Nobel Peace Prize
Research & Information

08-10 June 2017 experts gathered at the Norwegian Nobel Institute for a High-Level Panel on Nuclear Security. Three issues were put before them:

- Nuclear Security Summits (NSS): What has been achieved, and what remains?
- The nuclear energy-security nexus: promises and pitfalls
- Nuclear security After Nunn Lugar: Bringing the outsiders back in

Policy advice:

During the session, which was carried out under the Chatham House Rule the following policy advice was put forth:

- Direct international efforts towards the safe storage of spent nuclear fuel, ideally an international 'spent nuclear fuel bank'.
- Nuclear security and nuclear arms control cannot be disaggregated. The two agendas should be pursued in concert. The CTBT must be brought into effect.
- More states and stake-holders need to be brought into the nuclear security agenda which has focused too narrowly on the specter of nuclear terror.
- There need for recognition that the nuclear security challenges in countries not present at the NSS may differ from those who were invited to partake.
- There need to be efforts towards developing industry-based nuclear security standards & certifications.
- Bilateral cooperation between countries that share nuclear challenges should be encouraged.
- Established international frameworks must be protected.
- A best-practice culture of nuclear security should be encouraged on a global scale. This requires investing in capacity building and awareness.
- The important nuclear industry - civil society partnership needs to be nurtured and strengthened.

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The Nuclear Security Summits - Controlling nuclear doubts

Torbjørn Graff Hugo, Former WMD Project Leader, International Law and Policy Institute

The Nuclear Security Summits provided impetus to the important work of securing civilian nuclear materials, but it may also have had the unintended side-effect of casting further doubts about the sincerity of the nuclear-armed states' commitment to nuclear disarmament

In April 2009, in Prague, President Obama spoke of his vision of a world without nuclear weapons. In the speech he called for securing all vulnerable nuclear material around the globe within four years as one of several steps to reach this goal. Eight years and four Nuclear Security Summits (NSS) later, matters have improved on several fronts. Fewer countries possess high-risk nuclear materials, radiation detection equipment has been installed at transportation hubs (airports, seaports, and border crossings), and physical security upgrades have been undertaken at facilities storing weapons useable fissile materials.

The progress has been welcome, but it is worth remembering that while the NSS process took place international nuclear disarmament efforts appeared to grind to a complete halt. The 2015 Review Conference of the NPT ended in nothing, the CD remains paralyzed, the CTBT has had one (1) new Annex II ratification (Indonesia, 2012) since 2008, and no further bilateral arms limitation agreements have been negotiated since the New Start in 2010. This is not the fault of the NSS process, but in considering the impact, lessons learned, and way forward for securing nuclear materials, it is worth reflecting briefly on how the NSS process fits into the broader nuclear arms control picture.

First, securing *civilian* nuclear materials is important, but it only touches the margins of the larger problem, which is almost exclusively *military.* As long as thousands of weapons, as well as the nuclear material to make thousands more, remains outside the purview of the international control system, there is a considerable risk that nuclear weapons may one day be used—by accident or by design, by state actors or by non-state actors. Combating potential nuclear terrorism is and should be a high priority for the international community, but one should keep in mind that terrorists do not care about the distinction between civilian and military nuclear materials. If a terrorist group wants a nuclear weapon, they can be expected to follow the path of least resistance to obtain it.

Second, it is important to recognize that international efforts aimed at securing civilian nuclear

material is not primarily about *achieving* the peace and security of a world without nuclear weapons; it is about developing the tools and methods needed to *maintain* such a world. The NSS process was never about disarmament, but about the two other pillars of the NPT; the right to peaceful use of nuclear energy and the imperative of preventing proliferation of nuclear weapons. As is often pointed out, these two latter pillars are inherently at odds with each other, which is a conundrum that will most likely never go away, even if all nuclear weapons are irreversibly dismantled and secured. That it is why it is critical to develop rules, regulations and measures to ensure that this contradiction is handled in the best way possible. It must not, however, be confused with an effort to achieve disarmament.

This points to another source of tension that may have trickled out of the NSS process, concerning the old tug-of-war between the disarmament camp and the non-proliferation camp of nuclear diplomacy. Every time the nuclear-armed states and their allies climb the barricades to raise the banners of non-proliferation, questions are raised in other parts of the world about the sincerity of their commitment to disarmament. Are they truly devoted to the elimination of their own arsenals, and to the transition into a non-nuclear world order? Or is this just another little turn of the screw in the consolidation of the status quo—a status quo in which some select few are granted tacit approval for their indefinite retention of nuclear weapons while the rest of the world forgoes it? The grand bargain (of the NPT) is a fragile construction, glued together by trust and good faith. One summit doesn't make it shiver, but few dare predict how many it might take to bring it to the breaking point.

Third, and on a more process-oriented note, the NSS meetings demonstrate how effective a high-level political initiative can be in terms of nudging states forward on issues they already tend to agree on. In these situations, headline-generating summits involving heads of state and government can serve as important catalysts for change. Yet, the fact that all but one nuclear-armed state (DPRK, plus Russia at the final one) attended all the NSS meetings—many of them 'bearing gifts'—arguably says more about the level of ambitions than it says about the results achieved. When all the difficult topics are taken off the table, it is a lot easier to create an illusion of progress. At the end of the day, however, states will eventually have to return to the difficult questions. They have to go back to the Conference on Disarmament and figure out how to break the two-decade long deadlock, and they have to decide whether to boycott or support the negotiations on a treaty prohibiting all nuclear weapons. For these issues, the issues where common ground is in short supply, high-level summits and gift-basket diplomacy may not be the most effective approach. Sustainable, long term solutions tend to require tense negotiations,

red lines, uncomfortable compromises, and if all goes well, some form of legally binding instrument at the end of it all.

Fourth, different states play different roles in the quest to attain and maintain a world free from the threat of nuclear weapons. And not all states need to be included in all meetings at all times. But if the issues at hand have relevance and repercussions for all members of the international community, then a political initiative excluding three quarters of them runs the risk of some form of political backlash. So far, the exclusive character of the NSS process seems to have had limited impact in this regard. As an example, nearly half (19 of 41) of the states that ratified the International Convention on the Suppression of Acts of Nuclear Terrorism (ICSANT) between 2010 and 2016 were excluded from the NSS meetings. Similarly, of the 73 states that ratified the 2005 amendment of the Convention on the Physical Protection of Nuclear Material (CPPNM) in the same period, 44 did not attend any of the NSS meeting. On the other hand, more than 80 percent (106 of 132) of the state's that attended the first session of negotiations on a nuclear weapons prohibition treaty in February 2017 had not received invitations to any of the NSS meetings. Coincidence or not, guest-list diplomacy will always involve a higher risk of political friction than political processes open to all, and they should therefore be used with caution.

The Nuclear Security Summits were never meant to be a panacea for all the troubles of the multilateral nuclear weapons dossier. Yet, in placing the focus as it did, limiting the participation as it did, and generating the political attention that it did, there is a real chance that it may—however unintentionally—have contributed to an increased sense of frustration among those who feel the nuclear disarmament pillar is lagging ever further behind the non-proliferation pillar in the 'game of the grand bargain'. In staking out the path ahead for the international nuclear security agenda, one would do well to keep this in mind.

Cementing nuclear security improvements through security culture

Dr. Christopher Hobbs, Associate Professor of War Studies at King's College London

This paper starts by briefly discussing the impact of the Nuclear Security Summit (NSS) process. Its various achievements have been covered at length by other studies so only a brief overview is provided here. This is followed by a more detailed exploration of one crucial cross cutting area of nuclear security, security culture. Although its importance was highlighted during the summits, nuclear security culture remains very much an emergent area of practice where additional efforts should be focused.

Nuclear Security Summitry – Incremental Tangible Improvements

When discussing the significance of the summits it is important to consider the broader context in which the process was launched. Nuclear security itself is nothing new, with measures to protect nuclear materials and detect their trafficking having existed since the start of the nuclear age. Concerted international cooperation in this area can be traced back to the 1970s and the development of international guidance and negotiations towards the Convention on the Physical Protection of Nuclear Material (CPPNM). In the decades that followed additional instruments were developed and new informal initiatives launched to plug gaps in the international nuclear regime. Responding to changing threats and challenges, including most notably the breakup of the Soviet Union, chemical weapons use by Aum Shinrikyo and the 9/11 attacks. The result of these efforts was a 'messy' nuclear security policy landscape, which confronted President Obama in 2009 when initiating preparations to hold the first summit, to combat what he described as the 'immediate and extreme threat' of nuclear terrorism.

On the surface it appears that the NSS process has done little to change the international landscape, which remains a complex mix of legal instruments and informal initiatives. However, a dramatic shift to an overarching and binding framework, as advocated for by some, was never likely to be achievable. In contrast to nuclear safeguards, to which comparisons are often made, nuclear security is an extremely broad issue area and one that defies simple encapsulation. In addition diverging threat perceptions and broader nuclear politics act as barriers to increasing international nuclear security governance. Recognizing these limitations the NSS process benefited from taking a pragmatic approach to strengthening nuclear security,

seeking to build on existing initiatives. As has been widely noted the unique power of the summit process was its ability to bring together world leaders and generate the political momentum necessary to make tangible nuclear security improvements.

Notable achievements include the entry into force of the 2005 Amendment to the CPPNM, the removal of more than 1.5 tonnes of surplus highly enriched uranium or plutonium from facilities across the globe and the updating of national laws and regulation by multiple states. Other NSS initiated activities are only starting to fulfill their potential. Chief amongst there are the recently launched nuclear security 'Centres of Excellence'. These have the potential to play a crucial role as regional hubs for nuclear security training and other activities. Effective coordination will be key to their success through efforts such as the IAEA's Nuclear Security Support Centers (NSSC) Network.

More broadly and crucially as the focus shifts from diplomacy to implementation there are indications that the NSS process has served to enhance international nuclear security norms. For example, there has been a surge of requests by states to the IAEA for International Physical Protection Advisory Service (IPPAS) missions. These have continued to go up following the completion of the 2016 NSS. The diversity of presenters at the IAEA's 2016 International Conference on Nuclear Security has also increased relative to its inaugural 2013 conference, with many detailed studies delivered by organisations from countries outside of the traditional nuclear security advocates. It would seem clear that the NSS process has served to increase the volume of nuclear security work being performed globally at a technical level.

Central Importance of Security Culture

Arguably the most important cross cutting theme to emerge from the NSS process was that of security culture - the human factor within nuclear security systems. It is clear from both recent and historical cases that a weak security culture can serve to facilitate both the theft of nuclear material and the sabotage of operational systems. Here it is also important to emphasize that these incidences are not limited to facilities in developing nuclear countries. A weak security culture can and has occurred in organizations in advanced nuclear states (party to relevant international agreements and initiatives) that operate well-funded high-tech security systems and are regulated by mature competent authorities.

Weaknesses in security culture would undermine the many nuclear security improvements enacted through the NSS process and consequently it's important that additional attention be given to this relatively new area of practice. An organization's culture will inevitably evolve over time in response to a range of external and internal factors. Changes may be subtle and the emergence of potential security related weaknesses might be difficult to observe. As a consequence robust assessments should be carried out regularly in order to identify areas of potential weaknesses before a serious incident occurs and so that an appropriate enhancement programme can be enacted.

A number of nuclear operators and radiological source users have performed security culture type self-assessments but the majority of these have been pilot studies, limited both in scope and in terms of the methodologies employed. Consequently there is considerable opportunity for new initiatives to be launched in this area. Here industry may wish to consider partnerships with academia and NGOs in the performance of such studies, given the expertise necessary in social science methods to accurately assess culture. For academia and NGOs, security culture remains a relatively untouched and complex area of research given the influence of national and other cultural levels.

The IAEA has already developed general guidance on nuclear security culture as part of its Nuclear Security Series and is in the process of developing more focused documents on nuclear security culture self-assessment and enhancement. These provide a good base upon to which to develop tailored programmes. However, the former of these has been in draft form for nearly three years and consequently additional efforts should be made to complete the process of member state review necessary to finalise this key guidance document. At the national level, states may also wish to consider whether a comprehensive nuclear security culture assessment should become a formal regulatory requirement.

Effective education and training also clearly has a key role to play in sustaining a strong nuclear security culture into the longer term. Initiatives such as the International Nuclear Security Education Network (INSEN) and World Institute for Nuclear Security (WINS) Academy have helped dramatically increase the number of nuclear security courses available to current and future practitioners. In the academic community there is evidence that a shift has occurred in recent years from a Community or Interest to a Community of Practice and attention should be

given to how best to sustain new educational initiatives launched within developing nuclear countries.

Conclusions

In brief the summits should of course not be considered the start or end point of a continuing process to strengthen nuclear security. It is clear that they have served an important role in facilitating tangible nuclear security improvements although there are areas where significant work remains to be done. These include, for example, the security of radioactive sources and materials in military use (not discussed directly in this paper). In the sustaining of nuclear security improvements, security culture will have a key role to play and there is considerable scope for further activity in this area.

Global Nuclear Security Outlook - Nuclear Security Summits: What has been achieved, and what remains?

Kenneth N. Luongo, President and founder of the Partnership for Global Security

The outlook for the future improvement of global nuclear security is mixed but it is trending downward since the end of the Nuclear Security Summits (NNS). The NSS' significantly raised the profile and importance of nuclear security as an issue of global importance and the summit process resulted in some useful innovations. But, the NSS process did not create a strong enough bridge to sustain and expand its achievements after the summits ended in April 2016. The action plans that were designed to guide the international community in the post-summit period lacked detail and without the high level political attention of an ongoing summit process, the momentum and focus on the issue has significantly declined. A revitalized and coordinated post-summit multi-pronged strategy is required to regain the initiative.

The purpose of the NSS process (2010-2016) was to reduce the threat of nuclear terrorism by strengthening nuclear security measures through "responsible national actions and sustained and effective international cooperation."[1] It was originally established around U.S. President Barack Obama's call to "secure all vulnerable nuclear material around the world within four years."[2] While the first summit in 2010 focused almost exclusively on measures related to protecting civil highly enriched uranium (HEU), the NSS scope of work expanded to include radiological sources and the nuclear safety-security interface in 2012 and some governance issues in 2014 and 2016.

While much work remains, important progress was made during the summit process.[3] More than 1,500 kilograms of HEU and separated plutonium were recovered or eliminated. More than a dozen countries became HEU-free, and approximately 20 HEU research reactors were converted. Every NSS participant updated their nuclear energy laws, and new treaty ratifications allowed the 2005 Amendment to the Convention on the Physical Protection of Nuclear Materials to enter into force in 2016. More than a dozen Centers of Excellence (CoE) were established, offering new specialized training and education opportunities.

National and multinational commitments were a particularly important part of the NSS process. All 53 participants made at least one national commitment to improve their nuclear security,

[1] Communique of the Washington Nuclear Security Summit, April 13, 2010.
[2] Remarks by President Obama In Prague As Delivered, The White House, April 5, 2009.
[3] Michelle Cann, Kelsey Davenport, and Jenna Parker, The Nuclear Security Summit: Accomplishments of the Process, PGS-ACA, February 26, 2018.

and more than 90 percent of those countries issued progress reports on the steps that they took to implement those commitments and contribute to the global nuclear security regime.[4] Groups of countries also banded together to make multinational commitments in what became known as "gift basket diplomacy." This provided a collaborative, flexible form of targeted international cooperation which resulted in some of the most impactful achievements of the summits. For instance, the Strengthening Nuclear Security Implementation Initiative started out as a 2014 gift basket in which signatories committed to implement the International Atomic Energy Agency's (IAEA) voluntary guidance on nuclear security, ensure the demonstrable competence of personnel, and continuously improve their nuclear security practices.[5] It was the first of several NSS gift baskets to transition into IAEA Information Circulars, thereby moving to universalize the opportunities presented by the summit process. Unfortunately, few countries have taken advantage of these opportunities in Vienna.

A further legacy of the summits is the closer cooperation that has been initiated as a result of the nongovernmental and nuclear industry side summits that were planned alongside the official summits. That contact helped representatives from the industry and nongovernmental communities identify common ground, and several new initiatives were created, including the: Nuclear Security Governance Experts Group (NSGS) which is in transition to a broader focus as the Nuclear Governance Group (NGG); Global Nexus Initiative (GNI); and the Nuclear Industry Steering Group for Security (NISGS). All of these initiatives are built on a strong foundation created by the summit process but which will transcend the summits.

This is important because there are a number of significant challenges that the summit process did not tackle but that need attention. Cyber security is a mutating, persistent and escalating challenge that has significant implications for both facility operation and materials security. The non-light water cooled advanced reactor technologies poses new safety, security, and safeguards challenges to today's regulatory and governance systems. In addition, the future growth of nuclear power and facilities is going to be in tense and stability-challenged regions. A new wave of non-legacy nuclear exporters are seeking to supply the technologies for these programs. That raises the potential for the undermining of international norms in pursuit of sales and a backlash against proposals for new controls.

[4] Michelle Cann, Kelsey Davenport, and Jenna Parker, The Nuclear Security Summit: Accomplishments of the Process," PGS-ACA, February 26, 2018.
[5] Bart Dal, Jonathan Herbach, and Kenneth Luongo, The Strengthening Nuclear Security Implementation Initiative: Evolution, Status, and Next Steps, NSGEG, October 2015.

Unfortunately, but predictably, the disaggregated legacy mechanisms created at the 2016 summit have proven an insufficient platform for progress. Rather than creating new programs or funding streams to address the nuclear security system's emerging challenges and structural issues, leaders issued five "Action Plans" focused on the United Nations, IAEA, Global Initiative to Combat Nuclear Terrorism, and Interpol.[6] In effect, the plans reaffirm the existing order—which was deemed inadequate enough to have necessitated four heads-of-state summits— without giving the institutions any new instructions, money, or incentives to pursue the nuclear security mission in a more effective and innovative way.

In an attempt to maintain the NSS network, 39 of the 53 countries participating in the summit process agreed to form a "Contact Group" that would meet at the "Sherpa" level on the sidelines of other international events to keep the nuclear security conversation going.[7] This group has met a few times and formed working groups, but it shows no signs of being able to preserve the summit momentum or instigate new commitment making. Further, at the IAEA's December 2016 "International Conference on Nuclear Security: Commitments and Actions," the Ministerial Declaration was weaker than the 2016 NSS communiqué.[8] The difference is even more striking when compared to the 2013 version of the IAEA Ministerial Declaration from the same event. It was far more detailed and actively encouraged countries to pursue specific forms of cooperation with the IAEA as well as in other forums to further nuclear security goals.[9]

The weak follow-on mechanisms from the NSS process are not adequate to the task of confronting the new challenges that the global nuclear security system faces. To move forward, several steps should be taken so that the five Action Plan institutions are strengthened, supported, and supplemented by new structures and coalitions as outlined here:

- The Contact Group should be reconfigured to include those countries that are committed to progress. It must break political impasses and demonstrate progress, and it cannot do this while some members seek to hold back progress.
- The CoEs should be effectively networked with each other and national laboratory systems. These national assets can serve as information sharing hubs that have a

[6] Official Documents from the Nuclear Security Summits, PGS, 2016.
[7] Joint Statement on Sustaining Action to Strengthen Global Nuclear Security Architecture, NSS, April 1, 2016.
[8] Ministerial Declaration, International Conference on Nuclear Security: Commitments and Action, IAEA, December 2016; Communiqué of the Washington Nuclear Security Summit, April 2016.
[9] Ministerial Declaration, 2013 International Conference on Nuclear Security: Enhancing Global Efforts, IAEA, July 2013.

mandate for scientific and policy innovation and offer complementary regional and international programming.

- The important nuclear industry - civil society partnership needs to be nurtured and strengthened. It already has expanded to include energy and environmental experts and now is poised to be a true "break the mold" alliance that can offer guidance for the next generation of nuclear, including advanced reactors, the nuclear-climate-security nexus, innovation, governance policy, and geopolitics. Such a group could serve as the civil society partner for the Contact Group and the CoEs/National Labs. Together, they could develop and deploy innovative packages of technologies and policy solutions to meet new challenges.
- The expert community addressing the challenges of fissile material minimization and elimination need to continue its work. Insecure materials and facilities continue to pose a serious threat to the global economic development and security.

Non-state terrorist actors have proven that there is no line that they won't cross. Countries must remain vigilant in protecting the hard and soft targets that contain radioactive materials against them. But nuclear terrorism is a – hopefully – black swan event made less likely by the work of the summits. As a political issue, however, it may not have the oxygen required to sustain high level political attention. Broadening the nuclear security focus to include the full range of challenges and opportunities, strengthening the strategies for addressing them, and expanding the stakeholder communities that can support the effort is an essential step in the post-NSS environment.

Virtuous Circles: Linking Business and Nuclear Security

Laura S. H. Holgate, Fellow at the Harvard Belfer Center, Former US Ambassador to IAEA and other UN offices

National security challenges require the active participation and contributions of private-sector and industry actors to achieve efficient and enduring outcomes. Such cooperation should be embedded into the way companies do business, and in the way government engages with them as a "virtuous circle," in which doing the right thing from a security perspective is also rewarded in ways that business leaders recognize.

Nuclear energy's connection to nuclear weapons both through proliferation of dual use technology and diversion of weapons-usable material make it a critical example of this concept. For too long, the nuclear energy business has looked at nuclear security as a burden, as a drain on the bottom line. How can we create nuclear energy systems in which doing right by security is also doing right by shareholders? How do we make nuclear security good for business, and make the nuclear business good for security?

Nuclear energy's security risks must be understood clearly. A light-water reactor fuelled by low-enriched uranium by itself poses no proliferation risk – this is an advantage as we consider the growing demand for nuclear energy in the context of global economic development and reducing carbon emissions. The risks come from the inherently dual-use nature of current fuel cycle technologies – enrichment and reprocessing. Again, fortunately, a very small number of such facilities can serve a widely distributed set of power plants around the world. Additional risks come from existing stocks of highly enriched uranium and plutonium – whether in small quantities such as at research reactors, or in large civilian fuel cycle plants, or in military programs. These materials call for special care and attention to prevent their theft or misuse. Looking to the future, fast breeder reactors fuelled with highly enriched uranium and/or generating plutonium could be additional sources of proliferation risk, along with the fuel cycle facilities associated with these or other potential nuclear energy concepts. Smaller, more flexible advanced reactors have the promise to bring nuclear energy solutions to new countries and new applications, but may also create new vulnerabilities if care is not taken in their design and deployment. Looking across this spectrum, nuclear industries have a powerful role to play in managing risks from each of these elements, and national security actors have technology and insight to offer in pursuit of secure nuclear energy.

We have already proven examples of aligning interests between business and nuclear security. The US-Russian highly enriched uranium purchase agreement, the US Assured Fuel Supply, the "black box" around enrichment technology in the US-based URENCO plant show that business and nonproliferation goals need not compete with each other. Security measures can enhance the bottom line instead of draining it. Governments and industry need to work together to find additional ways in which good nonproliferation outcomes go hand in hand with good business outcomes.

One place to start in this joint effort is to consider the "wish list" for each piece of this puzzle. From a nonproliferation and nuclear security perspective, there are several key goals:

- Secure HEU and separated Pu as if they are the weapons they could become
- Phase out production/transport/use of HEU and separated Pu in the commercial sector
- Reduce stocks of weapons-usable material
- Limit spread of enrichment and reprocessing technologies

If these are looked at in isolation, they can seem to create limits or burdens on the expansionist, profit-driven nature of the nuclear industry. Industry has often looked at these goals as either a cost to be shifted to government, or policies to be opposed or undermined. But we have seen, from the examples above, that this doesn't always have to be the case.

The nuclear industry has its own wish list:

- Durable spent fuel solutions
- Reliable supplies of expertise, materials and financing
- Stable legal and regulatory environment
- Reasonable return on investment
- Government support (exports, loan guarantees, policies)
- Level playing field with other energy sources

We should be looking for ways to examine these two sets of goals to develop tools that bring them together. Governments have some tools at their disposal that can help shape the business environment towards the kind of "virtuous circles" that will benefit both sides of the nuclear coin:

- Loan guarantees and other financing arrangements
- Access to federal assets (land, technology)

- Opportunities for international cooperation
- Government purchasing power
- Taxes and tariffs
- Technology substitution (e.g., Mo-99 production using accelerators)
- Trade advocacy

Business and other non-government actors have tools at their disposal as well.

- Attractive technologies for export markets
- Sharing of best practices (e.g., World Institute for Nuclear Security)
- Security- and safeguards-by-design
- Codes of conduct
- Industry-based nuclear security standards & certifications (e.g., ISO-type standards)

Given the challenges of the Generation III and III+ reactors currently under construction, advanced reactors (Gen IV and others) provide a unique chance to "bake in" virtuous circles from the beginning. Since none of these reactors have been built yet, it is more possible than ever to apply security-by-design and safeguards-by-design to advanced reactor designs – and their associated fuel cycles – right from the start, which should reduce costs and increase efficiencies. These reactors – being smaller, cheaper, factory-built, and in some cases having lifetime cores – are intended to be more attractive than larger, gigawatt-scale reactors on price, schedule, grid-appropriateness, and fuel management grounds.

If they live up to these expectations, advanced reactors could have the additional benefit of bringing US back to the front of the line for reactor exports. This restoration will have not only economic benefits, but will also yield national security benefits by increasing interest among the "nuclear newcomers" in buying American (instead of Chinese or Russian) and in signing the Agreements for Nuclear Cooperation, or 123 Agreements, required for access to US nuclear technology. These agreements, by law, contain stricter nonproliferation and nuclear security provisions than what China or Russia requires, and thereby wrap signatories into a web of commitments that reinforce the global nonproliferation regime and maintains a US voice in global nuclear rules and norms. In this way, national security goals and nuclear commerce goals are aligned.

Another tool to align security and commerce may be found in the creation of industry-based standards for nuclear security. While national regulations create a baseline of nuclear security

compliance, we know that some operators have decided to make improvements beyond what regulations require, based on judgements around corporate liability or local security risks. What if nuclear operators could work together to identify standards for nuclear security analogous to LEED building standards, with gradations from good to better to best? When advertised, such recognition could enhance reputations and provide a deterrent to would-be thieves, but what if they could also be tied to financial benefits such as access to financing or variable insurance rates?

If security is in tension with profits, we will continue to be at risk from the kind of nonproliferation failures we have seen in the AQ Khan network, or from the potential for theft, diversion and misuse of nuclear technology or materials by states or terrorists. The most durable nuclear system is one that makes nuclear security good for business, and business good for nuclear security.

Atoms for Peace, Development and Prosperity

Tariq Rauf, former Coordinator, Multilateral Approaches to the Nuclear Fuel Cycle at the IAEA

This year marks the sixtieth anniversary of the establishment of the International Atomic Energy Agency (IAEA) and penultimate year before the fiftieth anniversary of the opening for signature of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). The Agency and the NPT together have provided the fundaments for global nuclear governance in both the peaceful and non-peaceful uses of atomic energy.

At the end of 2016, 450 nuclear power plants (NPPs) were providing 392 GW(e) of electricity in 30 countries marking an increasing of about 9.2 GW(e) over the previous year. New construction of NPPs is mainly in Asia with 40 of the 61 plants currently under construction, as were 47 of the 55 NPPs connected to the grid since 2005. In some parts of the developed world renewable energy is being favoured over nuclear with divestiture in Germany, slowdown in Canada and the USA, and under discussion in France, Switzerland and the UK. Reliance on nuclear generated electricity varies from a high of about 72% in France to 40% in Sweden, 33% in Finland, 17% in Russia, 4% in mainland China and 2% in Iran. Nearly every country in the world has some connection to nuclear whether it is for medicine, agriculture or water, and the IAEA contributes to the attainment of nine of the 17 sustainable development goals (SDGs). Thus, the safe and secure uses of atomic energy are vital for development and prosperity of the world's nearly 8 billion people.

On the other hand, nine States have misused the atom for weapons purposes and together these States have carried out about 2,050 nuclear detonations in all environments – atmosphere, oceans and underground – as well as in space. Some 15,000 nuclear weapons still exist in their arsenals together with nearly 2,000 tonnes of weapon-usable nuclear materials: 1,499 tonnes of highly-enriched uranium and 499 tonnes of plutonium sufficient for nearly 130,000 nuclear warheads. And, 36 States still rely on nuclear weapons for their security with 33 of them doing so in contravention of the objectives of the NPT, despite 185 NPT States having renounced nuclear weapons.

International nuclear governance

While the IAEA, an autonomous international organization within the UN system, is the recognized and designated authority to provide for nuclear safety and nuclear security standards

under its Statute, as well as for safeguards and monitoring and verification of peaceful nuclear activities under the NPT; there still is no agreement or organization to prohibit nuclear weapons and their related infrastructure.

The Comprehensive Nuclear-Test Ban Treaty (CTBT) of 1996 prohibits all nuclear explosions in all environments for all time, but its entry-into-force has been held up by a handful of countries while 166 have ratified. India, North Korea and Pakistan have not signed the CTBT, and China, Egypt, Iran, Israel, and the USA have not ratified – the US Senate rejected the treaty in 1999. More than 90% of the 321 monitoring stations of the CTBT's international monitoring system (IMS) are now in place, representing an investment of about US$ 1 billion. Civilian benefits of the IMS include providing early warning of earthquakes and tsunamis. Achieving the entry into force of the CTBT should become one of the highest priorities for the international community.

The main nuclear governance challenges today concern the possession and/or continuing reliance on nuclear weapons by some 36 countries; the lack of accountancy, international monitoring and elimination of stocks of 2,000 tonnes weapon-usable nuclear materials; and safe and secure peaceful uses of nuclear energy.

There have been five international summit meetings on nuclear security – Moscow (1996), Washington (2010 and 2016), Seoul (2012) and The Hague (2014). These summits have focused on improving security of 17% of nuclear materials in the world and these are in civilian uses, but about 83% in military uses remain outside of any international accountability and monitoring. Efforts to start negotiations on an international treaty banning the production of weapon-usable nuclear materials must include all existing stocks of these materials in its scope or coverage, and provide for international monitoring and elimination of these dangerous nuclear materials.

Disposition of weapon-grade nuclear materials can contribute both to disarmament and prosperity. Under a 1993 Russia-US "megatons to megawatts" agreement, 500 tonnes of highly-enriched uranium (HEU) from dismantled Russian nuclear warheads was blended down into nuclear power reactor fuel. For two decades some 25% of nuclear generated electricity in the US came from uranium that was once in about 20,000 Russia nuclear warheads previously aimed at the US. Pursuant to a 2005 decision, the US down blended 17.4 tonnes of surplus HEU to low enriched uranium (LEU) for power reactor fuel resulting in approximately 230 tonnes placed in a reserve sufficient for about six reloads for a 1,000 MW(e) power reactor. This

American Assured Fuel Supply (AAFS) will be available in the event of nuclear fuel supply disruptions.

In addition, in 2010, the IAEA LEU Reserve was established at Angarsk in Russia. The reserve comprising 120 tonnes of LEU is Russian property, but under a binding agreement with the IAEA LEU from the reserve will be provided on payment to any IAEA member State without nuclear weapons and party to the NPT that is experiencing a supply disruption. Under this agreement, the IAEA can supply LEU to an eligible member State even if Russia has denied LEU to the requesting State.

The IAEA LEU Reserve and the AAFS are part of a new approach to the nuclear fuel cycle first proposed by the IAEA in 2004, under which users of nuclear power need not invest in costly uranium enrichment facilities for their nuclear fuel requirements but rely on the market backed up by international assurances of supply.

The technology to enrich uranium to about 3.67% for use as nuclear power reactor fuel is the same as to enrich uranium to above 90% for use in weapons. With 30 countries already using nuclear generated electricity and additional countries either constructing or contemplating nuclear energy, the further spread of enrichment facilities is not desirable for non-proliferation purposes. Hence, if users of nuclear energy can be assured of their nuclear fuel supply they would not need to add to their financial burden by also building enrichment plants.

As the LEU Reserve and the AAFS are property of Russia and the US respectively, having an IAEA owned and operated IAEA LEU supply would provide the highest level of assurance. In September 2006, the Nuclear Threat Initiative (NTI) offered US$ 50 million to the IAEA with the challenge to raise $100 million to set up an IAEA LEU Bank. By late 2010, pledges had been received from the European Union, Kuwait, Norway, United Arab Emirates and the US totaling in excess of $100 million and Kazakhstan had offered to host the LEU Bank at no cost to the Agency. In December 2010, the IAEA Board of Governors authorized the establishment of the IAEA LEU Bank and in late 2011 the IAEA selected a site in Kazakhstan as its location. It is expected that the opening ceremony will be held in Astana on 29 August 2017.

With the inauguration of the IAEA LEU Bank one part of a new approach to the nuclear fuel cycle will have been implemented – pertaining to the front end that deals with assurance of supply of low enriched uranium for fuel. However, the back-end of the nuclear fuel cycle remains to be addressed – i.e., dealing with civilian spent nuclear fuel, as it contains plutonium

that under certain conditions could be separated out for military use. Approximately 400,000 tonnes of civilian used fuel is expected to be generated worldwide between 2010 and 2030, including 60,000 tonnes in North America, 69,000 tonnes in Europe and 15,000 tonnes in Japan. This can either be placed in interim and then long-term storage or reprocessed to produce mixed (uranium-plutonium) oxide fuel (MOX) for reactors. MOX generally is not cost efficient and reprocessing (like enrichment) poses a proliferation threat. Only Finland and Sweden thus far are constructing spent nuclear fuel repositories for long-term permanent disposition. Sporadic discussions continue on the feasibility of regional and international repositories, as well as on commercial arrangements for processing and disposition, thus far without agreement. Multilateral approaches are urgently needed for the back-end of the nuclear fuel cycle as stocks of spent nuclear fuel continue to increase and storages could be vulnerable to proliferation and security threats. IAEA member States need to take leadership and initiative to promote new collaborative approaches to regional and international storage and disposition of spent nuclear fuel.

Conclusion

It is clear that actions not words are needed to assure the safe and secure uses of atomic energy for peace, development and prosperity of the world's nearly 8 billion people. The solutions are obvious and known, they are not rocket science; but it is political will that is in serious deficit. As noted above, the CTBT must be brought into effect, elimination of weapon-usable nuclear materials through an internationally negotiated fissile material treaty, acquisition of LEU free of national restrictions for the IAEA bank, and solutions devised for civilian spent nuclear fuel disposition.

Finally, to close the loop, nuclear weapons should be banned as have biological and chemical weapons to rid the world of the dangers of weapons of mass destruction. Should nuclear weapons be abolished and dismantled, the nuclear material from dismantled warheads converted to fuel for power reactors or permanently rendered unusable for weapons purposes and placed in inaccessible storage – the world would be a much safer place with the atom being used solely for peace, development and prosperity.

Nuclear Energy "Newcomers" and Nuclear Security Challenges

Elena K. Sokova, Deputy Director, James Martin Center for Nonproliferation Studies
Middlebury Institute of International Studies at Monterey

Nuclear energy as a solution to growing electricity demands continues to be an attractive option for many countries, including – and especially – in the developing world, where it serves as a tool to facilitate economic development. Prior to the 2008 financial crisis and before the 2011 Fukushima nuclear reactors meltdown, the list of nations seeking nuclear energy comprised 60 candidates. The 2008 crisis and the 2011 accident, coupled with the decline in oil and gas prices, had a dampening effect on their plans. Many nations rescinded their decisions to pursue nuclear power or put their plans on a back burner. Some of the "old timers," such as Germany, Sweden, and Switzerland, opted to phase out nuclear power altogether.

Nonetheless, according to the World Nuclear Association, as of May 2017, "over 45 countries are actively considering embarking upon nuclear power programs."[10] While the statistics looks impressive, the number of these countries, often referred to as "newcomers," that have actually moved beyond declarations is much lower. In fact, since the Chernobyl accident, only three countries without prior experience in nuclear energy generation crossed the threshold or are close to joining the club of countries operating nuclear power installations. In 2013, Iran put its first nuclear power reactor into operation in Bushehr. The United Arab Emirates anticipates the launch of the first out of planned four reactors in 2017. For its part, Belarus is expected to have a nuclear power reactor operating in late 2019.

About half a dozen countries, including Bangladesh, Egypt, Jordan, Kazakhstan, Poland, and Turkey still claim to be committed to launching nuclear power programs. Until November 2016, Vietnam was also on the list, and hopes were high that it would demonstrate that nuclear power generation is not limited to developed and wealthy developing countries or to those with nuclear weapons programs. Vietnam heavily invested in developing the necessary infrastructure for nuclear power and met the majority of legal, technical, regulatory, and other requirements necessary for launching its construction. Nevertheless, citing post-Fukushima safety concerns and prohibitive costs, Vietnam decided to abandon the program.

Vietnam's decision and experience will likely affect the calculations of other states, particularly developing countries without substantial financial resources. Costs of at least $2 to $5 billion

[10] World Nuclear Association. Emerging Nuclear Energy Countries (updated May 2017).

per reactor, as well as operational and waste management expenses, will remain the main prohibiting factor. Other bottlenecks include insufficient engineers, scientists and trained managers, the lack of regulatory expertise and experience, and poor financial, legal, and physical infrastructure that cannot support a large-scale undertaking, particularly one as complex as nuclear power. Moreover, for the vast majority of African and Asian countries, the primary obstacle is the low capacity and quality of their current electrical grid systems, which are not able to support industrial-scale power reactors. Simply put, the declared interest in nuclear power, for the majority of developing countries, will remain little more than an aspiration.

When and if small modular reactors enter the nuclear market that have the potential to lower capital costs and demands on the electric grid, the "newcomers" will still need a national policy and strategy for the program, a legal framework, an independent regulatory body, adequate industrial and transportation infrastructure, and a skilled workforce in order to pursue nuclear power. These are just few of the key milestones developed by the International Atomic Energy Agency (IAEA) for nuclear power programs. Meeting these milestones is the only way to ensure that the program proceeds in a safe, secure and sustainable way.

Today, nuclear safety, security, and nonproliferation norms and requirements are much more advanced and demanding when compared with the first decades of the nuclear power development in the world. The Three Mile Island, Chernobyl, and Fukushima accidents were major shocks to the global nuclear safety system. The discovery of a clandestine nuclear program in Iraq triggered a much more rigorous and comprehensive safeguards system. The rise of terrorism is a key driver of significantly tougher requirements for physical protection and other nuclear security measures. Meeting all these conditions is costly and challenging even for countries with advanced nuclear power programs, to say nothing of the "newcomers," many of whom have to start from zero.

The requirements for nuclear security include the establishment of effective physical protection, control and accounting systems for nuclear materials and facilities; adherence to international treaties and conventions; the adoption of national legislation and regulations, including criminalization and penalties for offences involving nuclear and radioactive materials; the establishment of an independent and robust nuclear regulator; the assessment of nuclear security threats; response to nuclear security events; and the capability to maintain the nuclear security

regime. In addition to these and other essential elements, the IAEA and nuclear security experts stress the importance of the development of a nuclear security culture.

The requirements are daunting, and upholding them would require significant assistance to developing countries from experienced nuclear operating states and international organizations. While some opportunities are already available to emerging nuclear power countries, including through the IAEA and its Integrated Nuclear Infrastructure Review and International Physical Protection Advisory Service missions, training, and technical cooperation programs, the sheer scope and magnitude of work necessitates much broader involvement and contributions at government, industry, and expert levels. Regardless of future decision about pursuing a nuclear power program, the strengthening of nuclear security capacity in these countries, particularly in the developing world, is a worthy and much needed undertaking.

Such work needs to start as soon as possible and focus first on the security of radioactive sources and materials. These materials and sources are used in numerous industrial, agricultural, scientific, and medical applications. As countries pursue industrial development, the need for equipment and tools employing radioactive sources and other nuclear applications will continue to grow. At the same time, the global community is increasingly concerned that terrorists could gain access to high-activity radiological sources that could be used in dirty bombs. Unfortunately, many countries in Africa, Asia, and the Middle East, which have indicated their interest in nuclear power and other peaceful uses of nuclear and radioactive materials, are also experiencing a rise in terrorism. Some of them, including Algeria, Egypt, Nigeria, Philippines, Sudan, and Yemen, face very serious terrorism threats from ISIS, Boko Haram, and Al-Qaeda-type groups.

In addition to assisting with building a robust nuclear security system, international experts also propose reducing risk by replacing the most dangerous radioactive materials with less dangerous alternatives. In some cases, this process involves the use of a different radioactive material with significantly lower security risk. In other instances, equipment and tools can be replaced with alternative technologies that do not require the use of radioactive materials.

One of the more challenging cases is the replacement of cancer treatment machines that utilize radioactive cobalt-60. The availability of cancer radiation treatment machines in poorer countries is grossly inadequate. This is particularly acute in Africa, which only has 20% of the radiotherapy resources it needs and where one radiation therapy machine may serve as many as 10 million people and some countries have none. Simply removing current devices that use

cobalt-60 and other high-risk radioactive sources could prevent patients from getting the care they need. These machines can be replaced, however, with much more advanced and efficient linear accelerators (LINAC) that do not use radioactive materials. Doing so would contribute both to addressing shortages of these devices while reducing nuclear security risk. However, most current LINAC machines are more expensive than their high-risk alternatives and not suited to the more challenging environments of developing countries, which may suffer from unstable access to electricity, fewer trained medical technical technicians, and poor maintenance and supply chains. Advanced countries and the nuclear medicine industry could do much more to make these machines affordable and more appropriate for these countries.[11]

Other mitigation strategies include assisting in locating and securing old and disused radioactive sources, returning them to their countries of origin, and/or building adequately-protected storage facilities. Much more robust investment is also needed in personnel education and training in order to build cadres for regulatory bodies and nuclear medicine operators, as well as other radioactive sources applications.

In other words, a strategy to strengthen nuclear security in developing countries will require a multifaceted approach and the concerted efforts of multiple stakeholders to ensure that advances in nuclear science and applications serve development goals and contribute to prosperity. A nuclear security event involving a radioactive source or material in any of these countries would effectively put the brakes on their economic and technological advancement and most likely jeopardize their nuclear power ambitions.

Nuclear power development costs will continue to be high and require significant investment in political, legal, institutional, regulatory, and other prerequisites. Some countries will not choose a nuclear path in the end. Nevertheless, a major investment in nuclear security for non-power applications could help in meeting some of these requirements. Most importantly, it could serve to reduce the threats of nuclear and radiological terrorism, protect our collective health and the environment from accidental dispersion and contamination, and reduce and eliminate other security vulnerabilities.

[11] See "Treatment, Not Terror. Strategies to Enhance External Beam Cancer Therapy in Developing Countries While Permanently Reducing the Risk of Radiological Terrorism" report by Miles Pomper, Ferenc Dalnoki-Veress, and George Moore; February 2016:
https://www.stanleyfoundation.org/publications/report/TreatmentNotTerror212.pdf

International Efforts Towards Nuclear Security

Dr. Lassina Zerbo, Executive Secretary, Comprehensive Test Ban Treaty Organization.

A discussion on international efforts towards nuclear security is very timely. Last year, the series of US-led Nuclear Security Summits came to a conclusion. The latest NPT review cycle has begun. And, of course, negotiations on a treaty to prohibit nuclear weapons are about to begin. What do these things have in common?

They are all, in different ways, connected with the concept of nuclear security. I know that not everyone would immediately recognize that. The tendency has been to describe nuclear security in terms of preventing terrorist groups from obtaining nuclear material. However, I have consistently argued for a broader definition. This is not to minimise concerns over nuclear terrorism, which remains one of the gravest threats that we face. Everything must be done to prevent terrorist networks from acquiring the materials to assemble a nuclear weapon.

The simple truth is that control of nuclear arms, non-proliferation of weapons or materials, and nuclear disarmament itself are closely linked. It is difficult to make progress on one element without at least considering how it fits under the overall umbrella. Many efforts – legal, political, diplomatic, multilateral, bilateral – have been made to strengthen nuclear security. In the more narrow sense, we can point to examples such as the Convention on the Physical Protection of Nuclear Material (CPPNM), or innovative initiatives like the Low Enriched Uranium (LEU) Bank spearheaded by Kazakhstan. But we should not divorce these efforts from the huge advances made more generally in bringing us closer to the security of a world without the threat of nuclear weapons. With the NPT as a cornerstone, these include US-Russia nuclear arms limitation and reduction treaties, the evolving IAEA safeguards system, and the almost complete end to nuclear testing under the CTBT verification regime.

At a time of geopolitical uncertainty, we should be doing more to bring these issues together. The international community needs to forge a confident vision of collective nuclear security. If this does not happen, if a silo-based approach to nuclear security persists, that will only lead to more problems in future.

The question is: how do we build the trust and confidence needed to reach the endgame? Making progress on nuclear security requires action on five elements: understanding, leadership, innovation, culture, and partnerships.

1. Understanding

It is finally time to arrive at a common understanding of nuclear security. My definition is as follows: it means creating and maintaining the conditions of trust and mutual understanding necessary to free the world of any nuclear threat. Only through considering nuclear security in an all-encompassing way, can we establish a comprehensive and inclusive approach towards it.

2. Leadership

The second element is leadership. It is true that nuclear-armed states and the states that possess nuclear technology and materials have a special responsibility to lead. But leadership is also a matter for all the world's nations. In addition, measures and initiatives need to be non-discriminatory and inclusive in order to be truly effective in implementation terms. Some have argued that the Nuclear Security Summits were too selective and exclusive – and it may be that this perception was damaging to the process.

Leadership must be persistent. A vacuum in leadership will give rise to other approaches. Whatever one's view on the emerging nuclear weapon prohibition treaty, it is arguable that it is the result of stalled leadership in other parts of the nuclear non-proliferation and disarmament agenda.

3. Innovation

We must be ready to explore new, innovative, approaches to address long-standing nuclear security challenges. One interesting concept in the Nuclear Security Summit process was the "gift basket". Countries were encouraged to set and present their own goals, and then to hold each other accountable in achieving them. This is something that could be readily applied elsewhere. I could readily imagine it in the CTBT context, for example. At present States Signatories are asked to file annual returns on their efforts to promote the Treaty's entry into force. But why not turn this around and make it proactive? Those of us active in nuclear security must always be ready to learn from new ideas, and build on them where appropriate.

4. Culture

As the saying goes, culture eats strategy for breakfast. All the careful planning in the world is

for nothing if there is no bedrock of responsible behaviour on nuclear security. A number of the post-Cold War initiatives, such as the Nunn-Lugar Cooperative Threat Reduction program, had this at their heart. We need to reinvigorate the will to embrace a culture of nuclear security. This requires investing in capacity building. Taking the CTBTO as an example, our capacity-building programmes help build the expertise of developing countries in the use of monitoring data. That way all countries can confidently play an active part in CTBT verification.

Building a culture means continued engagement and outreach. We should not forget the role that civil society, the academic community and especially youth, can play. Progress on this issue is impossible without the engagement of the coming generation. In the CTBTO, we have been fostering a "culture of non-testing", for example through engaging with educational partners on academic curricula. This was also a major factor in the launching of our CTBTO Youth Group last year.

5. Partnerships

This brings me to the need to build inclusive partnerships. We must be careful to leave no relevant actor out in the cold. A good example is the CTBTO. The CTBT has set a clear example on nuclear security. By prohibiting all nuclear explosions, it places real constraints on both the first-time development of nuclear weapons and the means for improvements. It is backed up by a sophisticated and proven verification regime. The world has at its disposal an International Monitoring System made up of 337 facilities, which is almost complete and is operational. The CTBTO detected all five of the nuclear tests carried out by North Korea, including two last year alone. The CTBT is also one issue on which NPT States Parties can agree – we saw that at the 2015 Review Conference and again recently in Vienna during the first PrepCom for the 2020 cycle.

Yet there is a temptation to artificially divide international organizations and other institutions according to mandate, losing sight of the power they might have in partnering together. Take for example the Fukushima disaster. Data from our monitoring stations on radionuclide dispersal was made available within the first hour of the incident. Shortly afterwards, the CTBTO joined the Inter-Agency Committee on radiological and Nuclear Emergencies (IACRNE) and so remains a permanent part of the planning and response to nuclear disasters. Why did it take until Fukushima for CTBT data to be used in such way? Quite simply, because of the "silo approach" to nuclear safety. Let's not make that mistake where nuclear security is concerned.

In his last will, Alfred Nobel specified that a Prize should be awarded to those that “have done the most or the best work for fraternity between nations, for the abolition or reduction of standing armies and for the holding and promotion of peace congresses". This could be a manifesto for the CTBTO – indeed it should be the driving force for all of us promoting nuclear security. Nuclear security depends on all of us. Achieving it depends on shaping a culture of common understanding based on bold leadership, innovative ideas, and strong, inclusive, partnerships.

Bringing Outsiders Back In: Strengthening Nuclear Security Governance

Dr. Rajeswari Pillai Rajagopalan, Senior Fellow and Head of the Nuclear and Space Policy Initiative at the Observer Research Foundation (ORF), New Delhi.

For India, nuclear safety and security remains an important issue. The presence of the Indian prime minister at three of the four nuclear security summits is an illustration of this. India has had to battle a variety of internal and external threats including cross-border terrorism for a few decades now. A dangerous mix of nuclear proliferation and terrorism in the Indian neighborhood has kept the Indian policy makers and security managers concerned about the security of Indian nuclear facilities. Accordingly, India instituted several institutional and legal measures to maintain a high level of security of its nuclear facilities. While many of these measures originally came about in the 1960s and 1970s, these have been periodically reviewed and updated in accordance with the changing regional and global nuclear security developments.[12]

But there are many areas where India could still improve in its nuclear security policy and performance. India needs to approach nuclear security with a greater degree self-assurance, understanding that no country has the solutions to all the nuclear security contingencies. One such area that needs improvement is India's performance in the aftermath of an incident. India needs to plan response and contingency measures in a much more effective manner, particularly the ability to undertake seamless joint operations involving multiple agencies. Though individual security agencies undertake periodic mock drills and simulation exercises, exercises involving different security agencies have been fairly infrequent and this may prove to be in the case of an actual incident.

A second major shortfall has been India's poor outreach about its policy achievements. In the absence of a successful outreach, the general assumption among the global nuclear community is that India does not have a nuclear security policy. In fact, a study done by the Observer Research Foundation (ORF), which was the first comprehensive study on the subject, found that India has a fairly robust nuclear security policy in place. But India's reticence to talk about

[12] For details of India's nuclear policy and practice, see Rajeswari Pillai Rajagopalan, Rahul Krishna, Kritika Singh and Arka Biswas, *Nuclear Security in India, Second Edition*, October 2016, http://cf.orfonline.org/wp-content/uploads/2016/10/ORF_Monograph_Nuclear_Security.pdf

its policies and achievements has led to the perception that India does not pay attention to nuclear security, which is far from the truth.[13]

The ORF study made four key recommendations: First, India should endeavor to establish a separate police force. The Central Industrial Security Force (CISF) that has been responsible for maintaining the security of nuclear facilities has done a good job so far, but its mandate is large, extending far beyond nuclear security. Second, India must expand Personnel Reliability Programme (PRP) to all levels including temporary labourers who work at India's nuclear power plant for short periods of time. Third, there is need for better audit of nuclear materials as well as tightening of the licensing process to ensure that handling of nuclear materials is kept as limited as possible. Fourth and most importantly, India must step up its outreach efforts in nuclear security. This is particularly important in the context of India seeking to integrate into the global non-proliferation architecture. These measures could go a long way to making Indian nuclear security even more robust than it is at present.

Pakistan also faces several challenges regarding nuclear security. First is the uncertainty as to who is responsible for Pakistan's nuclear programme. After the AQ Khan episode, Pakistan has claimed that it has improved control over its nuclear establishment. But there are still doubts about the lines of authority when it comes to nuclear matters in Pakistan. Despite a civilian government in charge, it is widely believed that Pakistan's military nuclear establishment is directly managed by the army without any input from the civilian political leadership. On the other hand, Pakistan also does have a civilian nuclear sector but whether that civilian nuclear sector is independent of the military sector is also unclear. It is possible that this lack of clarity is because Pakistan sees the nuclear establishment as a vital national security asset that it should protect from the outside world. It is therefore possible that lines of authority may be clearer within the Pakistani establishment even if it is unclear to outsiders. But as long as there is no clarity, these questions are bound to be asked.

A second major problem with Pakistan's nuclear security is the terrorism threat. Pakistan is home to a wide variety of terrorist groups, many co-opted by the Pakistani military establishment. Pakistan military sees these groups as vital instruments in its regional policy both towards India and Afghanistan. But many of these groups have links to other radical networks that may not be fully under the control of the Pakistani military establishment.

[13] Rajeswari Pillai Rajagopalan, *Nuclear Security in India*, February 2015, http://www.orfonline.org/wp-content/uploads/2015/02/NUCLEAR_SECURITY_IN_INDIA.pdf

Moreover, some of these groups, especially factions of Taliban are in open war against Pakistan. Some of these groups were responsible for a nearly successful attack on General Musharraf when he was the head of the country. There have also been attacks on facilities such as military bases that could have been potentially hosting nuclear assets. It is unclear if any of the terrorist groups that the Pakistani establishment sponsors have interest in acquiring nuclear weapons. Even if the leadership of these groups are obedient to the Pakistani military, there is always the possibility that the more radical elements within the group might seek nuclear assets, making this a significant threat.

A third serious problem is Pakistan's own evolving nuclear policy. In order to deter India, Pakistan has always refused to subscribe to a No First Use (NFU) doctrine. This would presumably mean that Pakistan will keep at least some of its nuclear weapons some of the time in an assembled read-to-use manner. This itself is dangerous since it increases the chances of inadvertent use or accidents with nuclear weapons. But more recently, this threat has become more acute because Pakistan claims that it also wants to deploy tactical nuclear weapons to deter India's conventional military superiority. Though it is not clear that if Pakistan's tactical nuclear weapons have actually been deployed, it would make little sense to build tactical nuclear weapons unless they are deployed in forward areas. Given their short-range, these weapons will be useless if they are held far from the border. But deploying these weapons creates multiple dangers. To effectively use these weapons, Pakistan will have to delegate control over these weapons to lower level in the military hierarchy. This will put more fingers on the nuclear trigger. In addition, deploying and transporting these weapons in forward areas raises the likelihood of accidents or inadvertent use. It also increases the vulnerability of these weapons to theft or seizure by terrorist groups.

Of course, it is in Pakistan's interest to ensure that its nuclear establishment is secure and that its nuclear weapons are safe but some of Pakistan's choices though possibly understandable from a strategic point of view, increases the risk to nuclear security. How this balance between nuclear security and strategic needs is considered within the Pakistani establishment is unclear.

In its country statement to the 4th Nuclear Security Summit in April 2016, Islamabad stated, "As a responsible nuclear state, Pakistan takes nuclear security very seriously and accords it the highest priority in its security construct. Our nuclear security paradigm, evolved over the years, is effective and responsive against the entire range of possible threats. Nuclear security regime

in Pakistan is dynamic and regularly reviewed and updated."[14] Additionally, Pakistan has also ratified the 2005 Amendment to the Convention on the Physical Protection of Nuclear Material (CPPNM) reiterating its commitments to nuclear security in general. While this positive, the rest of the world will gain greater confidence in these assertions if Pakistan is more open about how it ensures these commitments and how these commitments square with Pakistan's actual behaviour.

How Can Global Nuclear Security be Strengthened?

Given the enormous consequences of a nuclear incident, every single country that possess nuclear material must be involved in efforts at strengthening nuclear security policies and practices. There is a pressing need for verification instruments that would govern the transfer, use and regulation of nuclear materials. There are additional measures necessary too:

New Rules of the Road: New rules of the road in the form of a convention on nuclear security along the lines of the IAEA Convention on Nuclear Safety must be developed. The need to categorize global standards and regulations covering both civilian and military nuclear materials through a comprehensive instrument such as a convention on nuclear security is real. Even as there is a broader agreement on nuclear security among major powers, political difficulties have played a spoiler role in preventing greater participation in nuclear security efforts. Absence of Russia at the 4th Nuclear Security Summit is a case in point.

An Inclusive Process: As the global nuclear community makes efforts to develop an effective nuclear security regime, there is a need for an inclusive process that would ensure greater acceptability and compliance. All nuclear material possessing states must be involved in such as exercise that would contribute to the longevity and effectiveness of the regime

Global than Regional Approach: Nuclear security is a global issue and must be treated thus. However, regional centres of excellence such as the Global Centre for Nuclear Energy Partnership (GCNEP) in India and Pakistan's centre of excellence and other regional centres could be used to initiate global conversations.

Expand the Stakeholder Base: An effective nuclear security regime would to a large extent depend upon the stakeholder base. The NSS process was a successful initiative despite initial

[14] "Pakistan's National Statement," Nuclear Security Summit, Washington DC, 31 March - 1 April 2016, April 01, 2016, http://www.nss2016.org/document-center-docs/2016/4/1/national-statement-pakistan

scepticism in certain quarters because it went beyond the states to establish a wider network of stakeholders including the NGO/ expert community and industry.

Enhanced Support for the IAEA: Increasing state support to the IAEA as it relates to human resources and funding is critical if the IAEA is to play a more effective role in ensuring nuclear security, which has been a long-standing demand of many states. The IAEA could also build a database that would record security lapses and breaches, which could be useful for other countries in order to avoid certain mistakes as well as tackle compliance issues.

The U.S. - Russian Cooperation in the Nuclear Sphere is a Necessary Condition in the Prevention of the Nuclear Threat

Anatoly S. Diyakov, Professor of Physics at the Moscow Institute of Physics and Technology and founding Director of the Center for Arms Control Studies.

Cooperation on nuclear issues between Russia and the United States, which together possess more than 90% of the world's nuclear weapons and weapons-grade nuclear materials and have accumulated unique experience in counteracting nuclear threats, is vitally important. Without cooperation between these countries, effective maintenance of the nuclear nonproliferation regime and prevention today's danger of nuclear terrorism, which is real serious and growing, is unlikely to be possible.

From 1992 to 2014 Russia and the United States actively and effectively cooperated on nuclear issues and achieved much, primarily in the field of nuclear security. In this regard, the Cooperative Threat Reduction Program (CTR), and the Nunn-Lugar program, deserves mentioning in this regard. As a result of these joint efforts, along with the dramatic reduction of the nuclear danger, an enormous and unique experience on political and legal issues was accumulated both in direct practical collaboration between nuclear laboratories, enterprises of the nuclear complex and among U.S. and Russian specialists. One of the most important results of this cooperation was the establishment of personal contacts and mutual understanding between Russian and American specialists.

Today, due to the differences, including those over Ukraine, Middle East and other issues, cooperation between Russia and the United States has almost come to a standstill and communication between nuclear and technical experts in U.S. and Russian nuclear complexes has been frozen.

In March 2014, the U.S. suspended cooperation in the bilateral Russian-American Presidential Commission’s (Poneman-Kirienko) working group overseeing the nuclear security programs. Then in May 2014, again at the US’s instigation, work was suspended under the 16 September 2013 inter-governmental Agreement on Cooperation in Nuclear- and Energy-Related Scientific Research and Development. In March 2014, the United States suspended cooperation in the Poneman-Kiriyenko working group, carried out within the framework of the Russian-American presidential commission, which oversaw nuclear safety programs. Then in April 2014, also at the initiative of the United States, work on the U.S.-Russian Agreement on Cooperation in

Nuclear -and-Energy Related Scientific Research and Development of September 16, 2013 was stopped.

In retaliation, the Russian side has terminated bilateral cooperation carried out within the framework of the intergovernmental 2013 Protocol to the Multilateral Nuclear Environmental Programme in the Russian Federation, signed on June 14, 2013 (2013 MNEPR Protocol). This protocol determined the list of areas for joint work in the field of nuclear security, including accounting, control and physical protection of nuclear materials.

Finally, in early October 2016, in accordance with the decree of the President of the Russian Federation, Russia suspended the intergovernmental Agreement concerning the management and disposition of plutonium designated as no longer required for defense purposes and related cooperation (PMDA), as well as the protocols to this agreement.

On the other hand, the dangers posed by terrorist organizations, such as ISIS and Al-Qaeda, who openly declared their intention to acquire nuclear and radiological weapons, compel cooperation between Russia and the United States. To provide the world community with guarantees that both countries are doing everything to prevent failing nuclear materials to the terrorist organizations, is impossible without cooperation among these two countries on nuclear security issues.

It should be noted that the understanding of this necessity was quite clearly expressed by Russian and American experts during the Review Conference held in Moscow in early June 2013 on the results and experience of joint work on the various projects carried out within the frame of the 20th anniversary of the CTR program. Russian and American scientific and technical experts who have directed the joint projects drew up a concluding conference decision in which they noted the urgent and shared need to continue mutually beneficial cooperation, in such areas as:

- Accounting, control, and protection of nuclear materials;
- Global nuclear non-proliferation and the elimination of global threats, including non- proliferation of nuclear technology;
- Scientific and technical aspects of nuclear anti-terrorism;
- Fundamental and applied scientific research in areas of mutual= benefit;
- Transfer of expertise acquired through cooperation to a new generation of academics and directors of RF institutes and US national labs;

- Extending the experience to cooperation with third countries for global security and nuclear non-proliferation.

In the conference decision it was further noted that cooperation should be carried out in the new format which is based on a symmetrical and mutually beneficial approach that takes into account changes in the world over the last twenty years. This position was later endorsed by US senators Sam Nunn and Richard Lugar. In an article they published in the Washington Post, they noted that the basis of this approach "should be reciprocity and mutual interest," and that in its support each of the countries should invest its own financial and technical resources.

It should be noted that when Washington discusses cooperation with Russia in the nuclear field, they usually have in mind security cooperation aimed at the Russian nuclear complex. This is due to the existing representations and concerns of the majority of American experts regarding the safety of Russian nuclear weapons and the reliability of physical protection systems for the storage of these materials and objects intended for their use.

In turn, Moscow is more interested in scientific cooperation in the field of science and development of civil nuclear power, and cooperation on security issues of special interest in Russian experts no longer causes.

However, despite the different approaches of Moscow and Washington to cooperation in the nuclear field, building on the success and experience of past cooperation, there is a serious potential for its development on a basis of mutual benefit and equality.

Sooner or later, Russian and American leaders will come to understand the need to resume cooperation on nuclear issues. At this point, it is desirable to have ready concrete proposals for cooperation between organizations and the national nuclear laboratories in Russia and the United States in the field of fundamental and applied researches.

The following is a list of prospective bilateral projects for nuclear science, nuclear energy and nuclear security cooperation that Russia and the United States could include:

- R&D related to nuclear materials and radiation damage, including in relation to reactor life extension;
- R&D related to radiation detection systems and border control;
- R&D related to back-end research;

- Utilization of existing and new reactors for creation of international research centers to work on a broad variety of scientific issues;
- Collaboration on innovative reactor designs;
- Address the security of radioactive sources in Central Asia;
- Establish joint technical-level working group and best -practice exchanges;
- Expand nuclear security education and training programs;
- Strengthen nuclear security regulatory cooperation;
- Conduct joint R&D on improved nuclear security and accounting technologies;
- Continue HEU minimization efforts;
- Cooperate to enhancing nuclear security in newcomer countries;
- Cooperate to block illicit trafficking of nuclear and radioactive materials;
- Establish a bilateral forum for nuclear forensic cooperation;
- Cooperate on emergency preparedness and response;
- Build on national experience in waste processing and materials disposition;
- Research and develop environmental remediation technologies;
- Develop tank waste-processing technology
- The benefits of this cooperation can be significant for both these countries and for the world.