of exports match reports of imports, but do not verify that this exchange has been made.

The CSA's material accountancy and control provisions become more stringent when source material is processed into forms more useable in the nuclear fuel cycle. Paragraph 34 (c) of a NNWS' CSA states:

> When any nuclear material of a composition and purity suitable for fuel fabrication or for being isotopically enriched leaves the plant or the process stage in which it has been produced, or when such nuclear material, or any other nuclear material produced at a later stage in the nuclear fuel cycle, is imported into the State, the nuclear material shall become subject to the other safeguards procedures specified in the Agreement.

Full safeguards therefore begin when nuclear material pure enough to be fabricated or enriched 'leaves the plant or process stage', traditionally interpreted as the output of conversion plants (where uranium ore concentrates are converted into uranium dioxide (UO_2) or uranium hexafluoride (UF_6) accordingly), while Paragraphs 34 (a) and (b) mark the 'starting point' of reporting to the IAEA with the trading of material containing uranium and thorium; 34(c) defines the starting point for material to be captured under full material accountancy and control.

Clarifying the starting point

The IAEA's attempts to expand its view of a state's nuclear activities began in the 1990s and culminated in the 1997 Model Additional Protocol (INFCIRC/540). This forms the template for augmenting protocols to a CSA, which grant broader information on (and IAEA access to) a state's domestic uranium production, as well as data on trade in secondary materials that may contain uranium or thorium. The Additional Protocol (AP) requires annual reporting of uranium and thorium holdings and production, along with reporting on exports and imports of 'pre-34(c)' source material (which is not of a composition or purity sufficient to be subject to safeguards) for non-nuclear purposes. These requirements formalise the need for AP states to apply prudent controls and evaluate the risk that uranium will be extracted for nuclear purposes. The AP however does not require full accountancy and control measures.

In 2003, thirty years after INFCIRC/153 was established, the IAEA reinterpreted paragraph 34(c) for the first time, affecting safeguards implementation in non-nuclear weapons states with refining or conversion facilities and a CSA. The introduction of 'Policy Paper 18' (PP18) brought full safeguards upstream from the output of conversion plants to the point at which such plants produce uranyl nitrate (or the first practical point earlier). It clarified that any aqueous uranium solution with impurity levels meeting or close to the levels identified by commercial standards (as defined by ASTM C788-98) is considered to be nuclear material of a composition and purity suitable for isotopic enrichment. It is important to note that uranyl nitrate is usually produced during the early stages of conversion (such as refining) where it is difficult to apply full accountancy to material 'in process.' In Canada, therefore, the 'first practical point earlier' meant applying the starting point of full material accountancy to when drums of UOC are added to production lines at Cameco's Blind River refinery. This marked the first time that Agency safeguards captured a refinery plant in Canada. The new starting point did not require Canada to report on the thousands of drums stored at the site because UOC remained a 'pre-34(c)' material and not subject to the full scope of IAEA accountancy and control provisions.

In 2009, PP18 was revised and extended to include R&D facilities and made reference to 'high purity' UOC but did not give any clarifications as to what would be considered 'pure'. This was prompted by some suppliers advertising their UOC as pure enough for fuel fabrication, along with cases of some states not declaring front-end activities. The 2009 version also removed the earlier reference to ASTM standards, which led to a number of complaints within the IAEA, particularly from the Department of Safeguards, which required further guidance to be able to implement PP18. This led to the development of a new policy paper to replace PP18.

In defining pure UOC, the IAEA was looking for a low threshold, but could not find one that was technically sound. The only standard available was the ASTM commercial

Uranium ore is packed into special, tightly sealed steel drums. Each barrel contains no more than 300 kg of ore when full. Image taken from the IAEA Imagebank.

standard for nuclear grade, sinterable UO_2 powder (ASTM-C 753-04) which is a high (and conservative) purity level. Thus, the introduction of Policy Paper 21 in 2013 retained most of the language in the 2009 PP18 version except PP21 added reference to ASTM-C 753-04—clarifying that any natural UOC meeting the purity specifications for UO_2 fuel would now be captured under paragraph 34(c). The focus of PP21 is therefore on material—not facilities—and it did not replace PP18's ASTM standards for uranyl nitrate and oxides. It also did not affect uranium in ore and ore residues being processed at milling facilities, which is exempt from IAEA safeguards under Article 33 of INFCIRC/153.

Implementing PP21

The revised definition creates new obligations for state regulatory authorities and producers of UOC, and new verification responsibilities for the IAEA. Remarkably, the IAEA has not made the clarified starting point public, nor has it effectively communicated it to states, making the process unduly bureaucratic and mysterious. Any clarifications to INFCIRC/153 (a public document) should be made widely available for states, industry and stakeholders to access—particularly when it concerns the point at which full safeguards obligations under the CSA kick in. Unsurprisingly, there is confusion among states and producers as to whether they are affected by PP21 or not.

There was anticipation that PP21 would capture only a handful of mills or UOC concentration plants. A closer look at PP21's specifications suggests that a larger number of operations globally will be affected in both large and small UOC producers. For large producers, with developed nuclear fuel cycles and well-established state systems for accountancy and control (SSAC), the process of implementation will be relatively straightforward. For small and new suppliers, where source materials are often the only nuclear material found in-country, the task is more challenging given they have never had 34(c) materials subject to full accountancy and inventory controls. Assistance in developing a SSAC for such countries will be essential to the success of PP21.

Moreover, the introduction of PP21 means that conversion plants will be receiving fully safeguarded material for the first time. With commercial conversion facilities in only five countries receiving the bulk of globally traded UOC, it would seem that implementing PP21 would be reasonably simple—

at least at first glance. Of the five (Canada, China, France, Russia, and United states), only Canada is a non-nuclear weapon state (NNWS). The other four are nuclear weapon states (NWS) that are not required to adopt safeguards agreements under the NPT unless they choose to on a voluntary basis at selected facilities. Their unique status allows them to exempt materials from third-party oversight and as such, the IAEA with its constrained budgets and resources, rarely accesses these facilities except for training purposes. Of the four NWS with commercial conversion, the United States is the only one that voluntarily offers its conversion plant in Metropolis, Illinois. (Note: The conversion plant in France is covered by Euratom safeguards and inspections, but it is not a facility offered to the IAEA). One way to ensure that PP21 material stays safeguarded in the NWS would be for the IAEA to negotiate an agreement with each to treat UOC considered 'pure' under PP21 as safeguarded material and to apply the proper accountancy and controls. Such an agreement would underscore a NWS commitment to enforcing front-end accountancy, not the least in sending a signal to the NNWS (and Iran) that all 34(c) materials in civilian facilities are safeguarded.

Iran and front-end monitoring

According to Paragraph 15 of the Joint Comprehensive Plan of Action (JCPOA) reached on 14 July 2015 between Iran and the E3/EU+3, the IAEA will monitor the production of UOC produced by Iran from all concentration plants for 25 years. The deal goes beyond the CSA and AP and marks the first time that the IAEA will monitor a state's UOC production and inventory in detail. The period of 25 years is also notable given that Iran's front-end activities will be monitored by the deal longer than for other stages of the fuel cycle. Enriched material will be monitored for 15 years, and the production of centrifuges for 20.

Paragraphs 68 and 69 of Annex 1 of the JCPOA underscore that all UOC produced in Iran or obtained from other sources and transferred to the conversion plant in Esfahan (or any future conversion facility) will be monitored. This is of particular importance given that PP18 was prompted by activities at the Esfahan Uranium Conversion Facility (UCF) and presumably conversion experiments such as the conversion of uranyl nitrate directly to uranium oxides that Iran had conducted in the 1980s and early 1990s. Paragraph 68 states that agreed measures to be applied 'will include containment and surveillance measures'. The terms 'containment' and 'surveillance' in IAEA lingo refer to tags and seals and the installation of cameras respectively. While the location of these seals and cameras is yet to be made public, or perhaps still need to be clarified by all parties involved, the JCPOA underscores how front-end activities are gaining international attention.

Franckly Speaking

Clarifications of 34(c) material demonstrate how proliferation concerns and technological advances are prompting a closer look at nuclear activities at the front-end of the fuel cycle. These clarifications do not alter the definition of 34(c) material and are far from applying the 'exact bookkeeping' of each pound of mined uranium advocated in the Franck Report. To do so would require a re-defining of what constitutes 34(c) material—an effort for which no political will exists.

What is clear today is the need for extensive outreach by the IAEA to all uranium producers on PP21 to ensure its success. Suppliers without established and mature SSACs will require additional support in creating nationally-appropriate systems of safeguards for the first time, while larger suppliers will need to work with industry to incorporate the new reporting obligations into their existing SSACs. At the same time, the IAEA will have to decide what level of verification it will dedicate to 34(c) material produced at mills and concentration plants and balance it with its current personnel and financial resources. These are already constrained by the requirements placed on the Agency with respect to Iran and the JCPOA. The objective of safeguards is to inspire confidence that activities across the entire nuclear fuel cycle are peaceful. Whether the nuclear fuel cycle is used for military or civilian purposes, uranium is the starting point. •

Cindy Vestergaard
Danish Institute for International Studies (DIIS)

Verification Watch

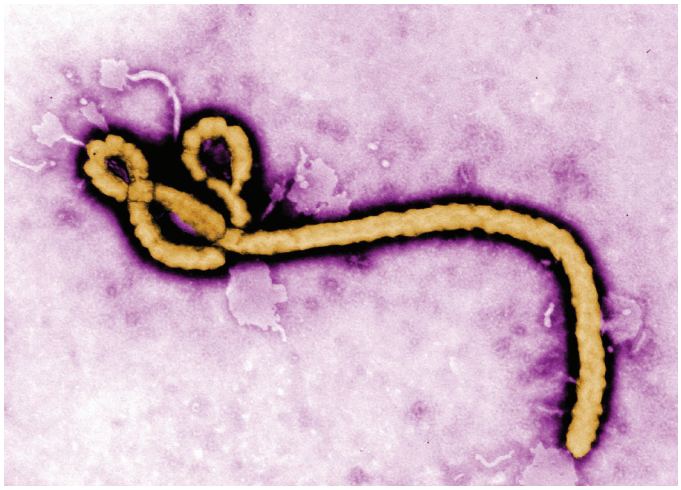
International Health Regulations (IHRs) put to the test

Angela Woodward, Christchurch

The 2014 Ebola outbreak in West Africa led to over 15,000 laboratory confirmed cases of infection and 11,000 deaths, primarily in Guinea, Liberia and Sierra Leone. The ease and speed of transmission of this disease understandably overwhelmed the national public health systems of these developing countries. It also tested the effectiveness of states' national implementation of the World Health Organization's (WHO) International Health Regulations (IHRs), which were specifically created to assist affected states and the international community in such cases of a 'public health emergency of international concern.'

The WHO's World Health Assembly adopted the most recent iteration of the regulations in 2005 and they entered into force in 2007. Article 2 specifies that their purpose and scope is 'to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks, and which avoid unnecessary interference with international traffic and trade.'

States' obligations pursuant to the IHRs are relatively straightforward in theory, including to: designate a national IHR focal point; develop, within five years, core capacities to be able to detect, assess, notify and report public health risks and emergencies of national and international concern to the WHO; and implement WHO recommendations. Achieving effective national implementation of these 'core capacity' requirements in practice is less clear-cut, especially in developing states. And while there are no explicit incentives for accomplishing national implementation of the IHRs—aside from strengthening national capacity to prevent and mitigate devastating outbreaks—there are notably no disincentives for not fulfilling all of these obligations. The IHRs do not provide for enforcement measures or independent assessment of states' self-reporting. The WHO has an ongoing responsibility to support its member states with national implementation tasks and has published guidance material on its website.



The Ebola virus under a colourised transmission electron micrograph. Image provided by CDC Global and Frederick A. Murphy.

An important feature of the IHRs is that public health responses to the international spread of disease must be appropriate and avoid unnecessary restrictions on travel and trade. There is currently no requirement to report an outbreak which is not yet of international concern. But in situations where a state perceives that an outbreak that is not yet of international concern may lead to the imposition of travel and trade restrictions that would put its economy at risk, there is a perverse incentive to downplay an outbreak and not report it to the WHO in a timely and comprehensive manner.

During this Ebola outbreak, over 30 states instituted travel restrictions and other measures that the WHO had not recommended—contrary to the IHRs—with significant negative political, economic and social ramifications for the affected countries. This was one of the key findings of the Ebola Interim Assessment Panel in its final report, issued in July 2015, concerning the IHRs, the WHO's emergency public health response capacity and its ability to cooperate with other health and humanitarian agencies in health security emergencies. Concerning the IHRs, the panel also concluded that member states have 'largely failed' to achieve the core capacities required under the IHR. Key issues that

were identified included disease surveillance and data collection, and that the WHO Secretariat was unjustifiably slow in declaring the outbreak a public health emergency of international concern. The panel deemed it 'untenable' that the international community did not appear to take IHR obligations seriously and called for a transformation in the WHO's organisational culture and service delivery, for which the Secretariat and member states must take responsibility.

Notably, the panel's recommendations on strengthening the IHRs include a request that the WHO prepare a 'prioritized and costed plan' to develop the IHR core capacities in all its member states. The panel also had specific recommendations for the Review Committee on the Role of the International Health Regulations in the Ebola Outbreak and Response, which the World Health Assembly established in May 2015. These include that the Review Committee consider developing incentives for states to notify the WHO of public health risks (before they become events of international concern) and disincentives for states that take measures that interfere with trade and travel contrary to WHO recommendations. Its call for enforcement measures did not end there, as it also recommended that the United Nations Secretary-General's High-Level Panel on the Global Response to Health Crises consider how to transfer health security matters to the United Nations Security Council—thereby elevating health security to the same level of UNSC scrutiny as traditional physical security issues—and also other possible incentives and disincentives to strengthen global health security.

The Review Committee must now make its own recommendations on how to 'improve the functioning, transparency, effectiveness and efficiency' of the IHRs, which thereby encompasses both the content of the current measures and how to improve states development and implementation of the core capacities, as well as the role the WHO should play in assisting states to do so. The committee convened its first meeting in August 2015 and is expected to present its final report to the WHO's World Health Assembly in May 2016. •

The 59th IAEA General Conference: steady as she goes?

Hugh Chalmers, London

Member States of the International Atomic Energy Agency (IAEA) gathered in Vienna for the 59th General Conference of the IAEA. Ever since the IAEA was created in 1957, the General Conference has been meeting annually to review the Agency's activities over the previous year and to pass resolutions guiding activities into the next year.

As one might expect from a forum that is approaching its 60th anniversary, the IAEA General Conference has settled into some established and predictable habits. Resolutions concerning the IAEA's membership, its budget appropriations, its financial accounts, and its funding contributions were all passed without much debate. Similarly, the IAEA membership discussed the Agency's approach to nuclear safety, the transport of radiological materials, and its technical cooperation and scientific promotion activities, and passed a series of resolutions supporting the IAEA's plans in these areas.

Some of the previously contentious issues seem to be becoming less so. The League of Arab States' draft resolution on Israel's controversial nuclear weapon programme failed to pass for the fourth year running, facing greater opposition than in 2014—when its passage might have threatened a now defunct dialogue on a WMD free-zone in the Middle East. Even the annual resolution on 'strengthening the ef-

Attendees in the plenary hall during the IAEA's 58th General Conference in Vienna, 2014.

fectiveness and improving the efficiency of Agency safeguards' passed without much hassle this year, with Pakistan's annual vote against a reference to the 'universal' application of Agency safeguards being joined by only three abstentions rather than the four in 2014. Similarly, the hard-fought notice of the IAEA's role in verifying nuclear disarmament that snuck into paragraph 20 of the 2014 resolution remained present and uncontested this year.

This left the IAEA's State Level Concept (SLC) as the most likely source of conflict in the 2015 safeguards resolution. The SLC allows the Agency to use state-specific factors (such as total nuclear fuel cycle, technical capabilities, and the safeguards agreement itself) to plan safeguards activities, with the aim of improving both their effectiveness and efficiency.

Concerns over the purpose and application of this concept were voiced in the Agency's Board of Governors, and prompted a report from the Director-General to clarify these issues. These concerns also manifested themselves in the 2014 resolution, which reiterated the Director-General's clarifications emphasising that the Agency is not abusing the concept to find a shortcut to acquiring the same rights offered by the Additional Protocol nor is it using information on state level factors for any purpose other than safeguards.

While these clarifications remained present in the 2015 resolution, they were neither adjusted nor expanded upon. Instead, they were joined only by a request for a report on the implementation of this concept from the Director-General to the IAEA Board of Governors, and by an encouragement to apply this concept in a financially efficient manner. Indeed, the only unexpected upset at the 59th General Conference related to language in a resolution pertaining to nuclear security. New language stressing the need for progress in nuclear disarmament to support nuclear security caught the eye of Russia, who called for a separate vote to remove this language. However, only two other states agreed with Russia, and the language remains.

While a lack of controversy in the general conference may seem less interesting than its presence, the smooth passage of the 59th General Conference is noteworthy because of the unsettled context in which it took place. The IAEA is currently addressing long-running concerns regarding the possible military dimensions of Iran's nuclear programme, and is gearing up to verify restrictions on this programme under the Joint Comprehensive Plan of Action (JCPOA). These tasks represent arguably the greatest test of the Agency's verification (and diplomatic) capabilities faced so far, and have multiplied the unfunded portion of the IAEA's verification activities in states with Comprehensive Safeguards Agreements by almost 88,000 per cent (from €10,422 to €9,184,422). Despite this there was little debate over whether the Agency's current approach to funding these tasks is sustainable.

Furthermore, the IAEA has been unable to conduct inspections at a research reactor and critical assembly in the disputed territory of Crimea since it was annexed by Russia. While Ukraine cannot provide the IAEA with access to the relevant facility, it still enjoys a 'broader conclusion' from the IAEA that all nuclear materials in Ukraine remain in peaceful activities. Russia has offered the IAEA access to the facility under its own safeguards agreement with the Agency, but doing so would recognise (and therefore legitimise) Russia's disputed claim to the territory.

This dilemma has forced the IAEA to note in its annual report that references to the location of nuclear facilities do not imply 'the expression of any opinion whatsoever on the part of the Agency concerning the legal status of any country or territory […]'. Despite this caveat, Russia refused to sign off on the report – arguing that it contained information that 'contradicts reality'.

In light of these pressures, it is perhaps worth considering whether member states should be prioritising the smooth passage of largely recycled resolutions over the necessary (if perhaps acrimonious) debate of pressing issues. •

Implementation Watch

Universalising legal instruments on nuclear security

Sonia Drobysz and Yasemin Balci, Paris and London

2015 marks the 10-year anniversary of the adoption of the Amendment to the Convention on the Physical Protection of Nuclear Material (CPPNM/A) and the International Convention for the Suppression of Acts of Nuclear Terrorism (ICSANT). This makes the entry into force of the amendment and universalisation of both instruments seem more pressing.

The CPPNM, its amendment, and ICSANT are key instruments that form part of the international legal framework for nuclear security. The 1980 CPPNM requires its states parties to take measures regarding the physical protection of civil nuclear material during international transport; to provide cooperation and assistance in the recovery and protection of stolen or unlawfully taken nuclear material in domestic use, storage and transport; and to criminalise certain acts involving such material. The 2005 amendment extends the scope of the Convention to fully apply to domestic storage, use, and transport of nuclear material used for peaceful purposes, and to civilian nuclear facilities. It adds new offences and formulates a number of fundamental principles of physical protection.

The ICSANT is broader in its scope than the CPPNM and its amendment as it also covers radioactive material other than nuclear material, and does not distinguish between radioactive material for civilian or military purposes. It includes offences involving radioactive material and provisions concerning mutual legal cooperation in criminal matters.

These instruments contribute to the prevention, detection and response to incidents involving nuclear and other radioactive material. By laying down the legal framework, they harmonise the level of protection to be enforced across states parties and allow for cooperation and action between states in the case of incidents.

The ICSANT entered into force in 2007 and now has 99 states parties, while the CPPNM, which entered into force in 1987, now has 153 states parties. The CPPNM requires that two-thirds of its states parties adhere to the amendment for it to enter into force. As the amendment currently has 88 contracting states, adherence by 14 more is still required. A number of states recently ratified the amendment: Italy, Turkey and the United States in July, and Botswana during the IAEA's Treaty Event on the margins of the 59th General Conference in September. During the same event, Kyrgyzstan deposited its instrument of accession to the CPPNM.

The IAEA General Conference's 59th session was also an opportunity to encourage other IAEA member states to adhere to the CPPNM and its amendment. In a resolution on nuclear security adopted on 18 September 2015, all parties were urged to ratify, accept or approve the 2005 Amendment as soon as possible. The General Conference also encouraged that 'all Parties to the Convention to act in accordance with the objectives and purposes of the Amendment until such time as it enters into force, further encourage[d] the Agency to continue efforts to promote the entry into force of the Amendment to the CPPNM at the earliest possible date, welcome[d] the organization by the Secretariat of the CPPNM meetings and encourage[d] all Parties to the Convention to participate in those meetings'.

Moreover, the General Conference encouraged 'all Member States that have not yet done so to become parties to the [ICSANT] as soon as possible.'

The universalisation of the conventions and the amendment still faces a few obstacles that need to be overcome. Firstly, states may not be familiar with these instruments and their obligations. Such a lack of awareness can be addressed through engagement, workshops and publications. Secondly, these instruments may not be considered priorities and political will to adhere to them may be lacking. This can be addressed by underscoring the benefits the instruments bring, such as strengthened national and international security, improved coordination among states and the availability of implementation assistance. •

Anti-neutrino detection for non-proliferation monitoring: recent advances

David Keir, Oslo

Nuclear energy is on the rise, particularly outside of Europe. A large number of new reactors are being procured or planned, and there are emerging new reactor designs. However, the IAEA budget for safeguards inspections will not increase in step with these changes. With an increasing number of facilities and limited resources for inspections, IAEA safeguards are evolving to make better use of remote monitoring systems to keep tabs on nuclear facilities.

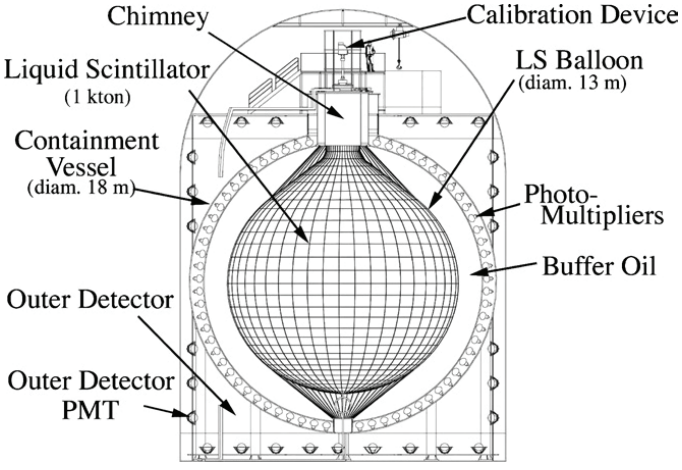
Within the last decade, there has been greater interest and increased research into monitoring the operational status of nuclear reactors and tracking reactor fuel histories using neutrino detectors. Researchers in the US and the Soviet Union proved in the 1980s, that reactor operations could be tracked using these elusive particles.

Every beta decay of a fission fragment, generated from consuming fissile material in a reactor, results in an anti-neutrino. Anti-neutrinos rarely interact with matter, passing unhindered through most materials. Because of this, anti-neutrinos escaping a reactor core cannot be absorbed or shielded. However, this startling property also means that they are very difficult to detect, as only one or two in a trillion particles can be picked up in a detector.

Anti-neutrino detectors have evolved over time. They once relied on large underground facilities such as liquid scintillator detectors (tanks containing a cocktail of chemicals dissolved in a liquid, which detect each neutrino that interacts with the liquid as a discrete flash of light). More modern detectors use above-ground detectors that only weigh a few tonnes, as oppose to the megatonne range. This has made possible a range of non-proliferation monitoring options that were once out of reach. This is especially so now that detectors can begin to perform effectively when placed outside (rather than inside) reactor pressure vessels.

Safeguards monitoring is becoming a real prospect in a remote, automated, non-intrusive, dose-free way. This will be achieved by tracking several attributes of nuclear reactor operations, such as (i) monitoring reactor operational status hour-by-hour; (ii) tracking reactor thermal power changes week by week; and (iii) monitoring burn-up of the fissile uranium in reactor fuel and the changing fissile isotope content of that fuel, on a weeks-to-months timescale. By knowing details about the reactor and its fuel, and calibrating detection of anti-neutrino rates with known states of reactor operations and monitoring changes in rate of anti-neutrino detection, it becomes possible to account for plutonium at the point of production in the reactor fuel itself.

There are a number of consortia pursuing these goals, by developing better, smaller, and more efficient detectors. This is happening internationally via systems such as the KamLAND system located in Japan, and in national initiatives, such as the French NUCIFER experiment conducted in collaboration with the Max Planck Institute.
One of the most recent advances in miniaturisation is being



Schematic of the KamLAND detector taken from 'Results from KamLAND reactor neutrino detector': http://www.iop.org/EJ/abstract/1402-4896/2005/T121/004/

trialed by the University of Liverpool in the UK. This uses a tonne-scale solid plastic scintillator detector. This system can detect more than 200 anti-neutrino events per day (after cutting out cosmic rays and other interferences) when placed within 60m of a nuclear reactor core of 1.6 Gigawatt thermal (GWth) power. Anti-neutrinos cannot be shielded, as stated above, so the core of a reactor is fully visible to the detector, whatever containment or building it is located in.

Unlike many systems, which need to be underground to screen out cosmic rays, the latest Liverpool detector is used above ground and uses a smart event-veto system to screen out cosmic rays and other interferences. This technology has the advantage of being remote and automated: it runs all day, every day, without requiring a human operator.

Current methods of safeguards monitoring will not be usable for future reactor types where nuclear fuel is not divided into neat, itemised amounts, pin-by-pin and fuel element-by-fuel element (such as pebble-bed or liquid salt designs). Anti-neutrino detectors will be quite suitable for these however, for all the reasons stated above.

This technology has been the unfortunate target of scepticism and even derision in the past due to their large size and impracticality. All that has changed. The technology is arriving at maturity. Some recent commentators have even suggested that this might be the key to verifying nuclear activities in Iran, under the Joint Comprehensive Plan of Action between Iran and P5+1 (China, France, Russia, the UK, the US—plus Germany). •

Programme News

Verification and Monitoring Programme

The Verification and Monitoring (VM) programme has delivered a number of key outputs from its portfolio of work over the past quarter. The programme attended the 59th General Conference of the IAEA between the 14th and 18th of September. VM Researcher Hugh Chalmers launched the programme's two recent publications on the IAEA and nuclear disarmament verification at a side event hosted by the Vienna Center for Disarmament and Non-Proliferation (VCDNP).

The first publication presents the results of a VERTIC survey of IAEA member states' views on the agency's role in disarmament verification. The survey suggests, among other things, that agency member states support a broader role for the IAEA in this area than is currently being prepared for. The second publication serves as a 'primer' to the issues raised by an IAEA role in nuclear disarmament verification. The programme continues to condense the results of this project into a comprehensive research compendium, which will be launched in November.

The VM programme has also continued its work developing a database of national approaches to nuclear safeguards implementation, with support from the Carnegie Corporation of New York. The framework of this database is now complete, and will be launched at the November 2015 meeting of the Asia Pacific Safeguards Network in Japan. This project complements the VM programme's on-going work assisting IAEA member states with the national implementation of agency safeguards.

The programme has also returned to issues of environmental monitoring with the publication of a Verification Brief on monitoring and reviewing options for a 2015 climate change agreement.

In addition, during the week of 22 September, Russell Moul and David Keir led a group of distinguished UK-based specialists and academics to Beijing as part of an on-going UK-China technical dialogue. The meeting was well attended by Chinese scientists and discussed nuclear non-proliferation and arms control verification plus similar issues in the chemical and biological spheres. •

VM Researcher Hugh Chalmers launching the survey report and the nuclear disarmament primer at VERTIC's side event at the IAEA's 59th General Conference.

National Implementation Programme

During this quarter, the NIM team remotely reviewed an Asian state's bill to implement the Chemical Weapons Convention (CWC). In addition, the team sent universality packages for adherence to the Amendment to the Convention on the Physical Protection of Nuclear Material and the International Convention for the Suppression of Acts of Nuclear Terrorism to one state and provided material to assist another in drafting regulations under a nuclear act.

On 8 June, the NIM team attended the event 'Arms Trade Treaty Cooperation and Assistance Activities: Avoiding Duplication and Building Synergies'. This was hosted by the Geneva Centre for Security Policy and the Stockholm International Peace Research Institute in Geneva.

On 3 August, NIM Programme Director Scott Spence presented on the national implementation of the Biological Weapons Convention (BWC) at a workshop for diplomats new to the Convention. This was hosted by the BWC Implementation Support Unit and the Geneva Centre for Security Policy in Geneva. In addition, on 9 August, Mr Spence went to a Chatham House event on '3D Bio: Supporting compliance with the BWC', in Geneva.

The following week, Mr Spence represented the NIM programme at the BWC meeting of experts. He delivered statements to the plenary session and a 'Guest of the Meeting' session during the standing agenda on national implementation.

On 14 and 15 September, Senior Legal Officer Yasemin Balci travelled to Nairobi, Kenya, and participated in a workshop on enhancing implementation of UN Security Council Resolution 1540 and other non-proliferation instruments. This workshop was hosted by the Institute for Security Studies and the Intergovernmental Authority on Development (IGAD) for IGAD states. She presented on effective practices and lessons learned in legislative implementation of the Resolution 1540, and facilitated a session on complementarities between the resolution and other non-proliferation and counter-terrorism instruments.

The same week, Mr Spence and Legal Officer Sonia Drobysz attended the 59th session of the IAEA General Conference. Dr Drobysz spoke at a 'Young experts in nuclear security' dialogue, hosted by the International Network of Emerging Nuclear Specialists (INENS). •

Publications News

In September, the VM team released two publications related to its project on multilateral verification of nuclear disarmament. One is a primer on the role of the IAEA in nuclear disarmament verification, looking at what involvement in such activities it has had to date, and what more could be envisaged in the future. The second presents the results of a VERTIC survey of IAEA member states' views on the agency's involvement in disarmament verification. This survey was conducted by VERTIC over the last two years. The primer and the survey report were officially launched during VERTIC's side event to the 59th IAEA General Conference.

VERTIC will also release a third publication in November 2015. This will take the form of a research compendium that presents the comprehensive results of VERTIC's work under this project that have been conducted over the last three years.

Earlier this summer, VERTIC also released VERTIC Brief 25: '2015 climate change agreement: strengthening future emission reductions and treaty review and monitoring processes'. In the brief, Joy Hyvarinen considers climate review and monitoring processes as states edge closer to the 2015 Paris climate change conference.

Under the NIM Programme, the article 'New tools for legislative implementation of UN Security Council Resolution 1540: The National Legislation Implementation Kit on Nuclear Security and the Legislative Guide to National Implementation of UN Security Council Resolution 1540 (2004)', written by Scott Spence, was published in the Summer 2015 issue of 1540 Compass.

VERTIC will also be launching its new biennial publication Verification & Implementation in the final part of 2015. Articles will include •

Verification Quotes

"This deal is not built on trust—it is built on verification." US President Barack Obama on the Joint Comprehensive Plan of Action.

"This modernization will enhance the IAEA's independent verification capabilities. It will provide the IAEA with increased sample capacity for nuclear material and environmental analyses, an improved sensitivity in analytical methods for environmental analysis and a wider variety of analytical services overall." Paul Martin, Head of Coordination and Support, IAEA Division of Safeguards Analytical Services, describing the modernization of the Agency's analytical laboratories under the Enhancing Capabilities of the Safeguards Analytical Services (ECAS) project.

"The number and complexity of the problems [of the World] require that we possess technical instruments of verification." Pope Francis, addressing the UN General Assembly.

"While the political obstacles to achieving further nuclear reductions are well documented, less known are the technical challenges we are sure to face. We know that the nuclear weapon states do not have a monopoly on possible solutions. The [International Partnership for Nuclear Disarmament Verification] pools together the collective expertise from twenty-seven countries to build confidence in the tools and technologies that will enable us to verify future arms control agreements." Anita E. Friedt, Principal Deputy Assistant Secretary to the Bureau of Arms Control, Verification and Compliance speaking at the Friedrich-Ebert-Stiftung Tiergarten Conference on 10 September 2015.

"With respect to the Iranians—don't trust, never trust, and always verify…And I think a very vigorous verification regime has been put into place." Former Secretary of State Colin Powell expresses support for the verification provisions contained in the Joint Comprehensive Plan of Action.

Grants and administration

At the beginning of September, VERTIC held a Strategic Review meeting, covering the organisation's activities and goals for the next three years. The meeting was well attended by staff, trustees and members of the International Verification Consultants Network. VERTIC would like to thank all of the participants for their input and time on a very successful meeting.

This autumn, VERTIC is saying goodbye to employee of five years, David Cliff. David served on the Verification and Monitoring team as a researcher and a key contributor to this publication. We have been very fortunate for all of his work here and wish him well in his future employment at the Vienna Center for Disarmament and Non-proliferation. •

building trust through verification

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VERTIC is an independent, not-for-profit non-governmental organisation. 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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