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No. 59 February 2017

Post-Nuclear Security Summit Process

Continuing Challenges and Emerging Prospects

Reshmi Kazi

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रक्षा अध्ययन एवं विश्लेषण संस्थान

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Dedicated to my Maa

Rehana Sultana

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Acknowledgements

In the twenty-first century, nuclear terrorism is a tangible threat that has the potential to inflict high consequences. Any act of terror involving nuclear and radiological materials can unleash catastrophic horror on the life, property and the environment worldwide. Such consequences can destabilise world peace and security. Though the probability of nuclear terrorism is remote, the consequences involved compel us to abandon any complacency and strive towards making every effort for strengthening nuclear security. Any weak link in the chain of nuclear security can be fatal for international peace and security.

The Nuclear Security Summit process played a phenomenal role in highlighting the importance of global cooperation and diplomacy in building effective defences against the threat of nuclear terrorism. Much was accomplished in terms of awareness, cooperation and commitment to combat the threat of nuclear terrorism. However, despite the phenomenal achievements, much still remains to achive a robust and strengthened nuclear security. With emerging vulnerabilities in terms of deadlier terrorist groups, technological advancement, increasing nuclear smuggling and other incidents of breach of nuclear facilities, tracking nuclear scientists etc., the threat of nuclear terrorism remains far from dissipated.

This monograph has attempted to highlight the existing challenges that continue to threaten nuclear security. At the same time, it also focuses on emerging prospects like centres of excellence that seek to plug the weak links in nuclear security. I am thankful to the Institute for Defence Studies and Analyses, New Delhi, for supporting me in the completion of my work. Special thanks to my husband Khurram and girls—Zaara and Zarmina—for their patience and support during this academic effort.

Abbreviations

ACPSR	Advisory Committee for Project Safety Review
ACS	Advisory Committee on Security
AERB	Atomic Energy Regulatory Board
AWE	Atomic Weapons Establishment
BARC	Bhabha Atomic Research Centre
CDMA	Code Division Multiple Access
CISF	Central Industrial Security Force
CoE	Centres of Excellence
CPPNM	Convention on the Physical Protection of Nuclear Material
CRPs	coordinated research programmes
CRSANF	Committee for Reviewing Security aspects of Nuclear Facility
CRSARF & T	Committee for Review of Nuclear Security Aspects of Radiation Facilities and for Transport of Radioactive Materials
CSSS	Centre for Science and Security Studies
CTR	Cooperative Threat Reduction
DAE	Department of Atomic Energy
DFSL	Directorate of Forensic Science Laboratories
DoE	Department of Energy
DPRK	Democratic People's Republic of Korea
e-LORA	Electronic Licensing of Radiation Application

ECIL	Electronics Corporation of India Limited
ERC	Emergency Response Centre
FBI	Federal Bureau of Investigation
FCA	Fast Critical Assembly
FMCT	Fissile Material Cut-off Treaty
GCNEP	Global Centre for Nuclear Energy Partnership
GICNT	Global Initiative to Combat Nuclear Terrorism
GRRS	Global Research Reactor Security
GSM	Global System for Mobile Communications
GTRI	Global Threat Reduction Initiative
HEU	Highly Enriched Uranium Materials Facility
I&C	Instrumentation and Control
IAEA	International Atomic Energy Agency
IAG	The Implementation and Assessment Group
ICSANT	International Convention for the Suppression of Acts of Nuclear Terrorism
IERMON	Indian Environmental Radiation Monitoring Network
IISS	International Institute for Strategic Studies
IM	Indian Mujahideen
INFCE	International Fuel Cycle Evaluation
INSEN	International Nuclear Security Education Network
INSServ	International Nuclear Security Advisory Service
Interpol	International Criminal Police Organization
IPPAS	International Physical Protection Advisory Service
IRRS	Integrated Regulatory Review Service
IS	Islamic State

ISIL	Islamic State of Iraq and the Levant
ITDB	Incident and Trafficking Database
ITU	Institute for Transuranium Elements
JAERI	Japan Atomic Energy Research Institute
JRC	Joint Research Centre
LeT	Lashkar-e-Taiba
LEU	low-enriched uranium
LoC	Line of Control
Mo-99	Molybdenum-99
MWt	megawatt
NAEC	National Atomic Energy Commission
NCA	Nuclear Cooperation Agreement
NDRF	National Disaster Response Force
NGOs	Non-Governmental Organisations
NMAC	Nuclear Material Accounting and Control
NNSA	National Nuclear Security Administration
NPCIL	Nuclear Power Corporation of India Ltd
NPT	Non-Proliferation Treaty
NSS	Nuclear Security Summit
NSSCs	Nuclear Security Training and Support Centres
NTC	Nuclear Terrorism Convention
NuFFA-16	Nuclear Forensics: Fundamentals and Applications
NWS	Nuclear Weapon States
R&D	Research and Development
RDD	Radiological Dispersal Device
RERTR	Reduced Enrichment for Research and Test Reactors

RRRFR	Russian Research Reactor Fuel Return
RSO	Radiological Safety Officer
SARCAR	Safety Review Committee for Application of Radiation
SARCOP	Safety Review Committee for Operating Plants
TNT	Trinitrotoluene
UAV	Unmanned Aerial Vehicle
UN	United Nations
UNGA	United Nations General Assembly
UNICRI	United Nations Interregional Crime and Justice Research Institute
UNODC	United Nations Office on Drugs and Crime
UNSC	United Nations Security Council
UNSCR	UN Security Council Resolution
USSR	Union of Soviet Socialist Republics
VNIIEF	All-Russian Scientific Research Institute of Experimental Physics WMDs weapons of mass destruction

Chapter 1

Introduction

Newer Challenges and Threats to Nuclear Security

In the twenty-first century, nuclear security has acquired a renewed prominence in view of new challenges. To combat these challenges, several dimensions of nuclear security have to be considered. However, its most distinctive aspect is ensuring security of nuclear materials and facilities against potential threats. The Nuclear Security Summit (NSS) process, which began in 2010, has made phenomenal contribution in profiling the threat of nuclear terrorism as a global concern. The Summit process, consecutively held in 2010, 2012, 2014 and 2016, has initiated the process of focusing attention on the critical importance of securing all existing stocks of nuclear material. The four summits have contributed in myriad ways to raise awareness, and also prompted meaningful actions from many states to improve global nuclear security. The summiteer nations have extended cooperation for enhancing and strengthening nuclear security. These world leaders have undertaken bold and tangible commitments that are purposed to mitigate the threat of nuclear terrorism.

The NSSs have proven to be pre-eminent forums for assessing the global nuclear security standards and have proposed means to strengthen the global nuclear security regime. This has facilitated the prospects of enhanced nuclear security architecture even as challenges continue to exist and grow. These challenges have kept the risk of nuclear terrorism at the forefront, and even though the probability of nuclear terrorism is remote, the risk cannot be overlooked. The most problematic aspect in computing the probability of nuclear terrorism is that it cannot be quantified; the only lead is that the probability factor, even though very low, is not zero. In a lecture delivered in India, Professor Matthew Bunn of Harvard University emphasised that "nuclear theft and sabotage are genuine dangers".[1] The dangers need to be adequately addressed, and timely mitigated, through an effective nuclear security culture permeating all the agencies/departments governing nuclear security. Thus, nuclear security also has the responsibility to embed a robust security culture through effective practices and detailed processes to reduce the risk of nuclear terrorism.

Why is Nuclear Security Important?[2]

The importance of nuclear security today is recognised globally. The deep global interest in bolstering nuclear security is apparent from the numerous measures that have been undertaken from time to time. The international community has laid down a roadmap with the goal to bring back the world from a dangerous "nuclear tipping point" to a relatively safe and secured nuclearised world that will eventually pave the way for global elimination of nuclear weapons. The roadmap comprises measures like the Non-Proliferation Treaty (NPT), bilateral treaties,[3] multilateral efforts,[4] workshops[5] and international commissions.[6]

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1 Matthew Bunn, "Evolving Opportunities for Cooperation in Nuclear Security", International Strategic and Security Studies Programme, National Institute of Advanced Studies, October 6, 2016, available at http://isssp.in/tag/evolving-opportunities-for-cooperation-in-nuclear-security/, accessed on December 13, 2016.

2 See Reshmi Kazi, "Nuclear Security in Asia: Problems and Challenges", *Strategic Analyses*, Vol. 39, No. 4, 2015, pp. 378–401.

3 For example, New Start Treaty, an Indo-Pak agreement on reducing risks from accidents relating to nuclear weapons.

4 For example, Nuclear Security Summits (2010-2016).

5 The Institute for Transuranium Elements (ITU) of the European Commission Joint Research Centre (JRC) and the United States (US) co-hosted a "Countering Nuclear and Radiological Smuggling Workshop" in Karlsruhe, Germany, February 11–13, 2014. See Simon Limage, "Welcome and Introductory Remarks at the Countering Nuclear and Radiological Smuggling Workshop", the US Department of State, February 11, 2014, available at http://www.state.gov/t/isn/rls/rm/2014/221575.htm, accessed on December 22, 2016.

6 WMD Commission and International Commission on Nuclear Non-Proliferation and Disarmament.

These high-profile political groupings have been successful in garnering significant international support to prevent the illicit procurement of nuclear materials by terrorists. These measures underscore the importance that the international community attaches to nuclear security. It also highlights that there is an inherent threat to nuclear security which, unless mitigated, can wreck havoc on the entire world. The increasing participation in the successive NSSs indicates the recognition of possible nuclear and radiological threats posed by non-state actors.[7] It is essentially a pointer to the necessity of establishing a robust nuclear security architecture that can protect against nuclear dangers.

> For purposes of this study, nuclear security is defined as: "The prevention and detection of, and response to, theft, sabotage, unauthorised access, illegal transfer or other malicious acts involving nuclear or other radioactive substances or their associated facilities."[8]
>
> The central tenets of nuclear security include an effective security culture that "plays an important role in ensuring that individuals, organizations and institutions remain vigilant and that sustained measures are taken to prevent and combat the threat of sabotage" or use of "radioactive material for malicious acts".[9] Nuclear security culture, on the other hand, is an "assembly of characteristics, attitudes and behavior of individuals, organisations and institutions which serves as a means to support and enhance nuclear security."[10]

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7 The 2010 Washington Summit was attended by 47 participants; the 2012 Seoul Summit had 53 participants; and the 2014 Hague Summit recorded 58 participants.

8 It should be noted that "nuclear security" includes "physical protection", as that term can be understood from consideration of the 'Physical Protection Objectives and Fundamental Principles', the *Convention on the Physical Protection of Nuclear Material* (CPPNM) and the Amendment to the CPPNM. See "Nuclear Security Culture", IAEA Nuclear Security Series No. 7, 2008, p. 3, available at http://www-pub.iaea.org/mtcd/publications/pdf/pub1347_web.pdf, accessed on December 22, 2016.

9 Ibid., p. 4.

10 Ibid., p. 3.

Nuclear security culture is crucial for effective governance of states possessing atomic capability. Understandably, as long as states continue to possess nuclear weapons, they should be accountable for the security of their strategic assets. Nuclear-armed nations must ensure that their nuclear arsenal is physically protected against any unauthorised access/ use, accidents or diversion. An effective nuclear security regime constitutes rules, legislations, regulations, intelligence agencies, threat assessment departments, cyber units, and response and mitigations facilities. A robust nuclear security culture is thus indispensible to facilitate proper coordination among the various departments. Nuclear security also deals with personal dedication and accountability of persons guarding nuclear assets so as to prevent deliberate and malicious abuse.

The community of nations' ability to hold nuclear-armed states accountable for the security of their weapons and technology is contingent on the proper knowledge of the structures and processes of domestic nuclear weapon governance in those states.[11] It is essential that countries with nuclear weapons establish proficient domestic nuclear governance, accountability, transparency, safety and security to facilitate emergence of responsible nuclear culture, which in turn can generate confidence among the members of the international community about the efficacy of nuclear policies in nuclear weapon states. The existence of nuclear weapons in unstable states (Pakistan) or in politically volatile regions (West Asia, Korean Peninsula) is susceptible to accidents, miscalculations, sabotage and pilferage. Additionally, there exists the threat of terrorists acquiring nuclear weapons or radioactive materials for malicious purposes. The exposure of the Pakistan-based A.Q. Khan network demonstrated that these concerns are not unfounded, and further serves to underscore the idea that effective nuclear security (through domestic governance) is central to non-proliferation efforts as well.[12]

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11 Hans Born, Bates Gill and Heiner Hänggi (eds), *Governing the Bomb: Civilian Control and Democratic Accountability of Nuclear Weapons*, New York: Oxford University Press, 2010, p. 3.

12 S.N. Kile, "Nuclear Arms Control and Non-Proliferation", in *SIPRI Yearbook 2006: Armaments, Disarmament and International Security*, Oxford: Oxford University Press, 2006, pp. 552–55.

Newer Challenges to Nuclear Security

The first critical challenge to nuclear security lies in the perception towards the threat of nuclear terrorism. The notion of nuclear terrorism is probably the least comprehended of all dangers emanating from nuclear weapons. This is simply because there is no document to substantiate any claim of a terrorist group to have developed, obtained or deployed nuclear weapons. Hence, the rigorousness of its threat remains contentious. Conventional notions indicate that nuclear terrorism is too difficult[13] to undertake since it would require substantial efforts, expertise and competence on behalf of the perpetrators.[14] This conditional conclusion, coupled with the fact that no incidence of nuclear terrorism has been reported, reinforces the perception that while "biological, chemical and radiological terrorism is likely, nuclear terrorism is improbable".[15] Some scholars have dismissed nuclear terrorism on the grounds of technical hurdles and internal factors such as geography and politics,[16] and have ridiculed it as "an overrated nightmare".[17]

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13 Gavin Cameron, "Nuclear Terrorism Reconsidered", *Current History*, Vol. 99, No. 636, April 2000, p. 154.

14 See J. Carson Mark, Theodore Taylor, Eugene Eyster, William Maraman and Jacob Wechsler, "Can Terrorists Build Nuclear Weapons", in Paul Leventhal and Yonah Alexander (eds), *Preventing Nuclear Terrorism: The Report and Papers of the International Task Force on Prevention of Nuclear Terrorism*, Lexington, MA: Lexington Books, 1987.

15 See Gavin Cameron, 'WMD Terrorism in the United States: The Threat and Possible Countermeasures', *The Nonproliferation Review*, Vol. 7, No. 1, Spring 2000, p. 172; Jerrold M. Post, "Differentiating the Threat of Radiological/Nuclear Terrorism Motivations and Constraints", Paper presented at the International Atomic Energy Agency (IAEA) symposium on International Safeguards: Verification and Nuclear Material Security, in Vienna, Austria, October 29–November 1, 2001, quoted in Morten Bremer Mærli, Annette Schaper and Frank Barnaby, "The Characteristics of Nuclear Terrorist Weapons", *American Behavioral Scientist*, Vol. 46, No. 6, February 2003, p. 743; D.C. Rapoport, "Then and Now: What have We Learned?", *Terrorism and Political Violence*, Vol. 13, No. 3, Autumn 2001, pp. xi–xvi.

16 Bernard Anet, Ernst Schmid and Christoph Wirz, 'Nuclear Terrorism: A Threat to Switzerland?' Spiez Laboratory, Defence Procurement Agency, available at http://www.vbs.admin.ch/acls/e/current/fact_sheet/nuklearterrorismus/pronto, quoted in Morten Bremer Mærli, "Crude Nukes on the Loose?", Paper No. 664, Norwegian Institute of International Affairs, 2004, p. 149.

17 Karl-Heinz Kamp, "An Overrated Nightmare", *Bulletin of the Atomic Scientists*, Vol. 52, No. 4, July–August 1996, pp. 30–34.

In fact, not all countries accept the priority of the danger posed by nuclear terrorism.[18] The naysayers advocate that this threat is primarily confined to the Western world and nuclear weapon states. However, this is an incorrect assessment of the threat of nuclear terrorism. Every country possessing fissile material, even in meagre quantities, must commit to adequately protect them. Many countries with less than 1 kilogram (kg) of fissile materials argue that it is not essential for them to implement effective controls on nuclear and other radioactive materials. They contend that their stockpiles contain limited quantities of fissile materials, mainly for peaceful purposes, and are devoid of nuclear weapons. However, such fallacious arguments are a major stumbing block preventing the universal acceptability and compliance to the essential international legal instruments of nuclear security—the Convention on the Physical Protection of Nuclear Material (CPPNM), and its 2005 Amendment, and the International Convention for the Suppression of Acts of Nuclear Terrorism (ICSANT). This essentially reflects a complacent attitude and lack of awareness about the efficacy of the legal instruments of nuclear security. Hence, an analysis of the potential benefits of implementing a robust regulatory framework of nuclear governance to combat the threat of nuclear terrorism is fundamental.

Nuclear security is also challenged by the expanding stockpiles of fissile materials, which heighten the risks of them being diverted for malicious activities. About 83 per cent of fissile material stocks are in the military sector and no credible information exists about efficacy of the physical protection system safeguarding them. Secrecy, confidentiality and political and strategic compulsions further inhibit transparency over the security measures undertaken for military stocks. Unlike the military stocks, the security of the civilian fissile materials is accorded greater coordinated attention by the international community. All existing conventions on physical protection of nuclear material, like the CPPNM,

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[18] Kenneth N. Luongo, "Nuclear Security Governance for the 21st Century", US–Korea Institute at Sais, March 2012, p. 9, available at http://uskoreainstitute.org/wp-content/uploads/2012/03/uski_nss2012_luongo.pdf, accessed on December 22, 2016.

ICSANT and the INFIRC/225/Rev5[19] , define how civilian materials should be guarded. Unfortunately, these important instruments do not include military stockpiles within its ambit. Essentially, this results in impeding the process of inspiring confidence about nuclear security measures among the international community, and consequently raises the bar of nuclear risks.

More than half of the existing fissile material stocks consist of military nuclear materials. It is difficult to assess the exact quantity of these stocks since strategic necessities limit transparency of sensitive information. However, concern lies in the posssibilty of terrorists accessing these stockpiles of fissile materials, particularly highly enriched uranium (HEU). There is significant concern over HEU which has both civilian and military appplications. A small amount of HEU would provide sufficient impetus to terrorists seeking fissile materials to develop a crude nuclear device. Nuclear smuggling is a potential pathway by which terrorists may successfully acquire nuclear materials. According to the International Agency Energy Agency (IAEA) illicit trafficking database, there have been 762 incidents of theft or loss of nuclear and other radioactive material since 1993.[20] The number of incidents reported to the Incident and Trafficking Database (ITDB) involving the loss or theft of material has steadily increased from the late 1990s (see Table 1).[21]

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[19] The INFIRC/225/Rev5 contains recommendations on nuclear security and provides guidance on the physical protection of nuclear material and nuclear facilities to States and their competent authorities on how to formulate, augment and effect a physical protection regime for nuclear material and nuclear facilities, through appropriate legislative and regulatory programmes. The recommendations reflect a general consensus among IAEA Member States on the requirements that are necessary to prevent theft, sabotage, unauthorized access or other malicious acts involving N&R materials and their associated facilities. See "Nuclear security recommendations on physical protection of nuclear material and nuclear facilities (INFCIRC/225/revision 5)," IAEA nuclear security series, 2011 at http://www-pub.iaea.org/MTCD/publications/PDF/Pub1481_web.pdf, accessed on December 22, 2016.

[20] "IAEA Incident and Trafficking Database (ITDB)", in IAEA, *2016 Fact Sheet*, p. 2, available at https://www-ns.iaea.org/downloads/security/itdb-fact-sheet.pdf, accessed on December 22, 2016.

[21] Ibid., p. 3.

Table 1:

IAEA Illicit Trafficking Database: Incidents of Nuclear and Other Radioactive Material Out of Regulatory Control

	1993-31 December 2011[ϕ]	1993-31 December 2012[γ]	1993-31 December 2014[22]	1993-31 December 2015[23]
Confirmed incidents reported by the participating states and a few non-participating states	2,164	2,331	2,734	2,889
Incidents involved in unauthorised possession and related criminal activity	339	419	442	454
Incidents involved theft or loss of nuclear or other radioactive materials	588	615	714	762
Incidents involved unauthorised activities	1,124	1,224	1,562	1,622

ϕ "IAEA Incident and Trafficking Database (ITDB)", in IAEA, *2013 Fact Sheet*, last accessed December 24, 2014.

γ "IAEA Incident and Trafficking Database (ITDB)", in IAEA, *2014 Fact Sheet*, last accessed December 5, 2015.

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22 "IAEA Incident and Trafficking Database (ITDB)", in IAEA, *2015 Fact Sheet*, available at http://large.stanford.edu/courses/2016/ph241/wolk1/docs/itdb-fact-sheet.pdf, accessed on December 21, 2016.

23 "IAEA Incident and Trafficking Database (ITDB)", in IAEA, *2016 Fact Sheet*, available at http://www-ns.iaea.org/downloads/security/itdb-fact-sheet.pdf, accessed on December 21, 2016.

Moldova has been a dangerous site of illicit trafficking of nuclear and radiological materials with several cases being reported since 2010.[24] Such incidents are reminder of the fact that there is a steady demand of fissile materials from quarters that are involved in illicit activities. There is a thriving nuclear black market that is engaged in theft, loss, unauthorised possesssion and illicit trafficking of nuclear and radiological materials. China's ongoing missile technology transfer to Pakistan and North Korea substantiates the claim.[25] Pakistan has been also following a "deliberate strategy of using deceptive methods to obtain dual-use goods", evident from its "systematic use of front companies to supply its strategic industries".[26] "Pakistan's strategic industries rely on a network of at least 20 trading companies in mainland China, Hong Kong, Dubai and Singapore which funnel dual-use goods to its strategic programmes."[27]

A primary reason for the ongoing intentional nuclear smuggling is the existing loopholes in export controls. Weak export control laws and

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24 In 2010, 1.8 kg of uranium-238 was seized in Chisinau when three people tried to sell it for •9 million (£6.6 million; $10 million). In 2011, six people were detained for trying to sell 1 kg of weapons-grade uranium-235 for •32 million; they said they also had access to plutonium. In 2014, smugglers allegedly tried to sell 200 grams of uranium-235 from Russia to undercover security agents for $1.6 million; and 1.5 kg of uranium-235 was seized close to Moldovan border in Ukraine. In 2015, an undercover agent bought ampoule of caesium-135; also, materials contaminated with caesium-137 were found in central Chisinau. See "Nuclear Smuggling Deals 'Thwarted' in Moldova", *BBC News*, October 7, 2015, available at http://www.bbc.com/news/world-europe-34461732, accessed on December 22, 2016.

25 Congressman Mike Rogers, Chairman of the Sub-committee on Strategic Forces, and Congressman Ted Poe, Chairman of the Sub-committee on Terrorism, Non-proliferation and Trade, 'Letter to the Obama Administration', Congress of the US, April 25, 2016, p. 1, available at http://poe.house.gov/_cache/files/ef82a74d-c281-4c5c-a48e-8e9cae2b6c49/pakistan-tel.pdf, accessed on December 22, 2016.

26 "Pakistan's Strategic Nuclear and Missile Industries", Project Alpha at the Centre for Science and Security Studies (CSSS) at King's College, London, September 2016, p. 28, available at http://projectalpha.eu/wp-content/uploads/sites/21/2016/11/20160929-Pakistan-public-version.pdf, accessed on December 22, 2016.

27 Ibid., p. 25.

practices significantly weaken nuclear security. It encourages illicit transfer of nuclear technology and materials to regimes aspiring for nuclear capability. For example, insecure transit points, uncontrolled movement of critical strategic dual-use goods and technologies, porous borders and weak export control systems allowed the A.Q. Khan nuclear black market to base itself, and operate, in Asia for almost two decades. There is no conclusive evidence to suggest that the proliferation racket is frozen. China's export policies have aggravated concerns over proliferation trends that "result in ambiguous technical aid, more indigenous capabilities, longer-range missiles, and secondary (retransferred) proliferation."[28] China's continued proliferation in dangerous missile technology transfer has endowed Pakistan with capability to build its domestic missiles programme.

Documented theft and losses of nuclear and radiological materials are critical pointers towards weak links within the existing global nuclear security system.[29] These incidents are also crucial pointers to the vulnerabilties within the security apparatus of the originating facilities. They reflect on a continuing apprehension over nuclear security system worldwide. Weak links exist due to lack of adequate coordination among critical centres both domestically and internationally. The weakening in bilateral relations between the US and Russia has had a significant impact in ascertaining whether smugglers are succeeding in selling nuclear and radiological material originating from Russia. Moreover, Russia's refusal to participate in the NSS 2016 has jeopardised several measures for strengthening nuclear security in the future. Lack of cooperation between the two nuclear weapons states may constitute a serious factor in creating more weak links in future.

In the twenty-first century, nuclear security remains challenged by the existence of huge stocks of HEU in some dangerous countries like Pakistan and North Korea. Nuclear-armed Pakistan has the world's

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[28] Shirley A. Kan, "China and Proliferation of Weapons of Mass Destruction and Missiles: Policy Issues", *Congressional Research Service*, January 3, 2014; see summary available at http://www.fas.org/sgp/crs/nuke/RL31555.pdf, accessed on December 22, 2016.

[29] See Table 1

fastest-growing nuclear arsenal and military stockpile of HEU and plutonium.[30] Pakistan, in fact, is the only known state to produce HEU largely for weapons purposes and could have produced about 3 ± 1.2 tonnes of weapons-grade HEU.[31] An additional 0.1 tonnes may have been consumed in Pakistan's six nuclear weapon tests in 1998.[32] These estimates are constrained by the uncertainty about Pakistan's enrichment capacity. Pakistan's steadily increasing nuclear stockpile coincides with escalating trend of terrorist violence. The *Pakistan Security Report 2013* indicated a total of 1,717 terrorist attacks across Pakistan in 2013, in which 2,451 were killed and 5,438 injured.[33] Experts prognosticate, "Post 2014 environment may usher more disaster for Pakistan's weak and politically fragmented state."[34] Pakistan's poor governance, economic ills, terrorism and violence made Prime Minister Manmohan Singh remark that the "epicentre of terrorism is located in Pakistan".[35]

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30 See International Panel on Fissile Materials, *Global Fissile Material Report 2013: Increasing Transparency of Nuclear Warhead and Fissile Material Stocks as a Step toward Disarmament*, 2013, p. 14, available at http://fissilematerials.org/library/gfmr13.pdf, accessed on December 22, 2016.

31 "Pakistan had a stockpile of about 0.15 ± 0.05 tonnes of weapons plutonium as of the end of 2012. This has been produced at the 40–50 megawatt (MWt) Khushab-I and Khushab-II reactors, which have been operating since 1998 and late 2009 or early 2010 respectively. Two additional production reactors are under construction at the Khushab site and are expected to come online in the near future". See ibid.

32 Ibid.

33 "Vicious Year: Terrorism Surged in 2013, says Report", *The Tribune*, January 6, 2014, available at http://tribune.com.pk/story/655329/vicious-year-terrorism-surged-in-2013-says-report/, accessed on December 22, 2016. As compared to 2012, the number of reported terrorist attacks in Pakistan in 2013 posted a 9 per cent increase. There was also a 19 per cent increase in the numbers killed and 42 per cent increase in those injured.

34 "Heading into 2014: Challenges ahead", Jinnah Institute, available at http://jinnah-institute.org/heading-into-2014-challenges-ahead/, accessed on December 22, 2016.

35 "Epicentre of Terror is in Pakistan: PM", *The Hindu*, September 29, 2013, available at http://www.thehindu.com/todays-paper/epicentre-of-terror-is-in-pakistan-pm/article5180918.ece, accessed on December 22, 2016.

The global nuclear security system faces grave challenges from several quarters of the world. The degree of nuclear and radiological threats cannot be subject to any quantification since detonation of a crude nuclear device or a "dirty bomb" anywhere could imperil international security. There must be cognisance that a security lapse in any one country (Pakistan) might endanger others nations too. Nuclear security risks are complicated by existing stockpiles of fissile materials, which continue to expand in some countries. While Japan houses the largest stockpile of civilian HEU, Pakistan, as mentioned earlier, continues to produce enriched uranium for weapons purposes. China is estimated to have a stockpile of about 16 $\pm$ 4 tonnes of HEU.[36] Recent reports claim that China is planning to expand "overseas uranium mining resources and aims to increase output to 2,500 tons per year by 2015, rising to 5,000 tons by 2020."[37] North Korea's HEU production is shrouded among uncertainties and remains a concern.

The competition for acquisition of nuclear-powered submarine complicates the global phasing out of HEU. In the coming decade, India and Pakistan are likely to acquire sea-based nuclear weapon deterrence platforms.[38] Naval propulsion requires 3 tonnes of HEU

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36 International Panel on Fissile Materials, *Global Fissile Material Report 2013*, n. 30, p. 13. However, this information lacks accuracy as China has consistently refrained from being transparent about the "capacity and operating history of China's enrichment plants".

37 Zhang Qi and Wan Zhihong, "Uranium Capacity will be Increased", *China Daily*, May 13, 2015, available at http://www.chinadaily.com.cn/bizchina/2010-11/17/content_11562450.htm, accessed on December 21, 2016.

38 While India is preparing for sea trials of its first nuclear ballistic missile submarine, Pakistan is eyeing a sea-based missile capability and expanding its interest in tactical nuclear warheads. See Reshmi Kazi, "Point, Counter-point: Sea-based Nuclear Deterrent—A Strategic Stabilizer?", *South Asia Voices*, November 28, 2014, available at http://southasianvoices.org/point-counter-point-sea-based-nuclear-deterrent-a-strategic-stabilizer/, accessed on December 21, 2016. China's nuclear submarine deployments, some naval experts say, may become the opening gambits of an undersea contest in Asia. China has already achieved its ambition of joining the elite club of countries with nuclear submarines. Jeremy Page and Rob Taylor, "Deep Threat: China's Submarines Add Nuclear-strike Capability, Altering Strategic Balance", Wall Street Journal, October 24, 2014, available at http://online.wsj.com/articles/chinas-submarine-fleet-adds-nuclear-strike-capability-altering-strategic-balance-undersea-1414164738, accessed on December 21, 2016.

annually, which is "four times that of the world's research reactors".[39] Though China is converting its HEU-based miniature nuclear reactors into low-enriched uranium (LEU), it has refused to dismantle its fast reactor and its critical assembly.[40] China has further resisted inclusion of naval fuel in the Fissile Material Cut-off Treaty (FMCT) since it would involve declaration of its HEU inventory.[41] The unceasing production of HEU stocks for naval propulsion provides prospective conduits for terrorists to obtain weapons-grade fissile materials. The four NSSs held so far have consistently drawn global attention to the potential dangers of continued expansion of HEU stockpiles, and also emphasised on the need for high-level security measures to establish world-class nuclear security standards. However, it is challenging to determine world-class level of nuclear security, predominantly because there are no universal guidelines to define any nuclear security measures as 100 per cent foolproof. This explains the several instances of nuclear security breaches that has happened worldwide.[42]

North Korea has an ambitious nuclear weapons programme and is reported to have built new nuclear reactors.[43] Its nuclear weapon tests and programmes pose a threat to the credibility of the international

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39 Alan J. Kuperman (ed.), *Nuclear Terrorism and Global Nuclear Security: The Challenge of Phasing out Highly Enriched Uranium*. Abingdon, Oxon: Routledge, 2013, p. 9.

40 Since the 1995 Statement of Intent, China has engaged in limited cooperation with the Reduced Enrichment for Research and Test Reactors (RERTR) programme, and subsequently with the US Global Threat Reduction Initiative (GTRI), on the possible conversion of China's HEU-fuelled reactors. See ibid.

41 China expects the US and Russia will exclude existing stocks of HEU from the scope of the FMCT.

42 Kazi, "Nuclear Security in Asia: Problems and Challenges", n. 2.

43 Though these reactors appear to be designed primarily for civilian nuclear power, they can be readily converted to produce HEU bomb fuel and the light water reactor (LWR) could be run in a mode to produce plutonium potentially suitable for bombs. Siegfried S. Hecker, "A Return Trip to North Korea's Yongbyon Nuclear Complex", Center for International Security and Cooperation, Stanford University, November 20, 2010, p. 1, available at http://iis-db.stanford.edu/pubs/23035/HeckerYongbyon.pdf, accessed on December 22, 2016.

non-proliferation regime, and its defiance potentially provokes other countries to imitate its path. North Korea's nuclear programme is especially of grave concern to Asia's nuclear security because of the failure of the Six-Party talks. Matters have become acute with continued defiant behaviour of Pyongyang and its conduct of successive nuclear explosive tests. Speculations over North Korea's uranium enrichment activities first began in 2002, when a declassified *Central Intelligence Agency* (CIA) assessment stated that "North Korea was constructing a plant that could produce enough weapons-grade uranium for two or more nuclear weapons per year when fully operational which could be as soon as mid-decade."[44] Pyongyang continues its nuclear programme in total violation of the non-proliferation norms. It remains uncertain whether Pyongyang has been producing HEU using the centrifuge-enrichment capability that it revealed in 2010.[45] Estimates of Pyongyang's potential warhead stocks, based on the amount of plutonium it has produced, range from eight to 12 warheads.[46] Pyongyang's belligerent threats of new nuclear tests appear to have unnerved South Korea and Japan, provoking them to exercise their nuclear option. On the other hand, North Korea's reported transfer of sensitive nuclear materials and technology to Syria, Pakistan and Iran underlines the proliferation challenges in Asia.

Newer and more dangerous terrorists groups' potential interest in acquring nuclear materials or technology makes nuclear security vulnerable. As evident from documented records, two dreaded terrorists groups—Al-Qaeda and the Aum Shinrikyo—have declared their intent to acquire nuclear weapons.[47] The rise of Daish[48] has, once

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44 CIA, untitled report, National Security Archive, November 2002, available at http://nsarchive.gwu.edu/NSAEBB/NSAEBB87/nk22.pdf, accessed on December 22, 2016.

45 International Panel on Fissile Materials, *Global Fissile Material Report 2013*, n. 30, p. 3.

46 Ibid., p. 57. Pyongyang possesses significant ballistic and cruise missile inventories, which are believed to be nuclear capable.

47 Rolf Mowatt-Larssen, "Al Qaeda's Nuclear Ambitions", *Foreign Policy*, November 16, 2010, available at http://foreignpolicy.com/2010/11/16/al-qaedas-nuclear-ambitions/, accessed on December 22, 2016.

48 Daish is also known as the Islamic State (IS), Islamic State of Iraq and the Levant (ISIL) and Islamic State of Iraq and the Syria (ISIS).

again, raised speculations about the terrorists' intention to acquire nuclear weapons. At present, there is no clinching evidence to suggest that the Islamic State (IS) operatives are actively trying to acquire nuclear and radiological weapons or materials. However, in recent times, the nature of terrorism has undergone a substantial change. While terrorists continue to look for nuclear materials and technology, they also want to spread chaos and devastation, on their targets, for several reasons. These include imposition of their will, signals to the political establishments and communicating the penchant for lethality for accomplishment of their goals.[49] Several sources have already claimed that Daish could pose a potential weapon of mass destruction (WMD) threat. That the alarm was not just a figment of imagination or merely hypothetical was clear when the British Home Secretary, Theresa May, warned that Islamic State of Iraq and the Levant (ISIL) "will acquire chemical, biological, or even nuclear weapons to attack us".[50] Nuclear/radiological weapons fit well into the strategy of terrorist groups' desire for imposing lethal costs through indiscriminate killings and mass destruction.

The indiscriminate uses of chemical weapons like chlorine and sulfur mustard agents by the Daish against innocent civilians in Iraq and Syria demonstrate their proclivity for mass killing.[51] Following the Paris attacks

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[49] See the detailed study of terrorists' inclination for mass killings in Reshmi Kazi, "The Danger of Nuclear Terrorism: The Indian Case", *Strategic Analyses*, Vol. 33, No. 4, 2009, pp. 503–05. Also, see Andrew H. Kydd and Barbara F. Walter, "The Strategies of Terrorism", *International Security*, Vol. 31, No. 1, 2006, p. 50.

[50] Joseph Cirincione, "ISIS will be in Position to get Nuclear Weapons if Allowed to Consolidate Power, Resources, says Expert", *Daily News*, September 30, 2014, available at http://www.nydailynews.com/news/national/isis-nukes-allowed-consolidate-expert-article-1.1958855, accessed on December 21, 2016.

[51] Eric Schmitt, "ISIS used Chemical Arms at least 52 Times in Syria and Iraq, Report says", *The New York Times*, November 21, 2016, available at http://www.nytimes.com/2016/11/21/world/middleeast/isis-chemical-weapons-syria-iraq-mosul.html, accessed on November 12, 2016; Reshmi Kazi, "Islamic State and the Threat of Chemical Weapons", in S.D. Muni and Vivek Chadha (eds), *Asian Stratgeic Review, 2016*, New Delhi: Pentagon Press, 2016, pp. 67–82.

of November 2015, a suspect—Mohamed Bakkali, a Daish operative—was arrested with surveillance footage of a high-ranking Belgian nuclear official, who had access to secure areas of a nuclear research facility in Mol.[52] Experts speculated whether the IS were trying to abduct the nuclear official and coerce him to obtain radioactive material for a possible dirty bomb terror attack. There were strong apprehensions that the Paris attackers had the "the intention to do something involving one of the four nuclear sites" in Belgium.[53] The Daish seeks to establish an Islamic Caliphate through a violent transformation for which they would require powerful and effective weapons. If the terror group is at all seeking nuclear and radiological weapons, it must not be ignored as an alarmist proposition since the IS have more resources in terms of money, territories, recruits[54] and intention than the Al-Qaeda or Aum Shinrikyo to realise their ambitions.

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52 Milan Schreuer and Alissa J. Rubin, "Video Found in Belgium of Nuclear Official may Point to Bigger Plot", *The New York Times*, February 18, 2016, available at http://www.nytimes.com/2016/02/19/world/europe/belgium-nuclear-official-video-paris-attacks.html, accessed on November 12, 2016.

53 Ibid. Sebastian Berg, spokesman for the federal agency in charge of Belgium's nuclear facilities noted, "they were concerned about a bombing inside the plant, or a 9/11 style attack with an aircraft"; see "Brussels Attackers Originally Planned to Attack a Nuclear Facility: Belgian Authorities", *Homeland Security News Wire*, March 28, 2016, available at http://www.homelandsecuritynewswire.com/dr20160328-brussels-attackers-originally-planned-to-attack-a-nuclear-facility-belgian-authorities, accessed on December 13, 2016.

54 Conor Gaffey, "ISIS Expands into the Sahel, Africa's Migration Hub", *Newsweek*, November 24, 2016, available at http://www.newsweek.com/isis-expands-its-brand-sahel-africas-migration-hub-524447, accessed on November 25, 2016; Ana Swanson, "How the Islamic State Makes its Money", *The Washington Post*, November 18, 2015, available at https://www.washingtonpost.com/news/wonk/wp/2015/11/18/how-isis-makes-its-money/?utm_term=.4009dda7f8e0, accessed on December 12, 2016; Matthew Bunn, William H. Tobey, Martin B. Malin and Nickolas Roth, "*Preventing Nuclear Terrorism: Continuous Improvement or Dangerous Decline?",* Belfer Center, March 21, 2016, p. 49, available at http://belfercenter.ksg.harvard.edu/files/PreventingNuclearTerrorism-Web%202.pdf, accessed on November 12, 2016.

Japan's Fukushima Daiichi accident of 2011 has not halted Asian nations from pursuing nuclear energy. Economic dynamism worldwide has been instrumental for expanding nuclear energy. At present, there are 438 operable civil nuclear power reactors in 30 countries, and another 70 under construction.[55] of the 30 countries already operating nuclear power plants (NPPs), 13 are either constructing new ones or actively completing previously suspended constructions.[56] There are 120 operating and 47 under-construction power reactors in Asia.[57] There are firm plans to build a further 100.[58] The "International Status and Prospects for Nuclear Power 2012" estimates that 29 newcomer countries are planning for nuclear power.[59] Expanding nuclear reactors raise the risk of nuclear accidents and emergencies, and also multiply the chances of misuse or diversion of nuclear/radiological materials and technology worldwide. There exist blurred lines between civil and military nuclear power programmes, which prevent implementation of universal standards for strengthening nuclear security. The trend of rising demand for nuclear energy will persist. Thus, nuclear energy programmes are emerging sources of proliferation risks. Nuclear security also faces challenges from rampant terrorism in volatile regions housing nuclear/radioactive materials (Pakistan and Yemen), as well as in conflict

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55 IAEA, "Nuclear Power Reactors in the World", Reference Data Series No. 2, 2015, pp. 12–13, available at http://www-pub.iaea.org/MTCD/Publications/PDF/rds2-35web-85937611.pdf, accessed on December 22, 2016.

56 IAEA Atoms for Peace, "International Status and Prospects for Nuclear Power 2014", GOV/INF/2014/13-GC(58)/INF/6, August 4, 2014, p. 1, available at https://www.iaea.org/About/Policy/GC/GC58/GC58InfDocuments/English/gc58inf-6_en.pdf, accessed on December 22, 2016.

57 IAEA, "Nuclear Power Reactors in the World", Reference Data Series No. 2, 2012, pp. 10–11, available at http://www-pub.iaea.org/MTCD/Publications/PDF/RDS2-32_web.pdf, accessed on December 22, 2016.

58 World Nuclear Association, "Asia's Nuclear Energy Growth", October 2013, available at http://www.world-nuclear.org/info/Country-Profiles/Others/Asia-s-Nuclear-Energy-Growth/, accessed on December 22, 2016.

59 Some of these states include Bangladesh, Indonesia, Vietnam, Thailand, Malaysia and Myanmar. IAEA, "International Status and Prospects for Nuclear Power 2012", GOV/INF/2012/12-GC(56)/INF/6, August 2012, p. 9, available at http://www.iaea.org/About/Policy/GC/GC56/GC56InfDocuments/English/gc56inf-6_en.pdf, accessed on December 22, 2016.

zones (Uighurs in the Xinjiang region in China, Syria and Myanmar). Factors like insider threat,[60] weak export control systems[61] and poor nuclear material accountancy raise the risk of nuclear accidents and emergencies, and also multiply the chances of misuse or diversion of nuclear/radiological materials and technology worldwide.

In India, threats to nuclear security are not as significant as in Pakistan or China. India has an effective nuclear security culture in place that permeates the various agencies and departments associated with its nuclear security establishment. India's Global Centre for Nuclear Energy Partnership (GCNEP) has been regularly holding training courses and workshops with participants from the US, the United Kingdom (UK) and IAEA. However, cross-border terrorism sourced from Pakistan has the possibility of threatening India's nuclear security. During cross-border firing across the Line of Control (LoC), terrorists can get the opportunity to infiltrate into Indian territories for nefarious activities. The Indian government must take adequate measures and step up vigilance to prevent infiltration of dreaded terrorists from across Pakistan.

The intelligentsia in India also does not consider the threat of Daish negligible. Recognising the emerging threat from Daish, Home Minister Rajnath Singh "admitted that online recruitment by Islamic State (IS) had become a major security challenge for India."[62] India is also

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[60] The risk of insider threat can be seen in Pakistan: "The fear of nuclear weapons and materials escaping the protective custody of the SPD or the Pakistani Army is ubiquitous and well founded"; see Pervez Hoodbhoy (ed.), *Confronting the Bomb: Pakistani and Indian Scientists Speak Out* Karachi, Pakistan: Oxford University Press, 2013, p. 172. "Islamist radicalism is deep-rooted within the ranks of Pakistani military. It is difficult to find another example where the defence apparatus of a modern state has been rendered so vulnerable by the threat posed by military insiders"; see Syed Saleem Shahzad, *Inside Al-Qaeda and the Taliban*, London: Pluto Press, 2011, p. 174.

[61] China has been a "key supplier" of technology, particularly with People's Republic of China (PRC) entities providing nuclear and missile-related technology to Pakistan and Iran. See Kan, "China and Proliferation of Weapons of Mass Destruction and Missiles: Policy Issues", n. 29, p. ii

[62] Milind Ghatwai, "Online Recruitment by Islamic State Major Security Challenge: Rajnath Singh", *The Indian Express*, September 13, 2015, available at http://indianexpress.com/article/india/india-others/online-recruitment-by-is-major-security-challenge-rajnath-singh/, accessed on December 13, 2016.

cognisant that the probability of Daish acquiring radiological weapons is not negligible. According to the Australian intelligence sources, Daish has seized enough radioactive material from government facilities to suggest that it has the capacity to build a large and devastating "dirty" bomb.[63] There has been no recorded incident of a dirty bomb being used anywhere in the world, including India. However, Dr K.S. Pradeepkumar—head of emergency preparedness for India's main nuclear laboratory, Bhabha Atomic Research Centre (BARC)—warns that there were attempts made where people have tried to make one using radioactive cesium-137 and explosives like RDX. He expresses concern over the increasing "use of radioactive sources and radioisotopes in a very significant way world over."[64] As the security of sites housing radioactive sources varies with some being poorly protected, there have been cases of lost sources, misplaced sources, etc. "These orphan sources can get into the hands of the bad-boys. It is believed that they can integrate these with explosives, and they can use it."[65]

Nuclear security is further challenged by the lack of sustainable mechanisms to build a robust nuclear security regime. Much has changed since the breakdown of Russia and the security threats emanating from loose nukes from Moscow. With technological revolution, enormous scientific literature on bomb making being available in the public domain and terrorists becoming more lethal, it is imperative to put necessary mechanisms in place immediately to prevent any occurrence of nuclear terrorism. Thus, presently, the nuclear security regime lacks effective

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63 Adam Withnall, "ISIS's Dirty Bomb: Jihadists have Seized 'Enough Radioactive Material to Build their First WMD'", *The Independent*, June 10, 2015, available at http://www.independent.co.uk/news/world/middle-east/isiss-dirty-bomb-jihadists-have-seized-enough-radioactive-material-to-build-their-first-wmd-10309220.html, accessed on December 13, 2016.

64 "Top Indian Nuke Scientist Busts Myths Surrounding 'Dirty Bomb'," *The Economic Times*, May 10, 2016, available at http://economictimes.indiatimes.com/opinion/interviews/top-indian-nuke-scientist-busts-myths-surrounding-dirty-bomb/articleshow/52201378.cms, accessed on December 13, 2016.

65 Ibid.

mechanisms to thwart the danger of nuclear terrorism. Sustainable nuclear security essentially implies a systemic ability of the nuclear security framework to continually strengthen the weakest links. Sustainable nuclear security ensures the smooth functioning of legal and regulatory machines that essentially develop an effective culture of nuclear security. It also facilitates transparency on critical nuclear security issues. This is possible if necessary mechanisms are developed that can facilitate cooperation and yet protect confidentiality over critical issues. Nuclear security can also be effectively made sustainable when there is universal adherence to critical tools of nuclear security: CPPNM, Amendment (2005) and the ICSANT.

The NSS process has been instrumental in emphasising not only how serious the threat of nuclear terrorism is but also in focusing on the several weaks links that endanger nuclear security. Increasing risks associated with expanding fissile material and its transportation, and a lack of universal acceptance of important legal instruments like the CPPNM, Amendment 2005 and ICSANT, are some of the major challenges that still leave the nuclear security regime fragmented and ineffective. However, the NSS process has helped evolve new concepts for strengthening of nuclear security. The concept of centres of excellence (CoEs) has evolved to serve as an important platform for interaction and coordination among all stakeholders within the world community, on all aspects of peaceful uses concerning nuclear energy, including nuclear security, safety and non-proliferation. The CoEs established by several nations have already kick-started the process of strengthening nuclear security through their training programmes, educational activities and sharing best practices in a coordinated manner. Regular workshops and symposiums are being held as part of national and regional training course curriculum to generate awareness about the dangers of nuclear and radiological terrorism and to develop a robust nuclear security regime.

This monograph seeks to explore the acute challenges to nuclear security, which are difficult to manage unless concerted efforts are undertaken by the international community to mitigate them. A detailed assessment is also made of CoEs and how they can enhance the prospects for a strengthened nuclear security in the face of grim challenges. The monograph concludes by emphasising on the importance of making the existing nuclear security regime cohesive and robust. It emphsises the importance of establishing integrated mechanisms that ensure the fulfilment of effective nuclear security commitments to combat the threat of nuclear terrorism.

The methodology adopted in developing this work includes a combination of qualitative and quantitative research methods. The historical background was researched based on books, journals and relevant articles. The crucial technical aspects were researched from quantitative datasets of IAEA. Questionnaires to elicit opinions on crucial aspects of nuclear security were circulated. Field studies in the Bhabha Atomic Research Centre (BARC), Mumbai, Nuvia India Radiological Instrument Calibration Facility, New Delhi and Stimson Center, Washington, DC, were also undertaken.

Chapter 2

Securing Fissile Materials

Problems and Challenges

Expanding production of weapons-usable nuclear materials has heightened concerns of them falling into the hands of terrorists. As of January 2015, the global stockpile of fissile material comprises approximately 1,370 ± 125 tonnes of HEU and 500 tonnes separated plutonium, of which about 270 tonnes is the material in civilian custody.[1] Even as the world community has expressed the urgent need for adequate security measures for all categories of weapons-grade fissile material, there appears to be a vast disparity in the physical protection system of civilian and non-civilian nuclear materials. Addressing this disparity is an essential requirement in the chain of nuclear security which, if neglected, can potentially become a weak link in the system. The chain is already vulnerable due to the terrorists' known determination to acquire nuclear materials. In December 2014, seven members of an organised criminal group suspected of smuggling uranium were arrested in Moldova with stocks of uranium-238 and unidentified radioactive material.[2] The radioactive substances are attractive materials to build dirty bombs, which could be potentially expended to spread radiological terror by potential terrorist groups. Expanding global commerce in weapons-usable nuclear materials, both for civilian and non-civilian purposes, constitutes yet another significant proliferation risk that multiplies the threat of nuclear terrorism. "Given the vast majority of non-weapons HEU commerce persist[ing]",[3] the

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1 International Panel on Fissile Materials, "Fissile Material Stocks", July 29, 2016, available at http://fissilematerials.org/, accessed on November 25, 2016.

2 Interpol, "Moldova Police Arrest Seven Suspected Uranium Smugglers", December 11, 2014, available at http://www.interpol.int/News-and-media/News/2014/N2014-238, accessed on December 25, 2016.

3 Alan J. Kuperman (ed.), *Nuclear Terrorism and Global Nuclear Security: The Challenge of Phasing out Highly Enriched Uranium*, Abingdon, Oxon: Routledge, 2013, p. 3.

international community must take concerted measures to minimise dangers of HEU commerce. It is equally important that proper attention is focused towards the security of weapons-grade plutonium.

In the 1970s, "concern that states might use HEU to launch clandestine nuclear programs led to the initiation of national and international programs to reduce its use."[4] This was followed, in the 1980s, with representatives from 59 states recognising that "the trade in and widespread use of HEU and the production of fissile materials constitute proliferation risks with which the International Fuel Cycle Evaluation (INFCE) is concerned."[5] They recommended urgent measures to downgrade enrichment level of uranium-235 "preferably to 20% or less",[6] so as to make the isotope incapable for weapons use, and to reduce the existing stockpiles of HEU. The NSS played a critical role in developing policies for HEU management for minimisation and eventual disposition of dangerous nuclear materials. These policies emphasised the importance of undertaking effective precautions for safeguarding HEU and separated plutonium; minimising the use of HEU through the conversion of reactor fuel from HEU to LEU and downblending separated plutonium; and motivating states to deliberate

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4 "In 1978, the US Department of Energy (DoE) initiated the RERTR programme that has converted over 40 research reactors using US-supplied nuclear fuel from HEU to LEU. The Emerging Threats and Gap Material programme was established to remove vulnerable nuclear material not covered by other clean-out programmes. The National Nuclear Security Administration (NNSA) established the Global Research Reactor Security (GRRS) programme to upgrade the security of those foreign research reactors that did not meet guidelines established by the IAEA. Later, in 2004, the NNSA established the GTRI that sought to identify, secure, remove and/or facilitate the disposition of high-risk, vulnerable N&R materials around the world that pose a threat to the US and the international community." See Cristina Hansell, "Practical Steps Toward a World Without Civilian HEU", *The Nonproliferation Review*, Vol. 15, No. 2, July 2008, p.289.

5 O. Reistad, S. Hustveit and O. Harbitz, "Measuring Progress in Reactor Conversion and HEU Minimization towards 2020—The Case of HEU-fuelled Research Facilities", IAEA, November 2007, p. 1, available at http://wwwpub.iaea.org/MTCD/publications/PDF/P1360_ICRR_2007_CD/Papers/O.C.%20Reistad.pdf, accessed on December 25, 2016.

6 Ibid.

on the advantages of "safe, secure and timely removal and disposition of nuclear materials from facilities"[7] consistent with their national requirements. In the 2012 NSS, representatives emphasised their commitment to minimise the use of HEU for civilian purposes, where technically and economically feasible, in order to advance the goal of nuclear security.[8] These obligations were reinforced in the following 2014 NSS wherein 12 nations agreed upon "the elimination of HEU within their borders".[9] Post-2016 Washington Summit, a gift basket on HEU management in civilian applications was adopted by 22 nations.[10] These states have recognised that HEU minimisation significantly reduces nuclear security threats and is thus "an integral component of the global effort to combat the threat of nuclear terrorism".[11] These nations have been joined by several other nations, including India,[12] in developing an effective strategy for HEU management. Given the

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7 "Seoul Communiqué", Nuclear Security Summit, Seoul 2012 p.3, available at https://pgstest.files.wordpress.com/2013/06/seoul-communique_final.pdf, accessed on December 25, 2016.

8 "Belgium–France–Netherlands–United States Joint Statement: Minimization of HEU and the Reliable Supply of Medical Radioisotopes", NSS, 2012, p. 1, available at https://pgstest.files.wordpress.com/2013/06/heu-minimization-and-medical-isotopes.pdf, accessed on December 25, 2016.

9 "Joint Statement on Countries Free of Highly Enriched Uranium (HEU)", NSS, March 24, 2014, p. 1, available at https://pgstest.files.wordpress.com/2014/04/joint-statement-on-countries-free-of-heu_gb_2014.pdf, accessed on December 25, 2016.

10 These states are Argentina, Armenia, Australia, Canada, Czech Republic, Chile, Denmark, Finland, Georgia, Indonesia, Mexico, the Netherlands, Nigeria, Norway, the Philippines, Poland, Republic of Korea, Romania, Singapore, Sweden, the UK and the US.

11 "NSS 2016: Gift Basket on Minimizing and Eliminating the Use of Highly Enriched Uranium in Civilian Applications", in *Nuclear Security Matters*, 2016 Washington Summit, available at http://nuclearsecuritymatters.belfercenter.org/files/nuclearmatters/files/nss_2016_heu_minimization_gift_basket.pdf?m=1461096497, accessed on December 7, 2016.

12 Ministry of External Affairs, "India's National Progress Report, Nuclear Security Summit 2016", April 2, 2016, available at http://www.mea.gov.in/bilateral-documents.htm?dtl/26590/Indias+National+Progress+Report+Nuclear+Security+Summit+2016, accessed on December 7, 2016.

relative ease in devising a weapon (even if crude) with HEU than plutonium, this chapter primarily focuses on the potential dangers emanating from the former. Also, understanding the proliferation risks associated with the use of weapons-usable HEU, this chapter seeks to explore:

1. What are the challenges involved in the elimination of weapons-grade HEU?
2. How has the continued production of nuclear materials challenged the enforcement of the FMCT?

Why is HEU a Threat?[13]

Experts agree that an act of nuclear terrorism is fraught with extreme challenges, but perhaps the most difficult step is the acquisition of requisite amount of fissile material—HEU or plutonium. Given this difficulty, the most reasonable option for potential terrorists would be to develop crude nuclear weapons.[14] There are basically two designs of nuclear weapons, which are likely to serve the purposes of terrorist outfits. First is a 'gun-type' bomb—the simplest type of nuclear bomb for terrorists to design from only HEU.[15] In most cases, building such a bomb would require some ability to cast machine uranium, a reasonable knowledge of the nuclear physics involved and a good understanding of cannons and ballistics.[16] In many cases, an ability to

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13 See Reshmi Kazi, "The Danger of Nuclear Terrorism: The Indian Case", *Strategic Analyses*, Vol. 33, No. 4, July 2009, pp. 498–515.

14 Alternatively, they can acquire weapons-grade N&R materials though the nuclear black market.

15 It involves little more than slamming two pieces of HEU together at high speed and can produce a powerful explosion. See Luis Alvarez, *The Adventures of a Physicist*, New York: Basic Books, 1987.

16 Matthew Bunn and Anthony Wier, 'Terrorist Nuclear Weapon Construction: How Difficult?', *The Annals of the American Academy of Political and Social Science*, Vol. 607, No. 1, 2006, pp. 133–49; J. Carson Mark, Theodore Taylor, Eugene Eyster, William Maraman and Jacob Wechsler, "Can Terrorists Build Nuclear Weapons?", in Paul Leventhal and Yonah Alexander (eds), *Preventing Nuclear Terrorism*, Lexington, MA: Lexington Books, 1987, p. 58, available at http://www.nci.org/k-m/makeab.htm, accessed on December 25, 2016.

do some chemical processing might also be needed; but the chemical processing required is less sophisticated than some of the processing criminals routinely do in the illegal drug industry.[17] Experts state, "compared to the other main fissile material in military arsenals, plutonium, HEU is much easier for terrorists or states to make into nuclear weapons."[18] The second design is an implosion-type device. This is a more difficult process than the first, and involves explosives arranged around nuclear material, which compress it to a much higher density, setting off the nuclear chain reaction. The yield is much higher in the implosion-type device.

Generally, it is much simpler to devise a crude nuclear bomb with HEU than with plutonium but the critical mass is larger in the former.[19] Due to its relatively low background of spontaneous fission neutrons, HEU is considered more suitable than plutonium for use in an improvised nuclear device.[20] Past experience suggests that crude HEU nuclear weapons will function without prior testing due to the low

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17 Professor James C. Warf, one of the leaders of the chemical processing programmes in the Manhattan Project, has argued that the steps needed to get HEU from research reactor fuel in which it is mixed with other materials "are not difficult procedures, particularly for someone intent on acquiring an atomic explosive; one might say, in fact, that they are not beyond the ability of most students in introductory chemistry classes at the college level." See Committee on Science, Space, and Technology, "Conversion of Research and Test Reactors to Low-enriched Uranium (LEU) Fuel", US Congress, House of Representatives, 98th Congress, 2nd Session, September 25, 1984, pp. 514–16.

18 Alan J. Kuperman, Nuclear Terrorism and Global Security: The Challenge of Phasing Out Highly Enriched Uranium (Abington, Oxon: Routledge, 2013), p.4.

19 A simple gun-type nuclear explosion device requires approximately 50 kg HEU that is 93 per cent enriched. Comparatively, a plutonium-based bomb would require roughly 8 kg of weapons-grade plutonium.

20 See 'HEU as Weapons Material: A Technical Background', Paper prepared by the organisers of the Symposium on Minimization of HEU in the Civilian Nuclear Sector, Oslo, June 2006, available at http://www.iran-resist.org/IMG/pdf/HEU_as_Weapons_Material.pdf, accessed on December 25, 2016.

neutron background and thus a limited risk of pre-ignition.[21] Terrorists seeking to detonate such devices could thus have "reasonable confidence in the performance of those weapons".[22] A crude nuclear bomb using HEU would have an explosive power of a few hundred to a few thousand tonnes and can serve the purposes of groups like Al- Qaeda.[23] In 2002, the US National Research Council appraised the threat of nuclear terrorism: "crude HEU weapons could be fabricated without state assistance", observing that "the primary impediment that prevents countries or technically competent terrorist groups from developing nuclear weapons is the availability of [nuclear material], especially HEU".[24] This essentially implies that once terrorists are successful in obtaining the desired HEU, they would no longer be constrained by financial, scientific and technological requirements to build a nuclear device. An article in *Foreign Policy* argues that a team of 19 terrorists (the same number as that of the 9/11 hijackers) could successfully procure HEU, design and fabricate an operational device, transport it to the target area and detonate it, all within a year and for less than US$ 6 million.[25] The HEU also provides the advantage of having weak

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21 Morten Bremer Mærli, Annette Schaper and Frank Barnaby, "The Characteristics of Nuclear Terrorist Weapons", *American Behavioral Scientist*, Vol. 46, No. 6, 2003, pp. 773–74.

22 See "Military Critical Technologies, Part II: Weapons of Mass Destruction Technologies (WMD), 1997, updated December 1999", quoted in *Measures to Prevent, Intercept and Respond to Illicit Uses of Nuclear Material and Radioactive Sources*, IAEA C&S Papers Series 12/P, August 2002, available at http://www-pub.iaea.org/MTCD/publications/PDF/CSP-12-P_web.pdf, accessed on December 25, 2016.

23 The gun-type weapon that destroyed Hiroshima had an explosive power equivalent to 12,500 tonnes of trinitrotoluene (TNT), while the largest conventional bomb used in World War II contained only 10 tonnes of TNT.

24 Committee on Science and Technology for Countering Terrorism, *Making the Nation Safer: The Role of Science and Technology in Countering Terrorism*, Washington, DC: National Academy Press, 2002, pp. 40, 45.

25 Peter G. Zimmerman and Jeffrey G. Lewis, 'The Bomb in the Backyard', *Foreign Policy*, November–December 2006, pp. 32–39.

radioactivity that makes it relatively easy to handle and hard to detect.[26] Perhaps the most endearing quality of HEU to terrorists is the ease with which it can be used to construct a crude nuclear explosive. The possibility of directly utilising HEU for the manufacture of nuclear explosive devices makes it particularly sensitive and requires special precautions.

Several civilian applications of weapons-usable HEU pose dangerous proliferation risks with consequences involving the threat of nuclear terrorism. The existing stocks of civilian HEU can be used to make hundreds of nuclear weapons. As the terrorists would not be determined to produce sophisticated bombs with complex weapons designs, adequate quantity of HEU having 90 per cent and above enrichment level would be attractive enough. Several nuclear research facilities and reactors use weapons-grade HEU in the areas of nuclear science and technology to provide important humanitarian benefits. The isotopes produced by these facilities are vital to medical treatments, industrial productivity, water management and several other humanitarian purposes. Nearly 100 civilian facilities around the world operate with weapons-grade HEU.[27] According to the 2015 IAEA database, there are 246 operational research reactors (nearly 100 of them in developing countries), seven under construction, 140 shut down (plus 19 temporary), 343 decommissioned and 11 more being planned.[28] It is noteworthy that for over two decades, more research facilities have been shut down each year and more than half of the currently operational research reactors are over 30 years old. The ageing materials and equipments raise increasing concerns about the safety of these

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26 Pablo Adelfang, "Non-proliferation and the Reduction of Commercial Traffic in HEU", Symposium on Progress, Challenges, and Opportunities for Converting U.S. and Russian Research Reactors from Highly Enriched to Low Enriched Uranium Fuel, Moscow, June 8–10, 2011.

27 Ambassador Jan Petersen, "Keynote Address: 2nd International Symposium on HEU Minimization", Nuclear Threat Initiative, January 23, 2012, available at www.nti.org/analysis/speeches/keynote-address-2nd-international-symposium-heu-minimization/, accessed on December 25, 2016.

28 "Research Reactors", IAEA, 2009–15, available at https://nucleus.iaea.org/RRDB/RR/ReactorSearch.aspx?filter=0, accessed on December 25, 2016.

reactors. It is also important to note that while guidelines exist for plutonium management, none have yet been adopted for HEU. These factors raise concerns about the risks of ageing reactors getting sabotaged (as old equipments are being used) by terrorists for obtaining weapons-usable uranium. After all, as per the Sutton principle, terrorists will attempt to obtain fissile materials from where it is easily available.

Civilian HEU research reactors, especially in Russia and the other states of the former Soviet Union, are often dangerously insecure. Political instability, poor economic conditions and widespread corruption result in meagre funding that has severely impeded security measures at many of these facilities. The Russian methods of material accounting of fissile material are often "done through archaic or informal methods, such as hand counting, that are prone to manipulation and human error".[29] Poor security apparatus, reliant on vintage methods of locks like padlocks or even wax seals, increases risk of theft or attempted theft.[30] The risks associated with HEU are also dependent on several factors like the amount of HEU used, the number of HEU storage sites, security of these locations and transportation risks. This is worrying, as civilian research reactors around the world that use or stockpile weapons-usable HEU constitute the weakest link in the international nuclear security regime. Hence, it is imperative that the international community, as responsible members, considers that a gradual decline in HEU volume can substantially reduce the risk of civilian HEU being stolen or diverted for weapons purposes.

Challenges Involved in the Elimination of HEU

The dangers of HEU are enormous given the proliferation risks posed by its application as fuel in research reactors and for weapons purposes. The concern is that if a small amount of this HEU should fall into the

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29 Stimson, "Global Cleanout of Weapons Usable Nuclear Materials", May 30, 2007, available at http://www.stimson.org/global-cleanout-of-weapons-usable-nuclear-materials-/#end3, accessed on December 25, 2016.

30 See "IAEA Illicit Trafficking Database", in IAEA, *2015 Fact Sheet*, available at http://www-ns.iaea.org/downloads/security/itdb-fact-sheet.pdf, accessed on December 25, 2016.

hands of terrorists, it can spell global catastrophe.[31] Hence, securing weapons-grade fissile materials is essentially the first safeguard against nuclear terrorism. However, even though HEU minimisation is the sustainable form of threat reduction, its realisation faces crucial challenges.

Medical Isotope Production

HEU is essential for producing medical radioisotopes for medical applications. The process involves the irradiation of HEU "targets" in a reactor, which produces the short-lived radioisotope molybdenum-99 (Mo-99).[32] Mo-99 is the isotope used for the production of technetium-99m (Tc-99m), which is a radioactive isotope required for medical diagnostic studies. For the production of the isotope Tc-99m, HEU is enriched to a level higher than 90 per cent at other major isotope production facilities.[33] Experts have attempted to calculate the amout of HEU required for medical isotope production. Approximately 1,000 targets of 15 grams are needed to meet the global Tc-99m demand.[34] This material contains nearly 14 kg of uranium-235, that is, a little more than half the significant quantity that the IAEA defines to be 25 kg.[35]

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31 Al-Qaeda has already expressed its desire to acquire nuclear weapons. Graham Allison, *Nuclear Terrorism: The Ultimate Preventable Catastrophe*, New York: Henry Holt, 2004, p. 20; Charles D. Ferguson and William C. Potter, *The Four Faces of Nuclear Terrorism*, Routledge: New York, 2005, p. 21; William McCants, "Going Nuclear", May 27, 2008, available at http://www.jihadica.com/goingnuclear/, accessed on December 25, 2016.

32 William Potter, "Nuclear Terrorism and the Global Politics of Civilian HEU Elimination", *The Nonproliferation Review*, Vol. 15, No. 2, 2008, p. 147

33 Ibid. The HEU targets typically are enriched to a level of 36–45 per cent at the Pelindaba facility in South Africa.

34 Martin B. Kalinowski, Martina Grosch and Simon Hebel, "Proliferation Risks of Highly Enriched Uranium (HEU) used for Medical Isotope Production", Carl Friedrich von Weizsäcker Centre for Science and Peace Research, University of Hamburg, November 8, 2014, available at http://www.researchgate.net/publication/267722691_Proliferation_risks_of_highly_enriched_uranium_%28HEU%29_used_for_medical_isotope_production, accessed on December 25, 2016.

35 Ibid.

Extensive use of HEU for civilian purposes raises the vulnerabilities of nuclear material being illicitly diverted by rogue states and non-state actors. Given the high-security nuclear risks, recommendations have been made to convert HEU into LEU as downblended uranium is an essential barrier against weapons use. However, the world's three largest producers of Mo-99, on the grounds of economic, technical and political reasons, have largely resisted this proposal.[36] Canada's MDS Nordion company—the world largest producer of Mo-99—continues to use HEU targets primarily because the conversion process to LEU is very costly. Politically, there is an existing agreement between MDS Nordion and Russia's ISOTOPE, under which Russia will produce and supply Mo-99 to Ottawa for 10 years.[37] The agreement poses concerns to the "security and non-proliferation communities" alike, since it may form a potential pathway for both rogue nations and terrorists to acquire enriched fissile material. On the one hand, the agreement allows Russia to continue producing HEU, which is detrimental to the larger interests of the non-proliferation regime. On the other hand, in security terms, it opens a potential proliferation pathway that embeds a loophole within the nuclear security chain and enhances the risk of nuclear terrorism.

Research Reactors

Russia has more research reactors than any other country and has been a major user of HEU to fuel its domestic reactors. It also has a large stock of HEU for civil research and power reactor programmes. However, Moscow provides little information about its HEU stocks, and the estimate of 15–20 tonnes is highly uncertain.[38] Although Russia, with the US' collaboration, has undertaken significant efforts to

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36 Kendra Vessels, "Canada and Russia: Medical Isotope Production", in Kuperman (ed.), *Nuclear Terrorism and Global Nuclear Security*, n. 3, p. 136.

37 Ibid.

38 David Albright and Serena Kelleher-Vergantini, "Civil HEU Watch: Tracking Inventories of Civil Highly Enriched Uranium", in Institute for Science and International Security, *Global Stocks of Nuclear Explosive Materials*, October 7, 2015, p. 3, available at http://www.isis-online.org/uploads/isis-reports/documents/Civil_Stocks_of_HEU_Worldwide_October_7_2015_Final.pdf, accessed on December 25, 2016.

downsize its nuclear stockpiles, the basic structure of its nuclear industry, including its production facilities and fissile materials, remains the same as during the Cold War era. Thus, ensuring high and sustainable security for its nuclear stocks continues to be a major task for Russia. The Soviet programme, *Russian Research Reactor Fuel Return* (RRRFR), seeks conversion of HEU reactors to use of uranium enriched to 36 per cent—which by virtue of being enriched beyond 20 per cent is still considered weapons-usable HEU.[39] Though Russia and the US have implemented several programmes like the *RERTR* and the RRRFR to reduce the enrichment level in civilian research reactors, Moscow, until very recently, had not pursued a domestic conversion policy.[40] The reasons for these shortcomings are the apparent high short-term financial costs of converting to LEU, perceived advantages offered by the use of HEU for some advanced research projects, fear of losing a potential technological edge vis-à-vis other countries (particularly in light of the anticipated nuclear energy renaissance), as well as other economic, social and political factors.[41]

Russia's support for a HEU phase out is deeply influenced by its status as an NWS that makes conversion of HEU-feulled reactors into LEU a minimal priority. Russia also believes that terrorists do not possess the required capability to build an improvised nuclear device and is confident that its nuclear security measures are impregnable and cannot be breached by any intruder.[42] Hence, Moscow is not keen in incuring

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39 Braden Civins, "Russia: Research Reactors", in Kuperman (ed.), *Nuclear Terrorism and Global Nuclear Security*, n. 3, p. 147.

40 Elena K. Sokova, "Phasing out Civilian HEU in Russia: Opportunities and Challenges", *The Nonproliferation Review*, Vol. 15, No. 2, 2008, p. 210.

41 Ibid., p. 215.

42 Matthew Bunn, William H. Tobey, Martin B. Malin and Nickolas Roth, *Preventing Nuclear Terrorism: Continuous Improvement or Dangerous Decline?,* Report for Managing the Atom Project, Belfer Center, March 21, 2016, p. 45, available at http://belfercenter.ksg.harvard.edu/files/PreventingNuclear Terrorism-Web%202.pdf, accessed on November 30, 2016; see also "Terroristicheskiye Organizatsii ne Mogut Sozdat Atomnoi Bomby, Zayavil Ministr Rossii po Atomnoi Energii" (Terrorist organizations are not capable of building an atomic bomb, says Russian minister of atomic energy), *ITAR-TASS*, May 19, 2003, quoted in Sokova, 'Phasing out Civilian HEU in Russia', n. 3, p. 210.

the high costs arising from decommissioning and disposal of fresh and spent fuel from its reactors.[43]

Social factors also prevent the conversion of HEU as it "may be considered a source of prestige in Russia with insitutions reluctant to close the door to future nuclear research that may require LEU."[44] Russia believes that, technically, the conversion to LEU is a major challenge since "research reactors installed in various facilities are diverse in design, power levels, fuel composition, and operation mode".[45] However, these arguments have been challenged by experts who argue that "many Russian research reactors are nearing the ends of their service live limits"[46] hence "the technological barriers to converting remaining reactors should be removed by 2011 or soon thereafter, when new high-density fuels become available."[47] In June 2012, the Department of Energy (DoE) reported that "nine out of 27 research reactors using HEU in the Russian Federation have been shut down"[48] (but the remaining 18 research reactors are still operating). Rising terrorist attacks prompted Russia to collaborate with the US in jointly conducting feasibility studies for the possible conversion of its HEU-fuelled reactors to LEU. The DoE-conducted studies confirmed that "it is technically

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43 See Thomas Young, Cole Harvey and Ferenc Dalnoki-Veress, "It's Not just New START: Two Other U.S.–Russian Nuclear Agreements Boost U.S.–Russian Reset", James Martin Center for Nonproliferation Studies, December 21, 2010, available at http://cns.miis.edu/stories/101221_nuclear_agreements.htm, accessed on November 30, 2016.

44 Ibid.

45 See "'Project #245 Radleg', 1996, Kurchatov Institute, www.kiae.ru/radleg/ch6e.htm", quoted in Kuperman (ed.), *Nuclear Terrorism and Global Nuclear Security*, n. 3, p. 148.

46 Elena K. Sokova, "Phasing out Civilian HEU in Russia", *The Nonproliferation Review*, Vol. 15, No. 2, July 2008,. p. 228.

47 Ibid., p. 227.

48 NNSA, "US, Russian Federation Sign Joint Statement on Reactor Conversion", Press Release, June 26, 2012, available at http://nnsa.energy.gov/mediaroom/pressreleases/jointstatement062612, accessed on November 30, 2016.

possible to convert the reactors to use LEU fuel".[49] Thereafter, Russia conveyed to the DoE that "one or two reactors will be converted in 2014".[50] Russia assessed the technical possibility of converting six research nuclear reactors from HEU to LEU in Tomsk and the National Research Center, Kurchatov Institute, subject to the financial impacts involved. However, studies continue to indicate Russia's lack of substantial interest towards conversion of its domestic reactors to LEU fuel.[51]

Critical assemblies and pulsed reactors, fuelled by weapons-usable HEU, pose risks of nuclear proliferation and nuclear terrorism. These assemblies contain large quantities of HEU, often enriched up to 90 per cent.[52] If a rogue state or potential terrorists obtained a relatively small amount of this material, they could build a crude nuclear weapon using information available through open sources, including the Internet.[53] These facilities have lifetime cores and low fuel burn-up rates, which result in low levels of radioactivity. The reduced risks of radiation make critical assemblies and pulsed reactors an attractive proliferation pathway for terrorists. At present, Russia has a total of 19

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49 Matthew Bunn, Eben Harrell, "Consolidation: Thwarting Nuclear Theft", Harvard Kennedy School, Belfer Center for Science and International Affairs, March 2012, p.24, available at https://dash.harvard.edu/bitstream/handle/1/10592470/Bunn_Consolidation_Thwarting.pdf, accessed on November 30, 2016.

50 "Russia to Convert Two Reactors to LEU in 2014", in Braden Civins, "Russia: Research Reactors", n. 3, p. 150.

51 Anatoli S. Diakov, "Prospects for Conversion of HEU-fueled Research Reactors in Russia", *Science & Global Security*, Vol. 22, No. 3, 2014, pp. 166–87, available at http://scienceandglobalsecurity.org/archive/sgs22diakov.pdf, accessed on November 30, 2016.

52 Frank von Hippel, "A Comprehensive Approach to Elimination of Highly-enriched-Uranium from All Nuclear-reactor Fuel Cycles", *Science & Global Security*, Vol. 12, No. 3, 2004, pp. 148–49.

53 See Frank von Hippel, "The Need to Address the Larger Universe of HEU-fueled Reactors, including: Critical Assemblies, Pulsed Reactors and Propulsion Reactors", Paper presented at the International Meeting on Reduced Enrichment for Research and Test Reactors, IAEA, Vienna, November 7–12, 2004.

pulsed reactors that collectively contain 2 tonnes of HEU in their cores.[54] Most notably, the BIGR pulsed reactor, at the All-Russian Scientific Research Institute of Experimental Physics (VNIIEF) in Sarov, contains 833 kg of 90 per cent uranium in its core.[55] Russia also houses more than half of world's approximately 50 HEU-fuelled critical assemblies.[56] These critical assemblies operate on 90 per cent HEU, which significantly heightens the nuclear security risks emanating from Russia. Conversion and decommissioning of HEU-fuelled critical assemblies and pulsed reactors are urgent requirements for strengthening nuclear security.

In spite of the security risks emanating from Russia's research reactors, critical assemblies and pulsed reactors, Moscow argues that any conversion of HEU-fuelled assemblies to LEU or decommissioning them involves high costs. The enormous financial costs involved in the development, testing and procurement of LEU is a major factor that complicates the conversion process. Cost concerns also arise from the storage of and disposal of slightly irradiated fuel that cannot be converted back to LEU under the RERTR blend-down programme. As these assemblies have compact cores with dense HEU fuel, any conversion process would require development of high-density LEU fuel, which might not be available in adequate quantity. Russia has also expressed doubt on whether computer simulations can replace critical assemblies and pulsed reactors. Though Russia, in cooperation with the US, has significantly assisted in the conversion of Moscow-supplied spent fuel to third countries, its own contribution has remained minimal in this regard. Under the April 2010 US–Russia agreement, Moscow had expressed willingness to conduct feasibility study of the conversion process, yet there has been an absence of any coherent approach towards HEU management in Russia.

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54 Frank von Hippel, "HEU in Critical Assemblies, Pulsed Reactors and Propulsion Systems", Paper presented at the Technical Workshop on HEU Elimination, Oslo, Norway, June 17–18, 2006, p. 2.

55 Paul Osborne, "Russia: Critical Assemblies and Pulsed Reactors," in Kuperman (ed.), *Nuclear Terrorism and Global Nuclear Security*, n. 3, p. 163.

56 Ibid., p. 164.

Naval Propulsion Reactors

Naval propulsion reactors used in submarines, icebreakers and aircraft carriers are the highest consumers of HEU and pose considerable challenge to its global phase out. Naval propulsion requires 3 tonnes of HEU annually, which is "four times that of the world's research reactors".[57] Presently, all the NWS and India and Brazil use HEU-powered submarines. In addition, the US has the world's largest nuclear-powered fleet with 84 submarines and aircraft carriers, all of which use HEU fuel that is estimated to use approximately 2 tons of HEU per year.[58] Russia has a formidable fleet of nuclear propelled icebreakers that are fuelled by HEU.[59] Though India does not have a large stockpile of HEU, it produces HEU enriched above 90 per cent to fuel its nuclear vessels. Apparently, China is converting HEU-based miniature nuclear reactors into LEU, but has refrained from shutting down its fast reactor and its critical assembly. Inspite of adhering to the 1995 Statement of Intent, China has extended little or no cooperation to the RERTR programme, and the US GTRI for possible conversion of China's HEU-fuelled reactors.[60] China has opposed to including of naval fuel within the ambit of the FMCT as it would invariably lead to the disclosure of its HEU stocks. In fact, China supports exclusion of existing stocks of HEU from the scope of the FMCT. The US Navy's sustained use of HEU in its naval propulsion sectors "tends to legitimize such fuel for other high-performance activities".[61] Driven by factors of economics and performance, the US has so far resisted conversion into LEU. Notably too, Russia's Navy "annually requires an estimated

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57 Alan J Kuperman, "Global HEU Phase-Out: Prospects and Challenges", in Kuperman (ed.), *Nuclear Terrorism and Global Nuclear Security*, n. 3, p. 9.

58 See Chunyan Ma and Frank von Hippel, "Ending the Production of Highly Enriched Uranium for Naval Reactors", The Nonproliferation Review, (Spring 2001), p.92; "Rebecca Ward, "USA and France: Naval Propulsion", in Kuperman (ed.), Nuclear Terrorism and Global Nuclear Security, n. 3, p. 177.

59 Christine Egnatuk, "Russia: Icebreaker Ships and Floating Reactors", in Kuperman (ed.), *Nuclear Terrorism and Global Nuclear Security*, n. 3, p.66.

60 See Shing-yao (Sandra) Feng, "Reactors and Nuclear Propulsion", in Kuperman (ed.), *Nuclear Terrorism and Global Nuclear Security*, n. 3, p. 102.

61 Kuperman (ed.), *Nuclear Terrorism and Global Nuclear Security*, n. 3, p. 17.

570 kg of fresh HEU" to fuel its submarines.[62] Reports claim that the Russian Navy plans to further increase the enrichment level of HEU to extend the core life of its vessels. Though Russia has sufficient fuel fabrication capacity, it has expressed no desire to go down the path of HEU conversion and facilitate global phase out of HEU. Nuclear politics, economics and technological prowess underlie strategic aspirations of global powers and undermine the process of global minimisation and elimination of HEU.

Military Nuclear Materials

The vast majority of nuclear materials in the world exist within state military programmes.[63] Military nuclear materials (HEU and plutonium) are thus found in active nuclear weapons, retired nuclear materials ready for dismantlement, non-civilian naval reactors, excess fissile materials awaiting downblending and stored stockpiles. The majority of these military stockpiles are found in Russia and the US. All states possessing military nuclear materials must ensure highest possible security measures for effective physical protection of their stockpiles. This is necessary not only for purposes of mitigating risks of nuclear terrorism but also to develop global confidence in the physical protection measures adopted by states for the security of their military nuclear materials. However, there is enormous disparity in the global efforts to secure weapons-grade HEU and plutonium. The 2005 CPPNM that entered into force on May 9, 2016, and INFCIRC/225/Rev.5 IAEA guidelines, entails measures for the physical protection of weapons-usable nuclear materials in the civilian programmes, which constitute only 17 per cent of global stockpiles of fissile material. There are no detailed recommendations governing the remaining 83 per cent fissile materials, most of which are in the military sector. Unlike civilian nuclear materials

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62 Yaroslav Primachenko, "Russia: Naval Propulsion", in Kuperman, *Nuclear Terrorism and Global Nuclear Security*, n. 3, p. 196.

63 "Enhancing the Security of Military Nuclear Materials", in Fissile Materials Working Group, *The Results We Need in 2016: Policy Recommendations for the Nuclear Security Summit*, p. 14, available at http://www.fmwg.org/FMWG_Results_We_Need_in_2016.pdf, accessed on December 8, 2016.

and radiation sources[64] that have defined provisions for their security and control, [65] there exist no internationally recognised standards for the security of military nuclear materials; nor there are any multilateral arrangements designed to build confidence in the security of those materials.[66] Presently, global nuclear security faces several challenges in the absence of any long-term plan for reducing the risks emanating from stockpiles of separated plutonium. Though the NSS process has emphasised on the need for securing HEU in civilian applications, no initiative has been taken to safeguard HEU and plutonium used in the military sector.

States possessing military nuclear materials have provided sparse information on measures undertaken towards the security of their military stockpiles. The NWS have refrained from being transparent on their weapons-grade nuclear material stockpiles for strategic reasons. The lack of transparency has increased the risks of nuclear proliferation and consequent dangers of illicit acquisition of weapons-grade fissile materials by terrorists. To mitigate the dangers of nuclear risks, all states must ensure that their nuclear materials are secured effectively and develop a sustainable confidence-building measure that strengthens and continously upgrade nuclear security. Security breaches in many sensitive sites have raised questions about the effectiveness of existing nuclear security measures in several countries. In December 2013, Ministry of Defence police officers at the Atomic Weapons Establishment (AWE) in Berkshire were accused of failing to complete routine patrols at a

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64 See "Code of Conduct on the Safety and Security of Radioactive Sources", *IAEA*, January 2004, available at http://www-pub.iaea.org/MTCD/publications/PDF/Code-2004_web.pdf, accessed on December 9, 2016; also see "Guidance on the Import and Export of Radioactive Sources", *IAEA*, March 2012, available at http://www-pub.iaea.org/MTCD/Publications/PDF/8901_web.pdf, accessed on December 9, 2016.

65 See ibid.

66 Des Browne, Richard Lugar and Sam Nunn, *Bridging the Military Nuclear Materials Gap*, NTI *Military* Materials Security Study Group, November 2015, p. 13, available at http://www.nti.org/media/pdfs/NTI_report_2015_e_version.pdf?_=1447091315, accessed on December 8, 2016.

nuclear site.[67] Such incidents indicate that irrespective of the highly sensitive nature of the complex, problems with security and supervision are persisting to a large degree. In August 2012, the breach of the Y-12 Highly Enriched Uranium Materials Facility (HEUMF)[68] near Knoxville, Tennessee, containing enough fissile material to make 10,000 nuclear bombs, demonstrated appalling security flaws. Such incidents of breach "raises important questions about the security of Category I nuclear materials across the complex".[69] The incident was a pointer to the multiple weaknesses in the security systems within the site. The February 2010 incident of a group of peace activists climbing over the perimeter fence at Kleine-Brogel Air Base in Belgium, where the US nuclear weapons are reportedly stored, exposed substantial weaknesses in the site's ability to detect, assess and respond to adversary intrusions in a timely manner.[70] In August 2007, a B-52 bomber flew from the Minot Air Base, in North Dakota, to Louisiana mistakenly loaded with six cruise missiles, each armed with a 150-kilotonne nuclear warhead for a

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67 The AWE, which occupies the site of a former munitions factory, is responsible for the complex final assembly and maintenance of nuclear warheads and their decommissioning. "Nuclear Arms Site Police Investigated over Allegations They Slept on Duty", *The Guardian*, December 14, 2013, available at http://www.theguardian.com/uk-news/2013/dec/14/nuclear-weapons-site-police-investigated-slept-duty, accessed on December 23, 2016.

68 The Y-12 HEUMF is the US' most critically important and highly secured weapons-related facility. It is also known as the "Fort Knox of Uranium" by industry observers. See Megan Rice, 'How Did an 82-year-old Nun get past a Nuclear Facility's Security?', *The Huffington Post*, December 9, 2012, available at http://www.huffingtonpost.com/2012/09/12/megan-rice-nuclear-breach-arrest_n_1878091.html, accessed on December 23, 2016.

69 See R. Jeffrey Smith, "How an 82-year-old Exposed Security Lapses at Nuclear Facilities", The Center for Public Integrity, September 12, 2012, updated January 18, 2013, available at http://www.publicintegrity.org/2012/09/12/10851/how-82-year-old-exposed-security-lapses-nuclear-facilities, accessed on December 23, 2016.

70 Matthew Bunn, "Securing the Bomb 2010: Securing All Nuclear Materials in Four Years", Project on Managing the Atom, Harvard University and Nuclear Threat Initiative, April 2010, p. 4, available at http://www.nti.org/media/pdfs/Securing_The_Bomb_2010.pdf?_=1317159794, accessed on December 23, 2016.

combined yield of about 60 Hiroshima-size bombs.[71] Russian weapons-usable nuclear material facilities also face the challenge of being guarded by ill-trained and poorly remunerated guards, who might be easily subverted by well-armed criminals in any pre-planned attack.

Elsewhere in the world, in November 2007, the Pelindaba nuclear facility in South Africa, housing hundreds of kilograms of weapons-grade HEU, was breached by two teams of armed men. Though South Africa has completed substantial security upgrades at Pelindaba, it has not yet committed to eliminating the hundreds of kilograms of weapon-grade HEU left over from its weapon programme, but talks on that subject are ongoing.[72] In 2010, *Wikileaks* cables revealed that poor security at Yemen's[73] National Atomic Energy Commission (NAEC) facility housing radioactive materials makes these dangerous materials vulnerable to terrorists. Georgia has become a transit point

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71 Gregory D. Koblentz, "Command and Combust: America's Secret History of Atomic Accidents", *Foreign Affairs*, January–February 2014, available at http://www.foreignaffairs.com/articles/140357/gregory-d-koblentz/command-and-combust?cid=soc-facebook-in-review_essays-command_and_combust-011914, accessed on December 25, 2016.

72 Matthew Bunn, Eben Harrell and Martin B. Malin, "Progress on Securing Nuclear Weapons and Materials: The Four-year Effort", Project on Managing the Atom, Harvard Kennedy School, Belfer Center for Science and International Affairs, March 2012, p. 11, available at http://belfercenter.ksg.harvard.edu/files/Progress_In_The_Four_Year_Effort_web.pdf, accessed on December 23, 2016.

73 The location in Yemen is obviously of particular concern since Al-Qaeda in the Arab Peninsula has an active base there. A senior government official in Yemen, the lone guard standing watch at Yemen's NAEC facility, had been removed from his post and its only closed-circuit TV security camera had broken down six months previously and was never fixed. See Karen McVeigh, "WikiLeaks Cables: Yemen Radioactive Stocks 'were Easy Al-Qaida Target'", *The Guardian*, December 19, 2010, available at http://www.theguardian.com/world/2010/dec/19/wikileaks-cables-yemen-al-qaida, accessed on December 25, 2016; and "US Embassy Cables: Yemen Sounds Alarm Over Radioactive Materials", *The Guardian*, December 19, 2010, available at http://www.theguardian.com/world/us-embassy-cables-documents/242991, accessed on December 25, 2016.

for illicit trafficking of unsecured nuclear and radiological materials.[74] Since 2005, special nuclear police unit has conducted 15 investigations, which have led to many arrests. Investigations have revealed that real buyers are clandestinely seeking nuclear and radiological materials in Georgia.[75] The likelihood of terror organisations planning for a nuclear attack was also evident from the revelations of Indian Mujahideen (IM) chief, Yasin Bhatkal, who stated that he was planning to set off a nuclear device in Surat with the help of Pakistan.[76]

These incidents are pointers to the necessity of addressing the challenges of implementing effective and sustainable nuclear security mechanisms for all existing military nuclear materials. Unfortunately, the existing multilateral agreements for mitigating proliferation risks of chemical, biological, radiological and nuclear (CBRN) weapons and materials do not explicitly distinguish between civilian and military nuclear materials.[77] It is necessary through international cooperation and proactive

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[74] Georgia's proximity to Russia, unsecured borders alongside South Ossetia and Abkhazia, abject poverty and corruption and existing trade routes opening into Asia and Europe make it a thriving black market hub for illicit trafficking of either unknown or suspected to be diverted nuclear and radioactive materials from Moscow via Tbilisi.

[75] Desmond Butler, "AP Exclusive: Georgia Details Nuke Investigations", *Associated Press*, December 9, 2012, available at http://bigstory.ap.org/article/georgia-details-nuke-black-market-investigations, accessed on December 25, 2016.

[76] Neeraj Chauhan, "Indian Mujahideen wanted to Nuke Surat, Yasin Bhatkal tells Cops", *The Times of India*, December 30, 2013, available at http://timesofindia.indiatimes.com/india/Indian-Mujahideen-wanted-to-nuke-Surat-Yasin-Bhatkal-tells-cops/articleshow/28116663.cms, accessed on December 25, 2016.

[77] These include the United Nations Security Council (UNSC), United Nations General Assembly (UNGA) and the Global Partnership against the Spread of Weapons and Materials of Mass Destruction (the Global Partnership), United Nations Security Council Resolution (UNSCR) 1540. See "*Improving the Security* of *all Nuclear Materials: Legal*, *Political, and Institutional Options* to *Advance International Oversight*", International Institute for Strategic Studies (IISS), the James Martin Center for Nonproliferation Studies and the *Vienna Center for Disarmament and Non Proliferation, September 2016, p. 5, available at* http://www.nonproliferation.org/wp-content/uploads/2016/09/160920_improving_security_of_all_nuclear_materials__iiss_cns_report.pdf, accessed on December 8, 2016.

diplomacy to address the challenge of effecting greater confidence among nations on all HEU and plutonium to mitigate the threat of nuclear terrorism.

RERTR and GTRI—International Efforts to Convert HEU to LEU

The RERTR programme was established in 1978 with the objective to develop the required technology to convert HEU-fuelled research and test reactors into LEU, without impacting upon their performance, economic or safety aspects. In 2004, the RERTR programme was absorbed into the new GTRI to identify, secure, remove and/or facilitate the disposition of high-risk, vulnerable, weapons-usable nuclear and radiological materials that pose a threat to the international community. As a result of these efforts, several newly constructed research reactors in the world use LEU as fuel. Today, the scope of the GTRI expands to over 130 countries worldwide. The GTRI aimed to remove 5,221 kg of HEU by 2016, of which 64 per cent is already believed to be have been achieved. The programme has successfully removed all HEU material from 21 countries so far.[78] Additionally, GTRI has taken measures to effect complete clean-out of HEU from eight countries following the 2009 Prague speech by President Obama.[79] The GTRI efforts have resulted in permanent threat reduction from all secured and disposed dangerous materials which have now been safeguarded against any illicit diversion in future.

Beginning 2006, the GTRI has removed approximately 323 kg of HEU and plutonium from Belgium, Canada, Chile, Italy, the Netherlands, Sweden and several other countries. The GTRI has, to date, converted all 20 US reactors capable of being converted with

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[78] Brazil, Bulgaria, Chile, Colombia, Denmark, Greece, Latvia, Libya, the Philippines, Portugal, Romania, Serbia, Slovenia, South Korea, Spain, Sweden, Taiwan, Thailand, Turkey, Ukraine and Mexico.

[79] Romania (June 2009), Taiwan (September 2009), Libya (December 2009), Turkey (January 2010), Chile (March 2010), Serbia (December 2010), Mexico (March 2012) and Ukraine (March 2012).

existing licenced LEU fuel.[80] The GTRI has also successfully converted 47 HEU research reactors and one isotope production facility in 34 countries.[81] It has also verified the shutdown of 20 HEU research reactors in 11 countries.[82] Additionally, Mo-99 is now being produced without HEU in Australia and Argentina; and South Africa, Belgium and the Netherlands are following suit.[83] India supports LEU application to prevent the misuse of HEU as one of the central aims of global nuclear security community. India is also following indigenous plans of HEU to LEU conversion and has shut down the CIRUS reactor using HEU; the planned replacement reactor will not use HEU. India is also setting up a facility for the production of medical grade Mo-99 by the uranium fission route using LEU targets.[84]

Despite the global efforts to phase out civilian HEU, the process has suffered several impediments. For instance, while some sectors (phasing out HEU as fuel from research reactors and its use in production of medical isotopes) of HEU trade have been focused upon, several others dealing with greater quantities of HEU, and hence constituting "critical assemblies", have been overlooked. Moreover, the HEU to LEU conversion programmes have "achieved only partial success".[85] There has been strong resistance from the major medical isotope

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80 NNSA, "GTRI's Convert Program: Minimizing the Use of Highly Enriched Uranium", Fact Sheet, May 29, 2014, available at http://www.nnsa.energy.gov/mediaroom/factsheets/gtri-convert, accessed on December 25, 2016.

81 Ibid. Argentina, Australia, Austria, Brazil, Canada, Chile, China, Colombia, Czech Republic, Denmark, France, Germany, Greece, Hungary, Iran, Japan, Kazakhstan, Libya, Mexico, the Netherlands, Pakistan, the Philippines, Poland, Portugal, Romania, Slovenia, South Africa, Sweden, Switzerland, Taiwan, Turkey, Ukraine, Uzbekistan and Vietnam.

82 Bulgaria, Canada, Chile, China, France, Germany, India, Japan, the Netherlands, Russia and the UK.

83 Kuperman (ed.), *Nuclear Terrorism and Global Nuclear Security*, n. 3, p. 7.

84 The LEU targets will be made in India and irradiated in an indigenous research reactor. See Ministry of External Affairs, "India's National Progress Report, Nuclear Security Summit 2016", n. 12, accessed on December 23, 2016.

85 Ibid., p. 8.

producers to covert HEU-fuelled reactors into LEU. Besides, the conversion programme "has converted or shut down mainly the reactors that required the least HEU".[86] The GTRI faces several other challenges in implementing its conversion programmes. There is no formal feasible study being carried out to determine if the conversion process can be done without any adverse impact on the performance and maintainance of the civilian reactors. This has raised speculations about the conversion programmes and has severely impeded the technical progress. There is also an absence of economic studies dedicated to assess the technological impact of the conversion process. Feasibility studies are essential to generate awareness that conversion from HEU to LEU fuel can be done safely and without hindering normal scientific activities. It also builds confidence that LEU-fuelled reactor operations fulfil all safety requirements. The GTRI is a timely and necessary step to prevent potential acts of nuclear terrorism and all international support must be rendered to make it a success.

FMCT and the Challenge of Military Materials

Perhaps FMCT is the essential and potentially achievable step to effect comprehensive minimisation and subsequent elimination of fissile materials. The treaty seeks to consolidate safeguards and verification mechanisms to prohibit state parties from assisting other states with plutonium separation or with producing HEU for weapons use, and effect periodic checks to prevent misuse of fissile materials for malevolent practices. Hence, it is imperative to broaden the scope of FMCT.

The US reluctance to accept the FMCT verification provisions has meant a severe blow to the treaty negotiations.[87] The US position on the verification issue is not only at odds with many of its allies, including

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86 Ibid.

87 Reshmi Kazi, "Fissile Material Cut-off Treaty: Time for the United States to Act Responsibly", *E-International Relations*, June 1, 2015, available at http://www.e-ir.info/2015/06/01/fissile-material-cut-off-treaty-time-for-the-united-states-to-act-responsibly/, accessed on December 25, 2016.

the UK and France, but also terminates the Shannon Mandate[88] that stands for a "verifiable treaty". In addition, China and the non-aligned nations headed by Egypt believe that the verification procedures are technically feasible. This tenacious situation has created a political impasse. China has refrained from including its naval fuel within the FMCT and does not oppose the US and Russia on the issue, as it might then have to declare its excess inventory of military nuclear materials. The draft FMCT contains a major "loophole" as it prohibits HEU production only for weapons purposes and not naval propulsion. By omission, the NPT allows withdrawal of fissile material from international safeguards for use in military reactor fuel.[89] This remains a major concern within the non-proliferation regime and a drawback towards the implementation of the FMCT. Hence, unless this loophole is purged from within the FMCT, there will always remain the possibility of states diverting fissile materials from their naval reactors for weapons purposes. The US is in consultation with China, France, Russia, the UK

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[88] On January 25, 1994, Ambassador Gerald Shannon of Canada was appointed by the Conference on Disarmament to seek the views of all member states on the most appropriate arrangement to negotiate an FMCT. In March 1995, the Shannon Mandate (CD/1299) established an ad hoc committee on a "ban on the production of fissile material for nuclear weapons or other nuclear explosive devices". Though the committee was never functional, the Shannon Mandate has since been used as a basis for negotiations. The Mandate addresses the discord regarding whether the scope of the FMCT should encompass only future production or the past production of fissile materials stockpiles as well. See "Report of Ambassador Gerald E. Shannon of Canada on Consultations on the Most Appropriate Arrangement to Negotiate a Treaty Banning the Production of Fissile Material for Nuclear Weapons or other Nuclear Explosive Devices", *Conference of Disarmament*, CD/1299, March 24, 1995, available at http://cns.miis.edu/inventory/pdfs/cd1299.pdf, accessed on December 25, 2016.

[89] Article III of the NPT states: "Each non-nuclear weapon state party to the Treaty undertakes to accept safeguards, as set forth in an agreement to be negotiated and concluded with the IAEA...for the exclusive purpose of verification of the fulfillment of its obligations assumed under this Treaty with a view to preventing diversion...from peaceful uses to nuclear weapons or other explosive devices." See Chunyan Ma and Frank von Hippel, "Ending the Production of Highly Enriched Uranium for Naval Reactors", *The Nonproliferation Review*, Spring 2001, Vol 8, Issue 1, p. 87.

and several other countries to find a way out of the current impasse. India has committed to work with the international community for an early implementation of the treaty. Pakistan, however, continues to remain a major opposor to the FMCT.

Conclusion

Elimination of weapons-grade fissile material is essentially a difficult task. There are several political, military, economic and technical reasons challenging the process. Continued production of nuclear materials is acceptable to many scientists, as well as military and technical personnel, as it is a lucrative affair. Their concern lies rooted in financial gains and efficiency of their military wares. Likewise, investing in the production of HEU for civilian purposes provides strategic advantage. It is a perfect cover for diverting fissile materials for an existing or future nuclear weapons programme. In June 2012, Iran announced that "preliminary steps in making an atomic submarine have started", which have raised suspicions that Tehran will use the requirement for naval nuclear reactor fuel as an excuse for producing HEU.[90]

Despite the challenges involved, more and more states are pledging cooperation to combat the risks of HEU. The US and Japan have announced that they will remove all plutonium and HEU from the Fast Critical Assembly (FCA) in Japan Atomic Energy Research Institute (JAERI) Tokai Research Establishment.[91] Japan has agreed to downblend the HEU to LEU and utilise it for civilian purposes. Since 2009, 12 countries have eliminated all HEU from their territories.[92]

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90 Greg Thielmann and Wyatt Hoffman, "Submarine Nuclear Reactors: A Worsening Proliferation Challenge", The Arms Control Association, July 26, 2012, p. 1, available at https://www.armscontrol.org/files/TAB_Submarine_Nuclear_Reactors.pdf, accessed on December 25, 2016.

91 Pavel Podvig, "United States and Japan to Remove Plutonium and HEU from Fast Critical Assembly", International Panel on Fissile Materials Blog, March 24, 2014, available at http://fissilematerials.org/blog/2014/03/united_states_and_japan_t.html, accessed on December 25, 2016.

92 Romania, Taiwan, Libya, Turkey, Chile, Serbia, Mexico, Ukraine, Austria, Czech Republic, Vietnam and Hungary.

Russia's support for minimisation of HEU is a fundamental requirement for any progress towards HEU minimisation. The Russian decision to use LEU fuel in its prototype floating nuclear power plant and its next generation of nuclear propelled icebreaker ships was a supporting gesture towards HEU minimisation.[93] Although financial complexities grossly obstruct the conversion of Russian HEU facilities into LEU, Moscow must strive to iron out these problems and facilitate the conversion process in the interest of global nuclear security.

It is essential to frame a roadmap for continued conversion and clean-up process of HEU worldwide. All HEU-possessing states must undertake appropriate obligations to ensure highest standards of physical protection and material accountancy for both civil and military HEU stocks. Additionally, the signatories to the ICSANT must continue to uphold their commitments to prevent and respond to unauthorised use of civil and military nuclear materials. The international community must also persevere for speedy implementation of the FMCT because an effectively verifiable cut-off treaty is the best mechanism to ensure international nuclear management of fissile material by all states possessing nuclear weapons and materials.

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93 Alan J. Kuperman, "Achieving a Global HEU Phase-out", in Kuperman (ed.), *Nuclear Terrorism and Global Nuclear Security*, n. 3, p. 226.

Chapter 3

Securing the Transport of Nuclear and Radiological Materials

We cannot afford to have weak links in our chain of defence. All countries must play their part.[1]

—Yukiya Amano
Director General,
International Atomic Energy Agency
June 28, 2013

Spent nuclear fuel and other highly radioactive sources, while in transit, are highly vulnerable and difficult to protect (unless adequately defended) from terrorists seeking them. The degree of vulnerability of moving nuclear and radiological materials is much higher than those sources, which are housed, in a fixed nuclear facility. What heightens the risks is that a potential terrorist attack can occur anywhere during the movement of nuclear cargo. Thousands of shipments of nuclear and radiological sources are routinely transported, making them potential targets for attack by technically competent terrorists. In the past, the main concern was to safeguard against theft and diversion of nuclear and radiological materials. However, increasing incidents of terrorism—Twin Tower attacks (2001), car bombings in Indonesia (2002), bombings in Spain (2004), Mumbai attacks (2008), bombings in army public school in Pakistan (2014) and truck bombing in Iraq (2015)—have heightened security sensitivities.

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1 Michelle Cann, Kelsey Davenport and Sarah Williams, "The Nuclear Security Summit: Assessment of Joint Statements," Arms Control Association, March 2014, available at https://pgstest.files.wordpress.com/2014/03/report_aca_pgs_nss_march2014.pdf, accessed on December 16, 2016.

Following these apprehensions, the NSS 2014, in its communiqué, encouraged states to share best practices and cooperate in acquiring the necessary technologies to enhance the transport security of moving nuclear and radiological materials. The 2014 NSS encouraged the "establishment of effective national nuclear material inventory management and domestic tracking mechanisms, where required, that enable States to take appropriate measures to recover lost and stolen materials."[2] The Transport Security Gift Basket,[3] led by Japan, expressed their "commitment to strengthen security in the transport of nuclear and other radioactive materials to meet the intent of the Seoul Communiqué."[4] The joint statement expressed the commitment of the five participating states to persevere towards enhanced transport security of nuclear and radiological materials in passage. The 2016 NSS reported that these states were further joined by other states and produced four good practices guides for air, rail, road and sea transport modes subject to respective country requirements.[5] India has supported this international initiative by putting into practice its commitment to strengthen transport security of nuclear and radiological materials.

Improvement in the overall security in the transport of nuclear and radiological materials addresses a vital weak link in the nuclear security chain. This chapter seeks to explore the role of the state in strengthening transport security of nuclear and radiological materials. It also critically examines India's contribution in enhancing transport security as a

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2 "Seoul Communiqué", NSS, Seoul, 2012, p. 4, available at http://www.un.org/disarmament/content/spotlight/docs/Seoul_Communique.pdf, accessed on December 16, 2016.

3 France, the Republic of Korea, the UK, the US and Japan.

4 "Joint Statement on Transport Security", Partnership for Global Security, March 24, 2014, p. 1, available at https://pgstest.files.wordpress.com/2014/04/joint-statement-on-transport-security-japan-part-1_gb_2014.pdf, accessed December on 16, 2016.

5 "Joint Statement on Transport Security", NSS 2016, pp. 1–2, available at https://static1.squarespace.com/static/568be36505f8e2af8023adf7/t/56ff0792b654f934aecc8059/1459554195076/Joint+Statement+on+Transport+Security.pdf, accessed on December 16, 2016.

measure to strengthen global nuclear security. The chapter concludes with certain recommendations to improve transport security.

Why is Transport Security of Nuclear and Other Radioactive Materials Important?

Nuclear and other radioactive materials are routinely transported worldwide from one location to another for many reasons. Several radioactive materials are used extensively for medicinal purposes, agriculture, research, manufacturing, non-destructive testing and mineral exploration. Similarly, applications of nuclear materials for civilian purposes can provide extensive benefits in different areas like medicine, the operation of nuclear installations for nuclear power generation, hospitals, pharmaceuticals, research, agriculture, industry or others. To meet these critical requirements, millions of packages of nuclear and radiological materials are shipped worldwide each year by rail, air, sea and road. It is uncertain how or for what purpose these dangerous materials would be used if they fall into the hands of terrorists. Irrespective of the uncertainty, what can be said with a fair degree of confidence is that once terrorists are successful in procuring hazardous nuclear and radiological materials, they will certainly not return it back to the authorities. The transportation of hazardous materials, even under the surveillance of deployed armed guards, is an open invitation to terrorists seeking to acquire these dangerous materials. Hence, it is of paramount importance that highest standards of physical protection measures are provided to nuclear and radiological materials in transit from one location to another.

Role of the State in the Physical Protection of Nuclear Materials

The physical protection of moving nuclear and radiological materials against malicious activities is a fundamental aspect of national nuclear security. It is primarily the responsibility of the state to set up the necessary regulatory framework to ensure the security of moving radioactive materials. The objectives of the state's physical protection regime must be compatible with the IAEA guidelines: protect against unauthorised removal; locate and recover missing nuclear material;

protect against sabotage; and mitigate or minimise effects of sabotage.[6] As recommended by the IAEA, the state is accountable for the protection of nuclear material against theft and other illegal diversion. The state must also undertake responsibility for ensuring the implementation of speedy and all-inclusive actions to recover unaccounted for or stolen nuclear material. The state must put comprehensive measures in place to safeguard nuclear material and nuclear facilities against any potential sabotage. In the event of any tragic incident of nuclear material loss or sabotage, the state is required to implement substantial measures to mitigate or minimise the radiological effects of sabotage. These above-mentioned objectives can be successfully undertaken and implemented only through some established mechanism. To achieve this objective, all states must ensure prevention of any unauthorised diversion by means of deterrence and protection of confidential information. It is also essential to implement an integrated system of detection, delay and response mechanism to effectively respond to any exigency of an attempted malicious act involving nuclear and radiological materials.

A state's responsibility for the physical protection of its nuclear and radiological materials is a critical aspect of the nuclear security regime. The state covers within its ambit the protection regime for all nuclear material in use and storage, during transport, and for all nuclear facilities. It is the responsposibility of the state to ensure the protection of nuclear material and nuclear facilities against any incidents of unlawful removal and sabotage. To deal with the evolving risks to nuclear and radiological materials, it is important that the state's physical protection system is periodically reviewed and made more effective to combat any threat situation. It is also important that a state's physical protection system remains dynamic and compatible with the emerging developments made in physical protection approaches, systems and technology. The regulatory framework must remain vigilant towards the development of any new types of nuclear materials and nuclear facilities developed in other countries. Further, it must implement appropriate safeguard

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6 "Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/REVISION 5)", IAEA Nuclear Security Series No. 13, p. 3, available at http://www-pub.iaea.org/MTCD/publications/PDF/Pub1481_web.pdf, accessed on December 20, 2016.

measures to prevent, detect and mitigate risks associated with dangerous materials.

State Responsibilities during International Transport

A state has the primary responsibility for ensuring that nuclear materials are adequately protected during international transport thereof, until that responsibility is properly transferred to another state as specified under the IAEA guidelines.[7] A state's accountability for physical protection of its nuclear materials in transit must be either by the borders of its sovereign territory or the flag of registration of the transport vessel or aircraft. States must ensure that their respective physical protection measures extend to all nuclear and radiological materials while being transported through international waters or airspace, until it reaches its determined destination and is accepted by the receiving state. The rationale is to confirm and assure that the nuclear material in transit is under the authority and continous vigilance of the state and states until it is transferred to other authorised state or states.

Physical protection against the theft and sabotage of nuclear material and facilities by individuals or groups with malicious intent has long been a matter of national and international apprehension. Hence, international cooperation is an essential requirement, especially when cargoes of dangerous materials are transiting across national frontiers. The effectiveness of physical protection measures in one state also depends on other states. Hence, a state must premise its physical protection system upon a graded approach that continously assesses the existing level of risks to the nuclear materials. A graded approach provides the advantages of higher levels of protection against high-consequence incidents involving nuclear materials. The graded approach to physical protection must be further complemented by a defence in depth concept. This system constitutes an effective arrangement of several layers and methods of protection, which will have to be

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7 "Measures to Improve the Security of Nuclear Materials and other Radioactive Materials", IAEA General Conference, GC(45)/INF/14, September 14, 2001, p. 2, available at https://www.iaea.org/About/Policy/GC/GC45/Documents/gc45inf-14.pdf, accessed on December 16, 2016.

compromised by terrorists to acquire access and conduct unauthorised removal of nuclear materials. The three physical protection functions of detection, delay and response should each use defence in depth and apply a graded approach to provide adequate and effective protection.[8] The defence in depth concept is a comprehensive mechanism to reduce any vulnerabilities in the physical protection system and nuclear material accountancy and control systems. Its goal is to ensure protection against insider and external threats.

Physical protection of nuclear materials is a critical requirement in strengthening nuclear security worldwide. The fundamental aim of these measures is to ensure the highest physical protection of nuclear materials in use and storage, during transport, and for nuclear facilities using or storing such materials. The IAEA strongly recommends that the state transporting dangerous nuclear materials must verify that all states (receiving and transit) involved in international transport are parties to the CPPNM (INFCIRC/274/Rev.1).[9] Any alternative action against the IAEA internationally accepted guidelines violates the objective of ensuring maximum security of nuclear and radiological materials in transit and heightens risks of unauthorised removal or sabotage.

Threats to Nuclear and Radioactive Sources in Transit

It is noteworthy that spent fuel is highly vulnerable; and there are several tactics terrorists can use, with a higher than anticipated probability, to breach a shipping cask.[10] In recent times, the security of moving nuclear materials has been severely compromised. According to sources, in Pakistan, "instead of moving nuclear material in armored, well-defended

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8 "Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/REVISION 5)", n. 6, p. 15.

9 See "The Convention on the Physical Protection of Nuclear Material (INFCIRC/274 Rev.1)", IAEA Information Circular, May 1980, available at https://www.iaea.org/sites/default/files/infcirc274r1.pdf, accessed on December 20, 2016.

10 "Terrorism Considerations in the Transportation of Spent Nuclear Fuel and High-level Radioactive Waste", Large and Associates, available at http://www.ciaonet.org/cbr/cbr00/video/cbr_ctd/cbr_ctd_09.html, accessed on December 20, 2016.

convoys, the SPD prefers to move material by subterfuge, in civilian-style vehicles without noticeable defenses, in the regular flow of traffic."[11] Sources further point out that in Pakistan, vans with a modest security profile are sometimes the preferred conveyance.[12] The US intelligence also claims "the Pakistanis have begun using this low-security method to transfer not merely the 'de-mated' component nuclear parts but 'mated' nuclear weapons."[13] Pakistan houses the headquarters of some of the deadliest terror organisations like Lashkar-e-Taiba (LeT) on its soils. Hence, any transport of dangerous fissile materials without appropriate physical protection measures heightens the risk of a potential pathway for their unauthorized access and illicit diversion of these fissile material by terrorists in Pakistan.

Earlier in October 2011, several of kilograms of weapons-ready plutonium that terrorists could easily make into a nuclear bomb was to be carried hundreds of miles from the Sellafield nuclear complex down the west coast of Britain in an unarmed ship to France. Weapons-ready plutonium constitutes a vital material for creating a nuclear release and is particularly essential for exploding a dirty bomb. The Nuclear Decommissioning Authority, which owns Sellafield, was to transport the dangerous nuclear material in a vintage ferry, having insufficient security and safety attributes. The Sellafield claimed that its nuclear shipments were "safe and secure" even as they refused to provide any details of the shipments for "security reasons." Despite significant concerns raised in several quarters, the government and international regulators approved the transport methods. The decision was severely

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11 Jeffrey Goldberg and Marc Ambinder, "The Pentagon's Secret Plans to Secure Pakistan's Nuclear Arsenal", Nuclear Threat Initiative, November 9, 2011, available at http://www.nti.org/gsn/article/the-pentagons-secret-plans-to-secure-pakistans-nuclear-arsenal/, accessed on December 20, 2016; Jeffrey Goldberg and Marc Ambinder, "The Ally from Hell", *The Atlantic*, December 2011, available at http://www.theatlantic.com/magazine/archive/2011/12/the-ally-from-hell/308730/, accessed on December 20, 2016.

12 Ibid.

13 Ibid.

criticised for putting environment and public safety and national security at risk.[14]

The possibility that North Korea may be illicitly transporting WMDs is a matter of serious security concern. It is apprehended that North Korea routinely smuggles drugs and counterfeit currency, and proliferates WMDs, via sea freights. The US and Japan have expressed deep concerns about Democratic People's Republic of Korea (DPRK) shipping WMDs and their related components. In 2003, for instance, one North Korean defector testified to the US Congress that North Korea obtained 90 per cent of its missile components from Japan using cargo ships that sailed between Wonsan and Niigata.[15] In June 1999, missile parts and missile designs were found on board a North Korean ship with fictitious end-user certificates.[16] Foreign-owned ships are also suspected of illicitly trafficking WMD components to and from North Korea. In April 2003, a French ship, *Ville de Virgo*, was seized by the German police who had discovered that the ship was carrying 214 aluminum tubes with false end-user certificates, with the destination being North Korea.[17] The tubes were dual-use goods that could be potentially used as gas-centrifuge components to enrich uranium for purposes of weaponization. There is no hard evidence to prove that North Korea has illicitly sold WMDs to terrorist groups. However, given the "structural frailties", there is significant concern

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14 Geoffrey Lean, "'Dirty Bomb' Threat as UK Ships Plutonium to France", *The Independent*, October 23, 2011, available at http://www.independent.co.uk/news/uk/home-news/dirty-bomb-threat-as-uk-ships-plutonium-to-france-793488.html, accessed on December 20, 2016.

15 Hazel Smith, "North Korean Shipping: A Potential for WMD Proliferation?", East-West Center, No. 87, February 2009, p. 2, available at http://www.ciaonet.org/attachments/15785/uploads, accessed on December 20, 2016.

16 Andreas Persbo, "The Proliferation Security Initiative: Dead in the Water or Steaming Ahead?", British American Security Information Council, December 12, 2003, available at http://www.basicint.org/sites/default/files/PUB031203.pdf, accessed December 20, 2016.

17 Mark J. Valencia, *The Proliferation Security Initiative: Making Waves in Asia*, Adelphi Papers 376, London: IISS/Routledge, 2005, p. 36.

that owners, managers, and individual crew members within the North Korean shipping sector may be potentially involved in smuggling of WMD material.[18] The dismal working conditions, minimal wages for crew members and timeworn ships (that renders them unsafe) give rise to vulnerabilities for unauthorised diversion of WMD cargo to wrong people. In October 2003, a German-owned ship, *BBC China*, en route to Libya with a suspected cargo of centrifuge components was intercepted.[19] At the request of Washington and Berlin, the ship owner directed the ship to proceed to Taranto where Italian officials inspected the vessel and seized the cargo.[20] In 2008, a Norwegian shipping agent was fined 1 million Norwegian crowns for making a false transit declaration in violation of both Norway's customs act and export control legislation.[21] The declaration related to export of gyroscopes with missile application and in civilian navigation destined for Azerbaijan.[22]

Given the known desire of terrorists to obtain nuclear and radiological materials, their attempts to do so with drone attacks on moving dangerous materials cannot be disregarded. There is a possibility that drones can become tools for terrorists to attack convoys of nuclear and radiological materials in transit. In September 2011, the Federal Bureau of Investigation (FBI) disrupted a home-grown terrorist plot to attack the Pentagon and the Capitol with a large model aircraft

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[18] Hazel Smith, "North Korean Shipping: A Potential for WMD Proliferation?" East-West Center, No. 87 February 2009

[19] Andrew C. Winner, "The Proliferation Security Initiative: The New Face of Interdiction," The Washington Quarterly, Volume 28, No 2, p. 137.

[20] Jeffrey Lewis and Philip Maxon, "The Proliferation Security Initiative", *Disarmament Forum*, No 2, 2010, p. 37.

[21] Sibylle Bauer, "WMD-related Dual-use Trade Control Offences in the European Union: Penalties and Prosecutions", Non-Proliferation Papers No. 30, EU Non-proliferation Consortium, July 2013, p. 8, available at http://www.sipri.org/research/disarmament/eu-consortium/publications/nonproliferation-paper-30, accessed on December 16, 2016.

[22] Ibid.

packed with explosives.[23] There have been other drone incidents—like in September 2013, a small unauthorised quadcopter flew quite close to German Chancellor Angela Merkel and Defence Minister Thomas de Maiziere, before crashing at a political rally in Dresden, Germany;[24] in January 2015, a small unmanned aerial vehicle (UAV) crashed in the White House lawn in Washington, DC;[25] and post-January 2015 deadly Paris attacks, there were a series of unidentified drone flights over the presidential palace and a bay in Brittany that houses nuclear submarines in France—that have left the authorities baffled.[26] There are several other reports of unmanned drones flying in close proximity to sensitive places like airports, in restricted airspace, and over stadiums and outdoor events. Although the payload capacities of small UAVs would limit the harm a terrorist attack involving conventional explosives could wreak, sophisticated drone attacks on moving nuclear and radiological weapons could prove to be disastrous.

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23 Bart Elias, David Randall Peterman and John Frittelli, "Transportation Security: Issues for the 114th Congress", *Congressional Research Service*, March 20, 2015, p. 9, available at https://www.fas.org/sgp/crs/homesec/RL33512.pdf, accessed on December 16, 2016.

24 Sean Gallagher, "German Chancellor's Drone 'Attack' Shows the Threat of Weaponized UAVs", *Ars Technica*, September 19, 2013, available at http://arstechnica.com/information-technology/2013/09/german-chancellors-drone-attack-shows-the-threat-of-weaponized-uavs/, accessed on December 16, 2016.

25 Philip Bump, "The Threat of Drone Attacks Harming the White House or the President is very, very Small", *The Washington Post*, January 26, 2015, available at https://www.washingtonpost.com/news/the-fix/wp/2015/01/26/sleep-well-mr-president-the-threat-of-a-drone-attack-at-the-white-house-is-very-small/, accessed on December 16, 2016.

26 Cole Moreton, "Paris Attacks: A City Reeling after 72 Hours which Saw Staff of a Magazine Gunned Down, Two Police Officers Shot Dead and Two Sieges End Violently", *The Independent*, January 11, 2015, available at http://www.independent.co.uk/news/world/europe/paris-attacks-a-city-reeling-after-72-hours-which-saw-the-staff-of-a-satirical-magazine-gunned-down-9970421.html, accessed on December 16, 2016.

Transport Security in India

India's regulatory agency, the Atomic Energy Regulatory Board (*AERB*), has established robust regulatory mechanisms for the safety and security of nuclear and radiological materials from "cradle to grave".[27] Following IAEA guidelines, the AERB has published two guides: "Security of Radioactive Sources and Radiation Facilities", AERB/NRF-TS/SC-1 (Rev.1); and "Security of Radioactive Material during Transport", AERB/NRF-TS/SG-10. The guides lay out a detailed programme of developing safety codes, safety standards and related guides and manuals for the purpose. The safety codes and safety standards are formulated on the basis of nationally and internally accepted safety criteria for design, construction and operation of specific equipment, structures, systems and components of nuclear and radiological facilities. These guides, prepared by experts in the relevant field, elaborate on various requirements and the implementation procedures. The guide on safe transport of radioactive materials enumerates the specified requirements for the design, tests of special form of radioactive material, different types of packages for transport, control measures to be implemented during transport, including the limits on the levels of radioactive contamination, radiation level and temperature at the external surface of the package, and marking and labelling.[28]

India's approach towards nuclear security includes recognition of an effective interface between nuclear security and safety. Given the increasing degree of safety–security interface, it is difficult to delineate nuclear security from nuclear safety. Hence, for India, both "these

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[27] In India, the radiation sources and radioactive facilities are much more in number than nuclear facilities, because of their wide applications for industrial and medical purposes. India strictly regulates its radioactive sources from cradle to grave, which implies the entire fuel cycle.

[28] AERB, "Security of Radioactive Material During Transport (AERB/NRF-TS/SG-10)", January 2008, available at http://www.aerb.gov.in/AERBPortal/pages/English/t/publications/CODESGUIDES/sg-10.pdf, accessed on December 16, 2016.

aspects are regarded as an added responsibility and not as liability".[29] India's approach towards security of nuclear and radiological materials in transit is compatible with the international guidelines as prescribed by the IAEA. It follows a three-tier defence strategy in terms of physical protection measures for nuclear and radiological material:

1. prevent any nuclear and radiological material going out of regulatory control as the first line of defence;

2. early detection of the material that has been illicitly diverted and taken out of the regulatory control as the second line of defence; and

3. maintaining strict vigilance over nuclear and radiological material that is going out of the regulatory control into the public domain.

With reference to nuclear and radiological materials going out of the regulatory control, India applies all stipulations enumerated in the IAEA's Nuclear Security Series No. 15 for the physical protection of materials in transit. In fact, India follows certain security practices that exceed what is stipulated in the IAEA guidelines.[30] The AERB is responsible for all the regulatory activities in the domain of safety as well as the security in the nuclear and radiological sources, facilities and its transport, and has instituted a three-tier review process for the purpose.[31] The first tier comprises of the Committee for Reviewing Security Aspects of Nuclear Facility (CRSANF) and the Committee for Review of Nuclear Security Aspects of Radiation Facilities and for Transport of Radioactive Materials (CRSARF & T). These Committees are responsible for review of all the nuclear fuel fabrication facilities under

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29 In discussion with Ranajit Kumar, Head of Nuclear Control & Planning Wing, India, on the side lines of the "Indo-UK workshop on Nuclear Security Culture", GCNEP, in Mumbai, October 19–21, 2016, available at http://www.gcnep.gov.in/programs/details/2016/NSCulture%20Workshop2016%20Prospectus.pdf, accessed on December 10, 2016

30 Ibid.

31 See Anjit Kumar and Charivukalayil Samuel Varghese, "Regulatory Review of the Nuclear Security aspects of Nuclear Facilities", Paper presented in the IAEA International Conference on Nuclear Security: Commitment and Actions, December 9, 2016, p. 1, available at https://conferences.iaea.org/indico/event/101/session/25/contribution/237.pdf, accessed on December 16, 2016.

their purview. The second tier comprises of the Safety Review Committee for Operating Plants (SARCOP), the Advisory Committee for Project Safety Review (ACPSR) and the Safety Review Committee for Application of Radiation (SARCAR). The SARCOP is the only authority authorized to review the safety status and enforce regulatory norms in all operating plants of the DAE Units. The ACPSR conduct review of the safety compliance of utility at the project design, construction and commissioning stage vis-à-vis the Indian and International safety requirements and current safety standards and perform vital roles in the consenting process of Nuclear Power Plants (NPPs) at the project stage.[32] The SARCAR reviews safety aspects of radiation application in all the non-DAE units. The Committee also reviews and advises on radiation safety issues in the application of radiation sources and equipment in industry, medicine, agriculture and research as well as transportation of radioactive materials in public domain.[33] SARCAR is also the nodal agency for granting of licenses to operators handling radioactive materials after fulfillment of all requirements under the Atomic Energy (Radiation Protection) Rules, 2004. The third tier is headed by the AERB itself in support with the Advisory Committee on Security (ACS) that advises the regulatory authority on all nuclear security aspects. In addition, AERB has developed a number of guideline documents which are not publicly available.[34] However, the security mechanisms have been internally peer reviewed by various committees and are taken very seriously. The multi-tier review process provides an efficient mechanism to monitor the safety–security interface-related aspects concerning nuclear and radiological materials and NPPs.

India follows a strict licensing process to ensure the highest physical protection for the installation and safe and secure source storage of

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32 "Advisory Committees," Atomic Energy Regulatory Board, Government of India at http://www.aerb.gov.in/AERBPortal/pages/English/committees/committees_jsp.action, accessed accessed on December 16, 2016.

33 Ibid.

34 IDSA-PRIO Conference Report, 'India's Role in Global Nuclear Governance', February 24–26, 2016, p. 23, available at https://www.scribd.com/document/308124448/India-s-Role-in-Global-Nuclear-Governance, accessed on December 16, 2016.

radioactive material. The rigorous process calls for a lot of information to be provided by the operators of radiological facilities, which includes submission of detailed emergency and security plans of the concerned facilities. The process also involves stringent security reviews. Besides this, the approval of a trained and certified radiological safety officer is mandatory. According to Mr. Gautam Narula, "RSO must maitain a check list which adhere to AERB guidelines and ensure safe operation and information to concerned person if over exposure happens; radiation monitoring instruments must be calibrated and operational."[35] A commitment has to be made by the operators to the supplier to return spent fuel sources to the latter. If the private sector wants to import certain radiological sources, approval of package and shipment of source transported within the country or coming from abroad has to be taken from the AERB. The AERB has deployed the new mechanism of Web-based licensing system called electronic Licensing of Radiation Application (e-LORA), which certifies approvals for transport of radioactive materials after they have passed the stipulated safety and security requirements. The regulatory body follows a strict process in this matter and has shut down several medical diagnostic X-ray facilities that have failed to comply with the AERB guidelines in India.[36]

In order to improve capacity building among human personnel entrusted with the responsibility of safety and security aspects of transport of radioactive material, several awareness programmes have been organised. The GCNEP, in collaboration with the IAEA, held a regional training course on "Security in Transport of Radioactive Material" in 2014, in Mumbai.[37] The purpose of the course was to provide the participants the necessary knowledge to develop and implement national transport security requirements for radioactive

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35 Interview conducted with Mr. Gautam Narula, Radiological Safety Officer, Nuvia Radiation Monitoring Instrument Calibration Facility, New Delhi, June 1, 2016

36 "AERB Shuts down Operation of Some of the Medical Diagnostic X-ray Facilities at Nashik, Maharashtra Owning to Medical Non-compliances", Press Release, AERB, September 23, 2016, available at https://elora.aerb.gov.in/ELORA/PDFs/pdf_xtra.pdf, accessed on December 16, 2016.

37 GCNEP, "IAEA Regional Training Course on 'Security in the Transport of Radioactive Material'", organised in Mumbai, March 3–7, 2014, available at http://www.gcnep.gov.in/programs/details/2014/STRMMarch2014.pdf, accessed on December 16, 2016.

material. However, there is a need to conduct more such programmes in India to increase awareness for the security of radioactive material in transit.

The transit of nuclear materials is probably the operation that is most vulnerable to any malicious act of illicit diversion or sabotage.[38] India accords physical protection to radioactive materials in transit on the basis of its design basis threat. These conditions must include "in depth" emergency measures in place to counter effectively the design basis threat. India periodically reinvigorates these measures with supplementary actions, for example, reducing the total time during which the nuclear materials remain in transit. In India, transportation operations are conducted by the Central Industrial Security Force (CISF). There are stringent measures in place during the transport of radioactive materials.[39] There are escort pilers between the jeeps that are part of the convoy carrying out transport operations. The vehicles have radio contacts with each other as well as transport control centre. This two-way communication system helps notifying the nearest emergency response centre in the area in case of any nuclear incident or accident. The transit of radioactive materials is pre-scheduled by CISF officials of commander level, and the local police is pre-informed about the transit operation. The faster the transport of nuclear materials from one authorised site to another is done, the lesser are the vulnerabilities involved. It is also important to lessen the extent of nuclear material cargo transfers, that is, transfer from one conveyance to another and transfer to and from temporary storage while awaiting the arrival of a vehicle. This can be an important measure to prevent leakage of any information about the scheduled movement of nuclear materials.

The state or states involved in transit of nuclear and radiological materials must warrant transport security by avoiding the use of routine transit time schedules. Particular attention is to be accorded to the choice of routes in terms of security passage and avoid areas of natural disasters or civil disorders. It is also important to coordinate with the

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38 IAEA, "The Physical Protection of Nuclear Facilities", INFCIRC/225/Rev.4, p. 23, para 8.1.1, available at https://www.iaea.org/sites/default/files/infcirc225r4c.pdf, accessed on December 16, 2016.

39 Interviews conducted with senior CISF officials in New Delhi, October 2014 and in Mumbai, October 19-21, 2016.

response forces to deal with any situation when nuclear materials are in transport. The routes, including any halts during the transport operations or any changes in routing, must be pre-approved only by competent authorities. There is strict confidentiality regarding information for transport operations of Category I and Category II radioactive materials, which is restricted to the minimum number of persons required. All critical information related to the schedule, route, mode of transport, transmission of messages concerning shipments of materials and the personnel involved in transport operations must be adequately safeguarded and prevented from being compromised at any stage.

In addition, instructions in writing regarding practical emergency measures for transport incidents involving radioactive cargo and protective devices are to be carried by the driver and his assistant in the vehicle. A transport emergency card (tremcard) containing emergency contact numbers in case of any incident during transit is to be kept in the vehicle. Provisions exist for speedy recovery in any potential situation where radioactive materials get illicitly diverted or sabotaged. An example of this was seen in October 2016, when the response teams from AERB, CISF, National Disaster Response Force (NDRF) and Delhi Fire Services swung into action to take control of the situation involving a false alarm about a radioactive leak from a medical consignment at the Indira Gandhi International Airport.[40]

Conclusion

Transport security of moving nuclear and radiological materials is an integral aspect of nuclear security. As transport takes within public domain and involves intermodal handovers, it is potentially the most vulnerable phase of national and international exchanges. The vulnerabilities involved in dispersal of nuclear cargo are intense and hence, transport security demands maximum attention for implementing, sustaining and further augmenting a robust nuclear

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[40] Ankur Sharma, "False Radiation Alarm Triggers Panic at Delhi's IGI Airport", *India Today*, October 10, 2016, available at http://indiatoday.intoday.in/story/false-radiation-alarm-triggers-panic-at-delhis-igi-airport/1/783978.html, accessed on December 16, 2016.

security regime. This objective can be achieved through facilitating a uniform and consistent approach towards enhancing security of nuclear and radiological materials in transit. An effective transport security system involving nuclear and radiological materials can be achieved by the following:

- Use advanced technology to thwart threats against moving nuclear and radiological materials in transport.
- Involve integrated tracking systems like "geo-fencing" to monitor cargoes of dangerous materials.
- Safeguard routine transport operations against jamming or hacking that can result in damaging the command and control system manning moving cargoes of dangerous materials.
- Strengthen state regulations regarding shipments of materials.
- Encourage shipping states and operators to provide timely information and responses in advance of shipments in order to address concerns regarding nuclear safety and security, including emergency preparedness.
- Reduce, to the extent possible, the frequency of transport and time span involved in transport operations.
- Maintain efficient and stringent measures regarding the reliability of people involved in transport operations.
- Maintain strict confidentialilty of all critical data related to shipments for dispersal.

The 60th IAEA General Conference urged the Secretariat to continue to strengthen its efforts to maintain and improve transport security.[41] A secure transportation system is critical to safeguard vital national security interests from terrorism. Nuclear and radioactive materials,

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41 "Measures to Strengthen International Cooperation in Nuclear, Radiation, Transport and Waste Safety", 60th IAEA General Conference, GC(60)/INF/11, September 21, 2016, available at https://www.iaea.org/About/Policy/GC/GC60/GC60InfDocuments/English/gc60inf-11_en.pdf, accessed on December 16, 2016.

while in transport are an attractive tool for terrorist groups or individuals motivated to disseminate terror among public and disrupt the economic and political interests. Thus, securing the transportation system is a critical consideration in overall security planning. Intelligent transportation systems are absolute necessity to prevent dangerous fissile materials or its related components from being diverted by terrorists. To prevent such incidents, the nuclear security regime must devote sufficient attention to transportation infrastructure to combat any types of security threats to nuclear and radiological materials in transit.

Chapter 4

International Legal Instruments of Nuclear Security

Strengthening the Process

Political commitments alone canot ensure the safety and security of nuclear material. Treaty instruments such as the International Convention for the Suppression of Acts of Nuclear Terrorism (ICSANT) and the Convention on the Physical Protection of Nuclear Material (CPPNM) and its Amendment provide a firm basis for translating broader political commitmnts into legally binding measures.[1]

Foreign Secretary, S. Jaishankar,
Implementation and Assessment Group Meeting Global Initiative to Combat Nuclear Terrorism (GICNT), New Delhi
February 8, 2017

The nuclear age poses different degrees of threats, of which nuclear terrorism poses catastrophic risks to global peace and security. These threats can only be tackled through universal responsibility and leadership of the international community. Equally important is developing a framework of an action plan that will reduce the existing risks to nuclear security regime. It is essential that states must persevere with their high-level commitments made in the NSS process and other international forums in order to improve governance on national, bilateral, regional and multilateral levels and strengthen the nuclear security architecture.

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1 Welcome address by Foreign Secretary at Implementation and Assessment Group Meeting Global Initiative to Combat Nuclear Terrorism (GICNT), New Delhi, Ministry of External Affairs, Government of India, February 8 2017, available at http://www.mea.gov.in/Speeches-Statements.htm?dtl/28012/Welcome+address+by+Foreign+Secretary+at+ Implementation+and+Assessment+Group+Meeting+Global+Initiative+to+ Combat+Nuclear+Terrorism+GICNT+New+Delhi, accessed on February 13, 2017.

The primary rationale for nuclear security is to moderate the dangers of nuclear proliferation and strengthen nuclear confidence worldwide. Hence, an institutionalised nuclear security structure in which the world community reposes its commitment is important. All states are required to adhere to the principal norms to exhibit confidence in such an institutionalised framework for strengthening nuclear security. A strengthened nuclear security regime eliminates all weak links and helps secure nuclear and radiological weapons and materials. It also contributes enormously towards removing any room for complacency. In fact, "the enemy of nuclear security is not only complacency; it's also paralyzing pessimism."[2] Since any occurrence of nuclear terrorism remains unprecedented, several experts question its likelihood and criticise it as a mere hypothetical threat. However, an impartial perspective is essential for understanding and combatting the threat. The chapter examines the state of global nuclear security system and the existing legal instruments to effectively combat the threat of nuclear terrorism and strengthen the nuclear security system. It also assesses the challenges to the legal instruments of nuclear security and what can possibly be done to overcome them.

The State of Existing Measures for Ensuring Global Nuclear Security

During the Cold War, nuclear security apprehensions primarily gyrated around concepts of "nuclear deterrence" and "nuclear proliferation" that dominated the military strategies of the superpowers. However, the discourse on nuclear security concerns has changed. With the end of the Cold War and disintegration of the former Soviet Union, a marked shift emerged in the nuclear security discourse from war-fighting strategies to proliferation concerns. The breakdown of the Stalinist regime heralded a nuclear calculus that was no longer confined between the bipolar power structure. The dissolution of the Union of Soviet Socialist Republics (USSR) initiated concerns of widespread proliferation of nuclear weapons and heightened the "danger of seizure,

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2 George P. Shultz, *Sidney* D. *Drell*, *Henry* A. *Kissinger* and Sam Nunn, *Nuclear Security: The Problems and the Road ahead*, Standford, CA: Hoover Institution Press, 2014, p. 23.

theft, sale or use of nuclear weapons or components".[3] To combat against these potential threats, several arms control measures like the Bush and Gorbachev proposals (1991), Nunn–Lugar Cooperative Threat Reduction (CTR) programme (1991), Clinton–Yeltsin targeting agreement (1994) and the GTRI (2004) were implemented. The CTR programme performed a significant role for over two decades, providing the necessary funding and expertise in collaboration with partner governments to secure and eliminate nuclear, chemical and biological weapon arsenals following the collapse of the Soviet Union.[4] These nuclear security measures started substantial steps for ensuring that nuclear and radiological materials do not fall into wrong hands. Recently, Austria, the Czech Republic, Hungary, Mexico, Sweden, Ukraine and Vietnam too have removed all or most of their weapons-usable nuclear material stocks and created a propitious atmosphere for nuclear security.[5] However, increasing globalisation, dissemination of nuclear technology and the rapid expansion of nuclear energy continue to intensify the threat of nuclear terrorism

Nuclear security is afflicted with geopolitical challenges in which nuclear weapons play a critical role. Strategic insecurities in bilateral relations compel states to depend upon nuclear weapons capability as a security enhancer and guarantee. The increasing salience of nuclear weapons intensifies risks of both horizontal and vertical proliferation, which

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3 There was increasing apprehension that "any weakening of control over weapons and components could spill outside the territory of the former Soviet Union, fueling nuclear proliferation worldwide." See Mary Beth D. Nikitin and Amy F. Woolf, "The Evolution of Cooperative Threat Reduction: Issues for Congress", *Congressional Research Service*, June 13, 2014, p. 3, available at http://www.fas.org/sgp/crs/nuke/R43143.pdf, accessed on December 21, 2016.

4 The CTC programme was established in 1991 and has since made remarkable progress in getting rid of weapons and other materials in the states of Ukraine, Kazakhstan and Belarus. See Reshmi Kazi, "Extend the Nunn–Lugar Cooperative Threat Reduction Program", *E-International Relations*, January 23, 2013, available at http://www.e-ir.info/2013/01/23/extend-the-nunn-lugar-cooperative-threat-reduction-program/, accessed on December 21, 2016.

5 "Global Community makes Progress, as Seven Countries Remove Weapons-usable Materials", NTI Nuclear Materials Security Index, available at http://ntiindex.org/progress-challenges/eliminating-nuclear-materials/, accessed on December 21, 2016.

bears serious consequences for nuclear security. The strategic differences in the US and Russian bilateral relations have led Moscow to withdraw from the CTR programme. The accord that secured loose nuclear weapons and materials for over two decades now faces a bleak future.

To diminish the ongoing threat of nuclear terrorism, the NSS series have emphasised the "need for a strengthened and comprehensive international nuclear security architecture, consisting of legal instruments, international organisations and initiatives, internationally accepted guidance and good practices."[6] The summit process underscores the necessity for the international community to comform copiously with all the fundamental provisions for an effective nuclear security system.

Instruments for Strengthening Nuclear Security

By the simple logic of reciprocity, if states possess nuclear weapons, they must ensure the highest standards of physical protection of their strategic assets against any unauthorised access/use, accidents or diversion. Since 1963, the international community has expounded on 14 universal legal instruments and four amendments to thwart terrorist activities.[7] Of these, the following are critical instruments for reducing nuclear risks and strengthening nuclear security: CPPNM of 1980; Amendment to the CPPNM of 2005; and ICSANT of 2005.

These legal instruments exhort both NWS and non-nuclear weapon states to collaborate for the prevention, repression and elimination of terrorism in all forms. They comprise crucial mechanisms for criminalising offences related to the misappropriation of nuclear and radiological materials, thereby strengthening the nuclear security regime. The present status of the nuclear security regime demonstrates that it is

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6 "The Hague Nuclear Security Summit Communiqué", Nuclear Security Summit 2014, p. 2, available at https://www.nss2014.com/sites/default/files/documents/the_hague_nuclear_security_summit_communique_final.pdf, accessed on December 21, 2016.

7 These instruments were developed under the auspices of the United Nations (UN), its specialised agencies and the IAEA and are open to participation by all member states. See "International Legal Instruments", United Nations Actions to Counter Terrorism, available at http://www.un.org/en/terrorism/instruments.shtml, accessed on December 21, 2016.

not as matured as the nuclear safety architecture. The international legal framework meant for strengthening nuclear security is actually limited by factors of non-adherence by several states of concern. Unlike the nuclear safety regime implemented under the aegis of the IAEA, compliance to the nuclear security regime is not demonstrably as robust. Issues of confidentiality, power politics and economic factors have severely impeded universal acceptance of the existing nuclear security framework. It is also important to acknowledge that in the new nuclear environment, there is an increasing interface between safety and security regimes. Given the emerging complexities, safety and security can no longer be treated as separate entities. Hence, it is important to address emerging nuclear risks within a nuclear safety–security framework.

Nuclear security has several dimensions, but its most distinctive aspect is ensuring security of nuclear materials and facilities against potential threats. The mandate of nuclear security also extends to ensuring security of technologies through stringent export controls. Nuclear security further ensures the development of technologies that are proliferation resistant as well as divising alternatives to the use of high radioactive sources. And for implementation, one needs national and global framework for governance. Hence, the role of international legal framework in developing a robust and sustainable nuclear security regime must not be ignored.

Convention on the Physical Protection of Nuclear Material (CPPNM) of 1980

The CPPNM, which was opened for signature in 1980 and subsequently entered into force in 1987, obliges all signatories to adhere to the highest standards of physical protection measures with regard to nuclear material used for peaceful purposes while in international nuclear transport.[8] All state parties are expected to ensure that all moving nuclear

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8 "International nuclear transport" means the carriage of a consignment of nuclear material by any means of transportation intended to go beyond the territory of the state where the shipment originates, beginning with the departure from a facility of the shipper in that state and ending with the arrival at a facility of the receiver within the state of the ultimate destination. See "Convention on Physical Protection of Nuclear Material (with annexes)", United Nations Treaty Series, Vol. 1456, No. 24631, p. 126, available at https://treaties.un.org/doc/db/Terrorism/Conv6-english.pdf, accessed on December 19, 2016.

material during international transit, whether across their territory or aboard aircraft or ship, is prevented from going out of their regulatory control. Expectedly, all states parties possessing nuclear materials must ensure the physical protection of their strategic assets against any unauthorised access/use, accident or diversion. A meaningful way of providing such guarantee is to implement the provisions of physical protection laid out in Annex I of the CPPNM, subject to the national legal framework of the respective state/states. The Convention further obliges states to make the commission that any malevolent act involving nuclear material with malicious intent like theft, embezzlement or intimidation is punishable under their respective national law. The CPPNM encourages cooperation among the state parties through the mechanisms of information exchange, with the aim to protect nuclear material during transit. It thus provides a technical and pragmatic mechanism for international cooperation towards protection, recovery and retrieval of missing or diverted nuclear material.

A constructive aspect of the CPPNM is that it is the only existing multilateral initiative concerning physical protection measures which is a legally binding international instrument.[9] Its principal objective is to enable the safe transit of nuclear materials. The Convention focuses on international legal commitments associated with the physical protection of nuclear material and nuclear facilities and seeks to guide the conduct of IAEA International Physical Protection Advisory Service (IPPAS) missions. The CPPNM underscores the importance of an effective personnel reliability programme for generating human forces "whose trustworthiness has been determined" before entrusting them with sensitive posts linked with the physical protection of nuclear materials.[10]

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[9] The *CPPNM* was signed at Vienna and at New York on March 3, 1980 and entered into force on February 8, 1987. "Convention on Physical Protection of Nuclear Material (CPPNM) and Amendment thereto", IAEA Nuclear Safety & Security, available at http://www-ns.iaea.org/conventions/physical-protection.asp?s=6&l=42, accessed on December 21, 2016.

[10] See Annexure I, "Amendment to the Convention on Physical Protection of Nuclear Material", IAEA INFCIRC/274/Rev.1/Mod.1, May 9, 2016, Annex 1, p. 16, available at https://www.iaea.org/sites/default/files/infcirc274r1m1.pdf, accessed on December 16, 2016.

However, the Convention lacks universality pending adherence by Egypt, Malaysia, Thailand and North Korea.[11]

International Convention for the Suppression of Acts of Nuclear Terrorism (ICSANT) of 2005

The ICSANT was conceived out of growing concerns of threat of illicit divergence of nuclear and radiological materials by terrorists. Also known as the Nuclear Terrorism Convention (NTC), it was formulated out of the increasing necessity for international cooperation and prevention of the misuse of nuclear and radiological materials. The Convention is embedded in the Declaration on Measures to Eliminate International Terrorism, annexed to UNGAR 49/60 of December 9, 1994.[12] Following the September 2001 attacks, the international community expressed grave concern over all manifestations of terrorism. They recognised the urgent need to review the scope of the existing legal provisions for countering terrorism worldwide. It was found that there is a serious lacuna in terms of international cooperation among states for adopting effective measures to combat terrorism in all its manifestations. This led to the formulation of the ICSANT as the first anti-terrorism convention adopted after the September 2001 Twin Tower attacks. The ICSANT is related to offences regarding unlawful and intentional possession and use of radioactive material or a radioactive device, and use or damage of nuclear facilities. It is designed to promote cooperation among countries through the sharing of information and required assistance for facilitating investigations and extraditions.

The ICSANT entered into force in July 2007 and requires all "States Parties to make every effort to adopt appropriate measures to ensure the protection of radioactive material, taking into account relevant

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11 The states of Malaysia and Thailand were important connecting points through which A.Q. Khan was able to operate his illicit nuclear black market network.

12 "Measures to Eliminate International Terrorism", UNGA, A/RES/49/60, February 17, 1995, available at http://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/49/60, accessed on December 21, 2016.

recommendations and functions of the Agency."[13] The ICSANT, as mentioned earlier, is a response to increasing proliferation concerns and the lack of appropriate multilateral legal provisions to combat them. The Convention aims to plug this loophole in the international legal framework through its stipulations. It upholds the principle of prosecution or extradition of offenders who make or possess radioactive materials or devices with the intention of causing substantial damage to life, property or environment.[14] The ICSANT emphasises the need to develop international collaboration between states in developing and adopting efficient physical protection measures for deterring any misappropriation of nuclear and radiological materials. Presently, the ICSANT lacks support from important states like Israel, Jordan, Malaysia, Cambodia, the Philippines, Singapore, Myanmar, Thailand, Syria, Egypt and North Korea. Lack of universal adherence to the ICSANT impedes efforts towards combating nuclear terrorism and strengthening the global nuclear security system.

Amendment to the CPPNM (2005)

In 1999, several states expressed that the scope of the CPPNM is too narrow and that a revision is desirable. The IAEA constituted a Senior Expert Group to review the efficacy of the Convention. In 2001, the working group recommended that "consideration should be given to the possible revision of the CPPNM to address the issues of prevention of unauthorized possession of nuclear material and access to nuclear facilities."[15] Thereafter followed the tragic 9/11 attacks in which the domestic passenger flight, *American Airlines Flight 11* was used as a

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13 See UN, "International Convention for the Suppression of Acts of Nuclear Terrorism", 2005, p. 6, Article 8, available at https://treaties.un.org/doc/db/Terrorism/english-18-15.pdf, accessed on December 21, 2016.

14 The Convention calls for the prosecution of and punishment against the accomplices who organise or direct others to commit such offences as detailed within it.

15 "Measures against Illicit Trafficking in Nuclear Materials and Other Radioactive Sources", IAEA General Conference, GC(43)/13, August 30, 1999, para 7, available at http://www.iaea.org/About/Policy/GC/GC43/Documents/gc43-13.html, accessed on December 21, 2016.

weapon of mass destruction. The incident demonstrated new manifestations of terrorism and raised serious concerns of terrorists' inclination to use WMDs to spread terror. In July 2005, a diplomatic conference was organised and the CPPNM Convention was amended.

The CPPNM Amendment 20005 highlights the fundamental significance of physical protection of nuclear materials for the benefit of safety, public health, environmental welfare, national interests and international security. The Convention makes it legally binding for states parties to protect nuclear facilities and materials in domestic use, storage and transport against sabotage. Under the Convention provisions, the state parties must commit to undertake responsibility for the establishment, implementation and maintenance of an effective physical protection regime under their jurisdiction. This is in contrast to the CPPNM that stipulates obligations of physical protection to nuclear material only during international transport. The legal framework has been made robust with the inclusion of provision for mandatory peer reviews on the physical protection system of the member states. The Amendment lays out specifics for expanded scope of international cooperation among states through mechanism of information exchange about incidents of theft, robbery or other unlawful taking of nuclear material. This serves as an important confidence-building measure among all state parties about the effectiveness of the existing physical protection measures in other states. The Convention provides procedures for international cooperation for detection and recovery of diverted or lost nuclear materials, mitigate radiological consequences of sabotage, and provides layered defence methods of protection. The Convention criminalises offences relating to the misuse of nuclear material and facilities under the national law of each state party. The Seoul Communiqué called for the 2005 Amendment to be brought into force by 2014.[16]

After a prolonged delay, the 2005 CPPNM finally entered into force in May 2016 with two-thirds of the state parties to the Convention ratifying

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16 "Seoul Communiqué: 2012 Nuclear Security Summit", NSS, Seoul, 2012, available at http://www.nss2014.com/sites/default/files/documents/seoul_communique_final.pdf, accessed on December 21, 2016.

its 2005 Amendment. It focuses on the importance of sharing best practices, which is essential for developing a stringent global physical protection system. The Convention encourages consultation, cooperation, coordination and assistance among state parties through established diplomatic channels, including the IAEA and other appropriate forums. The Convention emphasises that organised and systematic efforts would facilitate the prevention of illicitly acquiring nuclear and radiological materials. The method of sharing best practices among the state parties helps in promoting supervision of the design basis threat, maintenance and improvement of systems of physical protection of nuclear material in international transit. A rigid physical protection system goes far in developing a robust nuclear security culture that is critical for averting acts of nuclear and radiological terrorism. A culmination of all these efforts helps in fulfilling the higher objectives of reducing nuclear threats and strengthening global nuclear security. However, Amendment 2005 suffers from several shortcomings that have resulted in lack of universal adherence. It still remains to be ratified by its proposer, Russia. Other states like North Korea, South Korea, Japan, South Africa, Singapore, Thailand, the Philippines and Egypt are yet to join and ratify the Convention. This remains a crucial fissure in the global nuclear security system.

The CPPNM, Amendment (2005) and the ICSANT constitute important milestones to improve the physical protection of nuclear material and facilities and mitigate threats to nuclear security. These international instruments for nuclear security enforce a web of preventive measures to counter threats of nuclear and radiological terrorism. These legal instruments stress on the individual responsibilities of states to adequately focus on nuclear security as an international obligation. These conventions play a foremost role in reinforcing other anti-nuclear terrorism mechanisms such as the Proliferation Security Initiative and the Global Initiative to Combat Nuclear Terrorism (GICNT) for strengthening nuclear security. Given the importance of these legal instruments in strengthening global nuclear security, the IAEA has appealed for universal adherence to each of these conventions.

Challenges to the Legal Instruments

The international legal framework includes both binding as well as non-binding principles, supplemented by additional institutional measures, to reduce threats of nuclear terrorism and strengthen nuclear security. However, the legal framework, as it exists, is severely limited by several inconsistencies and duplications in its application to combat the threat of nuclear terrorism. A major shortcoming is that much of the provisions of the existing legal framework were adopted during the Cold War era. The ICSANT is an exception as it was formulated in the backdrop of the new emerging WMD concerns following the September 11 attacks. In spite of the dramatic Twin Tower attacks, there has not been significant assessment of newer threats emerging from the IS, the expanding nuclear energy demands or continuing proliferation concerns.[17] The current framework essentially requires substantial reinvigoration to effectively implement its commitment to combat nuclear terrorism.

The efficacy of the legal framework is further limited by the lack of universality to the existing instruments of nuclear security. Even as newer threats continue to pose threats to nuclear security, several states continue to remain non-parties to the conventions. There is a need to generate awareness to promote universal adherence by increased acceptance of the conventions among states that are yet to join. This is an absolute essential for developing a robust and sustainable nuclear security architecture.

Effective implementation of international legal framework considerably depends upon the voluntary commitment of the state parties. A significant reason for lack of universality to the legal instruments is the perception that observance to these treaties is not necessary for states that do not retain massive stockpiles of nuclear materials. These states contend that since most of them have less than 1 kg of fissile materials, it is not essential to implement effective controls on their nuclear and other radioactive stockpiles. Having limited quantities of fissile materials, mainly for peaceful purposes and not weapon making, is not motivating enough to non-adherents for expressing commitments to the legal

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17 "Pakistan's Strategic Nuclear and Missile Industries", Project Alpha at the CSSS at King's College, London, September 2016, p. 28, available at http://projectalpha.eu/wp-content/uploads/sites/21/2016/11/20160929-Pakistan-public-version.pdf, accessed on November 12, 2016.

instruments. This demonstrates a complacent attitude which substantially weakens efforts to strengthen nuclear security. States are wary of commiting to the legal instruments since they significantly influence national laws governing various aspects of nuclear security, including domestic criminal procedures, energy growth, extradition laws, etc. However, this impediment can be circumvented by suitably incentivising the naysayers to gain their support for a strengthened nuclear security structure and mitigate possibilities of incidents involving nuclear and radiological materials.[18]

The legal instruments, through procedures of information sharing, have the potential of being effective conduits for inspiring confidence and building trust about the physical protection system among the state parties. Article 14(1) of the CPPNM provides that each state party shall periodically provide information about its laws and regulations to the IAEA, which would then be communicated to all other signatories.[19] This implies that the state parties would have an obligation to provide relevant information to the IAEA regularly. If that be so, then there must be a provision for review of the security environment at frequent intervals and an assessment whether the domestic laws are suitable to combat the threat of nuclear terrorism. Presently, there is no provision for this requirement in the existing legal instruments.

The process of sharing information about nuclear materials among the state parties is subject to the element of confidentiality. Hence, the information that is shared periodically is very elementary.[20] Given the

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18 See Jonathan D. Herbach, "Strengthening the International Legal Framework for Nuclear Security: Means and Methods to Facilitate Compliance and Enhance Transparency", Paper presented at the International Conference on Nuclear Security: Enhancing Global Efforts, IAEA, Vienna, July 1–5, 2013, p. 6, available at http://conflictandsecuritylaw.org/web_documents/cn203_paper_strengthening_the_international_legal_framework_for_nuclear_security_jd_herbach.pdf, accessed on December 21, 2016.

19 "Convention on the Physical Protection of Nuclear Material", IAEA INFCIRC/274, November 1979, available at https://www.iaea.org/sites/default/files/infcirc274.pdf, accessed on December 21, 2016.

20 Herbach, "Strengthening the International Legal Framework for Nuclear Security', n. 18, p. 7.

complexities involving secrecy, there is no mechanism to verify whether the state parties are complying with the provisions of the international legal instruments. There also is an absence of mechanism to check whether the information submitted by the state parties is accurate. The legal framework is also devoid of any channels of inspection to confirm any intentional or inadvertent violation of the existing principles. Lack of basic transparency might significantly bear upon issues of compliance and confidence within the legal framework.

The Way Forward

The international legal framework of nuclear security has a central role to play in combating nuclear terrorism. Hence, the international community must take urgent steps to redress the challenges that substantially limit the binding and non-binding instruments. These instruments support the institutional obligations of the IAEA, like the physical protection measures under the INFCIRC/225 for enhancing nuclear security. The legal framework also supports IAEA-conducted missions like the International Nuclear Security Advisory Service (INSServ), which assists states to review their physical protections measures and prepares them for implementation of nuclear security plans. The international legal instruments also provide the necessary interface between the IAEA and state regulatory systems though the Integrated Regulatory Review Service (IRRS) missions. The IRRS examines a state's preparedness to combat threats of nuclear and radiological terrorism by assessing its regulatory mechanisms for securing fissile materials, their transport and waste management. The legal instruments are institutionalised and hence facilitate more transparency through information sharing. Increased transparency supports the cause for greater compliance with the legal instruments, which is integral in enhancing nuclear security. It is important that more and more states abandon the path of complacency and accept the legal instruments for building capacity, trust, confidence and robust nuclear security architecture. As a step towards increasing compliance to the international legal instruments, its scope must be broadened to include the participation of non-state actors like the nuclear industry. The IAEA encourages states that have yet to do so to nominate representatives from technical fields to the Nuclear Security Guidance Committee. The technical experts contribute to the establishment and review of internationally agreed Nuclear Security Series publications.[21] Greater participation from state and non-state institutions would increase the acceptability of the international legal framework. This can subsequently serve as a method of insistence to encourage non-adherents to comply with the provisions of the legal instruments.

Greater acceptability of the nuclear security legal framework can be achieved through implementation of regular review of the CPPNM and ICSANT meetings. Much of the provisions of the ICSANT have been derived from the CPPNM. Hence, a joint review of both the conventions' proceedings is a desirable initiative.[22] The ICSANT provisions do not mandate for a review meeting; however, its state parties must seek for periodic reviews for complete implementation of the objectives of nuclear security. Regular reviews of the conventions proceedings would facilitate effective monitoring of the commitments of the state parties and increase transparency and objective assessment by external actors. With the 2005 CPPNM Amendment entering into force, it is expected that there will be newer mechanisms for expanded cooperation among countries for detecting and recovering diverted or stolen nuclear material. This is of particular relevance for those states that are yet to develop nuclear material or nuclear facilities. The IAEA must also facilitate measures to work out a robust arrangement on information sharing and continue to promote peer-review missions to advise states on meeting their nuclear security obligations and commitments.[23]. In the post-Cold War era, the probability of a nuclear

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21 See IAEA Nuclear Security Series Publications, available at http://www-ns.iaea.org/security/nss-publications.asp?s=5&l=35, accessed on December 30, 2016.

22 Igor Khripunov and Carlton Stoiber, "Nuclear Security and Nuclear Counter-terrorism: Streamlining and Updating the Legal Framework, Workshop Executive Report", in Igor Khripunov and Dmitriy Nikonov (eds), *Legal Framework for Strengthening Nuclear Security and Combating Nuclear Terrorism*, Vienna: IOS Press, 2010, p. 7.

23 "Eight Questions and Answers on the Amendment to the Convention on the Physical Protection of Nuclear Material", IAEA, May 8, 2016, available at https://www.iaea.org/newscenter/news/update-eight-questions-and-answers-on-the-amendment-to-the-convention-on-the-physical-protection-of-nuclear-material, accessed on December 30, 2016.

war between states has significantly diminished, but the existence of mounting stockpiles makes accidental/unauthorised use of nuclear weapons a plausible risk. The CPPNM, 2005 Amendment and ICSANT are decisive instruments for alleviating the perils of nuclear terrorism. As state parties to these legal provisions, members shall have the benifit to receive support from co-members for purposes of investigation and consequent trial and punishment for any offences related to nuclear and other radioactive material. Consistent diplomatic cooperation may ensure better coordination for international reporting requirements and monitoring activities involving nuclear and radiological materials, thereby strengthening nuclear security. A robust nuclear security framework will undeviatingly consolidate national security and confer the status of a responsible nuclear nation to individual state parties. The universality of these legal provisions could substantially reinforce the non-proliferation regime. Thus, it is important that the CPPNM (2005 Amendment) and ICSANT are universally supported and accepted by the international community. Besides, to combat the global threat of nuclear terrorism, wider support of all nations, irrespective of nuclear or non-nuclear weapon states, is imperative.

CPPNM, 2005 Amendment, ICSANT and India

India recognises that mitigating nuclear security threats necessitates international cooperation. In consonance with this understanding, India has placed its nuclear and radiological materials under stringent physical protection measures of the INFCIRC/225. As part of its efforts towards strengthening nuclear security and thwarting any incidents of nuclear terrorism, India is party to all 13 anti-terrorism conventions, including the CPPNM, Amendment 2005 and ICSANT.[24] India's adherence to these legal instruments conveys to the international community, its stated conviction that every state must undertake responsibility for the physical protection of their nuclear facilities and material in peaceful domestic use, storage as well as transport. India's commitment to the established international standards of nuclear security

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[24] Ministry of External Affairs, "Nuclear Security in India", March 18, 2014, p. 6, available at http://www.mea.gov.in/Images/pdf/Brochure.pdf, accessed on November 28, 2016.

make its nuclear assets safe and under the highest physical protection legal measures. India's observance of the international norms enhances confidence of the global community about the high levels of security of its strategic assets. These steps significantly contribute towards the strengthening of the nuclear security regime.

Conclusion

The process of universalising the conventions on nuclear security must be supported by all states. The IAEA's central role in facilitating national efforts to strengthen nuclear security and in fostering effective international cooperation must also be supported. Efforts must also be undertaken to develop suitable mechanisms to promote awareness of the benefits of joining these legal instruments by non-nuclear-capable states. States must also ensure the highest physical protection for their nuclear and radiological materials so as to reduce their illicit trafficking. There is also a need to broaden the scope of the domestic law enforcement agencies to criminalise proliferation of nuclear weapons or other nuclear and radiological threats. States must also cooperate in the higher interests of preventing occurrence of nuclear and radiological terrorism and ensure proliferation-resistant peaceful uses of nuclear energy.

Nuclear security continues to face challenges that are essentially asymmetric and complex in nature. To combat against these challenges, the NSS process has highlighted the potential of these legal tools in improving the security standards of all nuclear and radiological sources. As a result, several member states have reinforced their commitment towards tackling the threat of nuclear terrorism.[25] The international legal framework is an important multilateral mechanism for ensuring highest standards of nuclear security and is critical in the process of building a strengthened non-proliferation regime.

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[25] The US, Italy and Turkey ratified the Amendment to the CPPNM in 2015. The US deposited its instrument of ratification for the ICSANT in September 2015.

Chapter 5

Nuclear Security Training and Support Centres and Centres of Excellence

Framework for Strengthening Nuclear Security Governance*

The mission of the Nuclear Security Training and Support Centres is to contribute to the global efforts to enhance nuclear security capacity building through an effective and collaborative network of nuclear security training and support centres.[1]

-NSSC Network
International Atomic Energy Agency

Post-NSS process spanning over six years (2010–16), many initiatives have been suggested to combat the threat of nuclear terrorism and enhance the prospects for strengthened global nuclear security architecture. Efforts have been doubled to develop a robust security system capable of producing sustainable nuclear excellence. The idea is to build comprehensive efforts that would plug the existing weak links constantly in the chain of nuclear security. One such suggested effort is the development of national Centres of Excellence (CoEs) and regional support centres that can make a significant contribution to promote training, advice and education in nuclear security. The concept of CoEs received an overwhelming response at the 2010 NSS. The participants expressed confidence in the value of CoEs for strengthening international and regional cooperation and collaboration to promote nuclear security education and training. Improved synergy

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* Parts of this chapter have been published in Reshmi Kazi, "Global Centre of Nuclear Excellence: India's Nuclear Security Provider", *Defence and Diplomacy Journal*, *Vol. 5, No. 2*, April–July 2016, pp. 41–60.

1 "NSSC Network", International Atomic Energy Agency, available at http://www-ns.iaea.org/security/nssc-network.asp?s=9&l=76, accessed on December 10, 2016.

between education and training can lead to enhanced national, regional and global nuclear security. At the 2014 Hague NSS, 31 states recalled the joint statement on nuclear security training and support centres (NSSCs) issued at the 2012 Seoul Summit.[2] This recorded a significant increase in support of the CoEs since the 2012 Seoul NSS.[3]

The 2016 NSS has further recognised the expanding IAEA NSSC Network and the progress achieved by it in promoting sustainable nuclear security. A distinctive aspect of the NSSCs and CoEs is that they can play a critical role in developing, sharing and promoting excellence in nuclear security education at domestic and regional levels, with the aim of strengthening and sustaining the global nuclear security architecture. India's own CoE—GCNEP—is playing an important role in addressing the threat of nuclear terrorism through capacity building and disseminating awareness on nuclear threats at both national and regional levels. This chapter seeks to explore:

1. How can the CoEs contribute towards leading the world on a path of high nuclear security system?
2. How has the GCNEP contributed in strengthening nuclear security?

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[2] The 31 countries are: Algeria, Argentina, Armenia, Australia, Belgium, Canada, Chile, France, Georgia, Germany, Hungary, Indonesia, Israel, Italy, Japan, Kazakhstan, Republic of Korea, Lithuania, Mexico, Morocco, the Netherlands, Pakistan, the Philippines, Romania, Spain, Sweden, Turkey, United Arab Emirates, the UK, the US and Vietnam. See "Joint Statement on Nuclear Security Training and Support Centres/Centres of Excellence for the 2014 Nuclear Security Summit", Submitted by Italy, Partnership for Global Security, NSS Official Consensus Documents 2010 – 2016, p. 1, available at https://pgstest.files.wordpress.com/2014/04/joint-statement-nuclear-security-support-centres_gb_2014.pdf, accessed on November 12, 2016.

[3] "Joint Statement on Nuclear Security Training and Support Centres/Centres of Excellence for the 2012 Nuclear Security Summit", Partnership for Global Security, NSS Official Consensus Documents 2010 – 2016, available at https://pgstest.files.wordpress.com/2013/06/nuclear-traning-center-gift-basket-final.pdf, accessed on November 12, 2016.

NSSCs/CoEs

The CoEs and NSSCs are efficient channels for promoting nuclear security through regional and national mechanisms. For the purpose of this study, a CoE for nuclear security is a "centralized location where a country or region can send professionals for training in various aspects of nuclear security."[4] The primary objective of a CoE is to spread awareness about the importance of strengthening nuclear security through capacity building and technology development, thereby optimising regional and international cooperation and coordination on wide-ranging aspects of nuclear security. It is because of this important role that CoEs have been strongly supported as "gift baskets" in all the summit communiqués. At present, the International NSSC Network has over 100 members from 39 states; 12 states have established such centres since the 2010 NSS.[5] The stupendous success achieved by the Asia Regional Network created under the Nuclear Security Support Centers (NSSC) International Network of the IAEA has encouraged the NSS process members, in collaboration with the IAEA, to promote the development of additional centres and expand regional and international collaboration through the NSSC Network. The NSSC Network aims to develop essential mechanisms of regional coordination to promote best practices, exchange training experiences, share curricula and other activities on a regional basis.

The CoEs are also focusing on the strong requirement to build capacity in nuclear security by developing highly trained nuclear security personnel entrusted with the responsibility to provide technical services for the maintenance, installation and operation of devices required for nuclear security. The network is also responsible for providing scientific resources to assist local, regional and national responses to combat nuclear security events. It also provides necessary support for detection, collecting evidence and nuclear forensics. The enormous potential of

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4 The US Department of State, "Nuclear Security Centers of Excellence", March 22, 2012, available at http://www.state.gov/t/isn/rls/fs/186680.htm, accessed on November 12, 2016.

5 "Joint Statement on Nuclear Security Training and Support Centres/Centres of Excellence for the 2014 Nuclear Security Summit", n. 2, p. 1.

NSSC Network has led the IAEA to develop a conceptual framework "to facilitate the development of human resources and the provision of technical and scientific support on several levels to ensure the long term sustainability and effectiveness of nuclear security in a State."[6] The three major functions of the NSSC Network—(i) developing a team of highly qualified, well-trained and dedicated nuclear security personnel; (ii) providing technical support; and (c) providing scientific support—are of critical importance and significantly contribute to the improvement of regional and international nuclear security by reducing the risks of criminal or unauthorised activities involving nuclear and radiological materials in use, storage and/or transport. The NSSCs and their related CoEs significantly contribute to nuclear security by assisting member states to self-assess and implement their obligations under the IAEA nuclear security-relevant legal instruments.

The important role of the NSSC Network for developing an effective nuclear security infrastructure has been recognised in the "Nuclear Security Plan 2014–2017". The NSSC Network constitutes a comprehensive capacity-building vehicle that can be valuable at the national, regional or international levels for guaranteeing sustainability of national nuclear security regimes, and for fostering the transfer of nuclear security knowledge and exchanging best practices.[7] The NSSC Network plays a critical role in developing a sustainable nuclear security culture, which is the central tenet of nuclear security. Nuclear security culture bears crucial importance for the effective governance of states possessing atomic capability. Hence, focusing attention on human resource development through education and training programmes is indispensible for a strong security culture. This is an essential requirement for developing and supporting the infrastructure entrusted with the responsibility of promoting high-level nuclear security standards at regional and international levels. The 60th IAEA General Conference agreed to develop, foster and maintain a robust nuclear security culture

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6 "Establishing a National Nuclear Security Support Centre", IAEA-TECDOC No. 1734, 2014, p. 2, available at http://www-pub.iaea.org/MTCD/Publications/PDF/TE-1734_web.pdf, accessed on November 13, 2016.

7 IAEA, "Nuclear Security Plan 2014–2017", GOV/2013/42-GC(57)/19, August 2, 2013, p. 2, available at https://www.iaea.org/About/Policy/GC/GC57/GC57Documents/English/gc57-19_en.pdf, accessed on November 13, 2016.

compatible with their nuclear security regimes, and organise an international workshop on the same.[8]

A primary objective of the NSSC Network and its subsidiary CoEs is to coordinate the achievements of the NSS process at regional and international levels. In achieving this objective, the NSSC Network is supported by the International Nuclear Security Education Network (INSEN) which facilitates greater coordination and information sharing among the regional CoEs. The INSEN promotes excellence through educational and academic activities for enhanced global nuclear security. The 2016 NSS recognised the role of CoEs as critical for building a strong nuclear security culture.[9]

The CoEs are gradually developing and undertaking responsibilities as they have enormous potential in carrying forward the task started in 2010 and carried throughout the summit process. With international support, the CoEs might emerge as a powerful mechanism to promote transparency, consistency and sustainability in crucial nuclear security matters. The principal role of the CoEs is to improve awareness about nuclear security and non-proliferation through education, quality training programmes and technological support. They emphasise on practical training through experimental facilities. The CoEs play a cardinal role in enhancing understanding and responsiveness to proliferation risks and consequent threats to nuclear security. The CoEs also facilitate the conduct of degree courses, in collaboration with universities that assist in development of a dedicated body of technologically trained specialists for improved functioning of the nuclear industry.[10] These

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8 "Nuclear Security", 60th IAEA General Conference, GC(60)/RES/10, September 30, 2016, p. 5, available at https://www.iaea.org/About/Policy/GC/GC60/GC60Resolutions/English/gc60res-10_en.pdf, accessed on December 14, 2016.

9 "Joint Statement on Nuclear Training and Support Centres", NSS 2016, April 5, 2016, available at http://www.nss2016.org/document-center-docs/2016/4/1/joint-statement-on-nuclear-training-and-support-centres-gb, accessed on December 14, 2016.

10 In India, the Homi Bhabha National Institute, Mumbai, offers degree courses like PhD and MSc in various aspects related to nuclear security. See Homi Bhabha National Institute, Mumbai, available at http://www.hbni.ac.in/, accessed on December 14, 2016.

centres also play a crucial role in providing regular exercises and conducting programmes to build efficient technical personnel trained to prevent potential thefts, sabotage and deal with the threat of nuclear terrorism.

The CoEs thus promote practices that ensure effective physical protection of nuclear facilities and materials. They play a crucial role in facilitating the development of appropriate accounting of nuclear materials and promote technical capacities to expedite the same. The CoEs are extremely useful for research and development (R&D) that facilitate maintainance of database of nuclear material signatures. This database helps in developing nuclear forensics technology that is essential in detection of nuclear materials and nuclear detonation. The CoEs have the potential to effect enhanced cordination with the nuclear industry and improved nuclear governance. These measures strengthen export controls and prevent illicit trade of nuclear materials. The NSSC Network of CoEs may serve as an important framework to promote nuclear security and to meet the challenge of nuclear terrrorism.

GCNEP

To achieve the objectives of a safe and secured nuclear system and combat the existing challenges to the physical security of nuclear materials and facilities, India announced the establishment of the GCNEP at the 2010 NSS. In January 2014, Prime Minister Manmohan Singh laid the foundation of the centre in the Jasaur-Kheri village of Haryana, announcing that the centre "aims to continue strengthening the security of its nuclear power plants and nuclear materials…together with the development of human resources in the field of nuclear energy."[11] The primary mission[12] of the GCNEP is to:

1. "conduct research, design and development of nuclear systems that are intrinsically safe, secure, proliferation resistant and

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[11] "Indian Research Centre takes Shape", *World Nuclear News*, January 3, 2014, available at http://www.world-nuclear-news.org/NN-Indian-research-centre-takes-shape-0301144.html, accessed on November 14, 2016.

[12] Department of Atomic Energy, Government of India, "Global Centre for Nuclear Energy Partnership (GCNEP)", available at http://www.gcnep.gov.in/about/about.html, accessed on November 14, 2016.

sustainable" with the aim of strengthening nuclear security in the future; and

2. "to organize training, seminars, lectures and workshops" on critical issues by Indian and international experts and build a group of trained human resource.

The GCNEP is visualised to be a state-of-the-art facility premised upon international participation from the IAEA and other interested foreign partners. The GCNEP-related memorandum of understanding and other cooperation arrangements have been signed with France, Russia, the US, the UK and the IAEA.[13] The centre houses five schools:

1. School of Advanced Nuclear Energy System Studies;
2. School of Nuclear Security Studies;
3. School of Nuclear Material Characterization Studies;
4. School on Radiological Safety Studies; and
5. School for Studies on Applications of Radioisotopes and Radiation Technologies.

This centre will become an important platform for India to interact with the world community in all aspects of peaceful uses concerning nuclear energy, including nuclear security, safety and non-proliferation.[14] It will support international cooperation in nuclear energy applications and facilitate the establishment of "extensive facilities" related to advanced education, research and training in the field of proliferation-resistant nuclear system designing in nuclear power plants, nuclear security, radiological safety, nuclear material characterisation and

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13 "Nuclear Security Summit 2014: National Progress Report India", NSS, 2014, p. 2, available https://www.nss2014.com/sites/default/files/documents/india.pdf, accessed on November 14, 2016.

14 R.B. Grover, "The Technological Dimension of Nuclear Security", *Strategic Analysis*, Vol. 38, No. 2, 2014, p. 155.

applications of radiation technologies and radioisotopes.[15] The centre will also focus on improved technologies for cutting-edge nuclear energy systems, advanced nuclear forensics and establishment of accreditation facilities for radiation monitoring.

India as a Security Provider

The GCNEP is a specialised R&D unit under the guidance of the Department of Atomic Energy (DAE). It is expected to be an effective forum to highlight India's progress and development in the field of nuclear safety, security and advanced nuclear and radiation technologies. It has already conducted several programmes to build capacity in technology training and human resource development for purposes of enhanced nuclear security. The GCNEP is expected to provide a platform for research to participants from India as well as foreign countries. Its agenda also includes imparting training to Indian and international participants on various aspects of nuclear and radiological terrorism; conducting international seminars and group discussions by experts; and development and conduct of courses in association with interested countries and the IAEA. The GCNEP thus upholds India's pledge to be a "responsible nation with advanced nuclear technology" by harnessing ways to explore international nuclear best practices.

The GCNEP has a dedicated Outreach Programme Cell that promotes publicity of technologies developed by DAE for training in several areas, like physical protection of nuclear material and nuclear facilities, prevention and response to radiological threats, nuclear material control and accounting practices, protective measures against insider threats, radio chemistry and application of radio isotopes, applications of radioisotopes in agriculture and radiation processing of food and public awareness programme on DAE technologies for rural India. The outreach cell holds regular courses, symposiums and workshops, and assists in capacity building by providing training to nuclear security

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15 DAE, Government of India, "Global Centre for Nuclear Energy Partnership", Rajya Sabha Unstarred Question No. 3724, p. 1, available at http://dae.nic.in/writereaddata/rsus3724.pdf, accessed on November 14, 2016.

professionals. At the Nuclear Industry Summit 2016 Expo in Washington DC, the GCNEP, along with the industry partner Electronics Corporation of India Limited (ECIL), set up a pavilion to showcase India's efforts towards global nuclear security through a display of programmes, technologies and products in the areas of nuclear security, radiological safety, advanced nuclear energy systems and safeguards.[16] Many delegates and industry representatives visited the pavilion and showed keen interest in the activities of GCNEP and ECIL. The outreach cell has been methodically conducting courses, symposiums and workshops on several aspects related to nuclear security. These courses provide training to participants from various security establishments and facilitate the building of efficient human resources through relevant training. The GCNEP is reaching out to a range of target communities using domain-specific training programmes, as well as orientation programmes for students to promote science among young people.[17]

Why is Training Important?

Training is an integral necessity for all aspects of nuclear security. Training does not involve any formal education but plays a role in sensitising all human personnel to important aspects of nuclear security, like modern technologies, physical protection, vulnerability analysis, material control and accounting and detection techniques. Training can be further

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16 "GCNEP at Nuclear Industry Summit 2016 Expo," GCNEP, March 31–April 1, 2016,,available at http://www.gcnep.gov.in/downloads/GCNEP%20at%20Nuclear%20Industry%20Summit%202016%20Expo.pdf, accessed on December 13, 2016.

17 Several children from middle school are regularly invited from specific classes spanning over almost a week. The course curriculum pertains to issues on nuclear and radiological security. The objective is to spread awareness about sensitive nuclear materials from a very early stage. The author found this information during the field trips to events organized by GCNEP in Anushaktinagar, Mumbai, in May and October 2016. Also, see Ashish Tkur, Ansul Kumar, L.R. Jangra, Ranajit Kumar and Y.S. Mayya, "GCNEP—Boosting Global Efforts on Nuclear Security", Paper presented at the IAEA International Conference on Nuclear Security: Commitment and Actions, December 9, 2016, p. 1, available at https://conferences.iaea.org/indico/event/101/session/40/contribution/349.pdf, accessed on December 13, 2016.

improved through sharing of best practices, curricula and periodic peer-review exchange mechanisms. The GCNEP has held collaborative research and detailed studies from time to time through the IAEA NSSC Network for development and running of training courses on various aspects of nuclear and radiological security, like physical protection of nuclear material and nuclear facilities, nuclear forensics, nuclear security culture, personnel reliability programme, detection and response mechanisms to radiological emergencies, transport security and insider threats. The promotion of security culture must start in the educational phase. The GCNEP, through it consistent training efforts, assists in the development of a proliferation-resistant and sustainable nuclear security system.

Physical Protection of Nuclear Material and Nuclear Facilities

The GCNEP has till date conducted almost 10 course programmes on physical protection of nuclear material and nuclear facilities. The topics that have been covered in the curriculum are: definition of physical protection system requirements, including detailed discussions on facility characterisation, target identification, threat definition and legal and regulatory requirements; and assessment of the design of the physical protection systems, including an account of intrusion detection, alarm communication and display, alarm assessment, personnel and material access control, delay and response. The course also conducts an evaluation of the physical protection system practices used in India, which covers the design and implementation of physical protection system in Indian nuclear power plants, safety and security for transport of radioactive material and insider threats. These courses introduce the participants to the importance of physical protection of nuclear material and nuclear facilities against theft and sabotage. The participants are also briefed about the working of the various security systems. They are educated on the working principal and operating procedures of the different security systems, as well as provided training on state-of-the-art digital security systems and their use in nuclear security. To generate awareness, the participants are made a part of group exercises and demonstration sessions, where they handle sophisticated equipment used for physical protection of nuclear materials and facilities. These courses are deliberated by efficient faculty members who are associated with the various departments of India's nuclear security establishment.

To assess and develop essential mechanisms to prevent and respond to radiological threats, GCNEP and the IAEA held a regional training course on "Physical Protection of Nuclear Facilities against Sabotage, Assessing Vulnerabilities and Identification of Vital Areas" for 25 participants, including 17 foreign nationals and eight Indian participants, in November 2011 in New Delhi.[18] The week-long course discussed topics related to physical protection of nuclear material and facilities, nuclear material accounting and computer security controls, measures to mitigate or minimise consequences of sabotage, etc. A regional training course on "Design and Evaluation of Physical Protection System for Nuclear Material and Nuclear Facilities" was held in November 2013, in Mumbai.[19] The course was intended for Indian and foreign participants associated with the designing and/or assessment of physical protection systems. Its purpose was to acquaint participants with the existing concepts and technologies associated with physical protection, so as to train them to initiate and operate appropriate security programmes in their respective countries subject to the requirements of 2005 CPPNM, as amended in 2005, and IAEA circular, INFCIRC/225/Rev.5. A "National Training Course on Physical Protection of Nuclear Material and Nuclear Facilities" was organised for security personnel in 2014, and included a visit to the Emergency Response

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[18] See IAEA and GCNEP, "Report on Regional Training Course on Physical Protection of Nuclear Facilities against Sabotage, Assessing Vulnerabilities and Identification of Vital Areas", organised in New Delhi, November 14–18, 2011, p. 3, available at http://www.gcnep.gov.in/programs/details/ReportRTConPPS2011.pdf, accessed on December 13, 2016. Amongst the foreign participants, five were from Indonesia; three from United Arab Emirates; two each from Thailand, Bangladesh and the US; and one each from Malaysia, the Philippines and Korea. Among Indian participants, three were from BARC; two from Nuclear Power Corporation of India Ltd (NPCIL); and one each from AERB, Bharatiya Nabhikiya Vidyut Nigam Ltd (BHAVINI), and Heavy Water Plant, Kota, Rajasthan. There were two observers from the US.

[19] GCNEP, "Design and Evaluation of Physical Protection System for Nuclear Material and Nuclear Facilities", Regional training course held in Mumbai, November 18–22, 2013, pp. 1–2, available at http://www.gcnep.gov.in/programs/details/DEPPNov2013Report.pdf, accessed on December 14, 2016.

Centre (ERC).[20] The goal was to provide first-hand knowledge of various radiation detection equipments and emergency response activities to the security personnel. India continues to partake in the IAEA's coordinated research programmes (CRPs). Currently, Indian institutions are engaged in 65 CRPs.[21] India hosted a six-day IAEA inter-regional training course related to production of Mo-99, and proposed to host more events in November 2015.[22] India has participated in several training activities, "including participation in the IAEA effort to take nuclear security training to different member states and to make it really global."[23] The training strategy provides the regional trainees modern and internationally accepted concepts and technology in the area of security of nuclear and radiological material and nuclear installations.

Nuclear Forensics

India is cognisant of the menace of nuclear smuggling activities and overt evidence of nuclear materials found outside the controls of lawful authority, as recorded by the ITDB fact sheet. The GCNEP has emphasised that nuclear forensics is an important scientific application not only to identify and characterise illicitly trafficked nuclear materials but also to investigate into their intended use. It can be also used to

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[20] GCNEP, "National Training Course on Physical Protection of Nuclear Material and Nuclear Facilities", organised in Mumbai, March 24–28, 2014, pp. 1–2, available at http://www.gcnep.gov.in/programs/details/2014/NTCPPNMMarch2014.pdf, accessed on December 14, 2016.

[21] "Statement by Dr. Ratan Kumar Sinha, Chairman of the Atomic Energy Commission", 59th General Conference, Vienna, September 16, 2015, p. 6, available at http://dae.nic.in/writereaddata/gc2015.pdf, accessed on December10, 2016.

[22] Ibid. See "Awareness program on "Applications of Radioisotopes & Radiation Technology in Healthcare, Environment and Industries", School for Studies on Applications of Radioisotopes and Radiation Technologies (SARRT), GCNEP, November 19-20, 2015, SRM University, Sonepat, Haryana.

[23] National Academy of Sciences, *India–United States Cooperation on Global Security: Summary of a Workshop on Technical Aspects of Civilian Nuclear Materials Security*, Washington, DC: The National Academies Press, 2013, p. 90.

investigate into potential nuclear black market routes involved in illicit trafficking of dangerous nuclear and radiological materials. In this regard, even though the GCNEP remains a site under construction, it has started conducting several "off-campus" courses in New Delhi, Mumbai, Hyderabad and Haryana.

The author attended a workshop on "Nuclear Forensics: Fundamentals and Applications" (NuFFA-16), organised by the School of Nuclear Material Characterization and School of Radiological Safety Studies, from May 4 to May 7, 2016, in Mumbai. The course consisted of 16 lectures and a demonstration session was also held on various gadgets for radiation detection systems. The objective of the workshop was to generate awareness about the effects of radiation hazards and the necessity for effective detection mechanisms to prevent, detect and respond to any nuclear and radiological incident. While attending the four-day course, the author found that NuFFA-16 provided an excellent opportunity to generate awareness among the participants about the fundamentals of nuclear forensic sciences and its uses in combatting nuclear and radiological security threats. The course highlighted the advantages of nuclear forensics to categorise, characterise and interpret illicitly trafficked materials, and then reconstruct the entire nuclear and radiological trafficking scenario. The workshop also critically examined the various challenges associated with such investigations. It discussed the various techniques[24] that have been used in India and abroad for accurate identification of sensitive materials. The workshop emphasised upon the necessity of international cooperation as an indispensible part of the investigation procedures linked to nuclear forensics. Several foreign faculty members presented their views to generate awareness

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[24] The author attended lectures on investigation techniques involving destructive and non-destructive assay methodologies, along with traditional forensic analysis, as discussed in the course material for the workshop on "Nuclear Forensics: Fundamentals an Applications" (NuFFA-16) organised by the School of Nuclear Material Characterization and School of Radiological Safety Studies, GCNEP, and DAE, India, May 4–7, 2016, in Anushaktinagar, Mumbai.

among the participants about the advantages of developing a sophisticated application of nuclear forensic sciences.[25]

Scientific techniques help investigators to get facts from the accused, which could be the best source of information about the crime. However, nuclear forensics application requires much more sophistication as a response mechanism in India.[26] The GCNEP must undertake appropriate measures to enhance the effectiveness of nuclear forensics to respond to incidents of illicit nuclear trade and transportation risks. The Directorate of Forensic Science Laboratories (DFSL) in Bangalore had drawn up a comprehensive perspective plan, with the aim to take forensic sciences to a global level with the establishment of a centre for nuclear forensic science.[27] The plan is expected to take off by 2018–19, but the proposal is still pending with the state government.[28] The GCNEP may consider coordinating and expediting the DFSL plan to implement a dedicated nuclear forensic science centre in India.

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25 The author attended lectures by Vitaly Fedchenko from Stockholm International Peace Research Institute (SIPRI) on "International Cooperation and Nuclear Forensics Support at the IAEA," and Maegon Barlow from *National Nuclear Security Administration* (NNSA), U.S. Department of Energy, on "Mobile Source Tracking", "Nuclear Forensics: Fundamentals an Applications" (NuFFA-16) organised by the School of Nuclear Material Characterization and School of Radiological Safety Studies, GCNEP, and DAE, India, May 4–7, 2016, in Anushaktinagar, Mumbai.

26 In discussion with an official from India's nuclear security establishment in Mumbai, May 5, 2016.

27 Dr. Gopal Ji Misra & Dr. C. Damodaran, "Perspective Plan on Nuclear Forensics", Ministry of Home Affairs, Government of India, July 2010, available at http://mha.nic.in/sites/upload_files/mha/files/pdf/IFS(2010)-FinalRpt.pdf, accessed on December 15, 2016.

28 "Dirty Bomb: Forensic Lab to take Lead in Fighting Nuclear Terrorism", *DNA Analysis*, March 6, 2011, available at http://www.dnaindia.com/bangalore/report-dirty-bomb-forensic-lab-to-take-lead-in-fighting-nuclear-terrorism-1516166, accessed on December 14, 2016.

Insider Threat

The GCNEP, under the aegis of the IAEA, has addressed the issue of insider threat that presents a unique problem for physical protection systems. Potential elements having authorised access rights to nuclear facilities and materials can bypass dedicated physical protection elements or other provisions for malicious activities. An "International Training Course on Preventive and Protective Measures against Insider Threats" was held in December 2015, in Mumbai.[29] The course was aimed at raising awareness of nuclear security measures that address insider threats, including theft, sabotage and cybersecurity risks at facilities housing nuclear material. The course provided detailed information about target identification in a specific facility, characterisation of potential insiders and role of various components of the nuclear security system, such as physical protection, nuclear material accounting and control (NMAC), safety and operations, in addressing the insider threat. The course was primarly structured on the basis of the implementing guide, "Preventive and Protective Measures against Insider Threats" (IAEA Nuclear Security Series No. 8), subject to the specifications contained in the 2005 CPPNM and NMAC for nuclear security at the facility level in sync with the UNSCR 1540. The course also dealt with scenario development and evaluation in a hypothetical facility and discussed response and mitigation strategies against insider threats.

Earlier, in December 2013, a regional training course on "Preventive and Protective Measures against Insider Threat" was conducted, under the joint aegis of the GCNEP and the IAEA, to evaluate preventive and protective measures and explain how these measures can be applied

[29] The course was open to 30 participants from IAEA member states that have either at least one nuclear power plant or at least one research reactor in operation, or that have active projects to develop such facilities. See IAEA and GCNEP, "International Training Course on Preventive and Protective Measures against Insider Threats", organised in Mumbai, December 14–18, 2015, available at http://www.ursjv.gov.si/fileadmin/ujv.gov.si/pageuploads/Info_sredisce/Tecaji_konference_seminarji/tecaji_MAAE/Insider_T_2015_Att.pdf, accessed on December 15, 2016.

to enhance nuclear security for neutralising insider threats.[30] The participants undertook practical exercises in a hypothetical facility. The course was delivered by a group of international experts from the IAEA, Los Alamos National Laboratory, King's College, London, and BARC. The workshops organised by the GCNEP in collaboration with the IAEA help in achieving the primary objective of the NSSC Network to promote nuclear security through sharing of best practices, raising awareness and sharing curriculum. These initiatives significantly help in enhancing nuclear security without compromising any sensitive information.

Vulnerability Assessment

Following the Fukushima Daiichi nuclear accident, the Indian nuclear establishment took measures to safeguard against multiple external hazards in nuclear power plants. In collaboration with the IAEA, an international workshop was held on "Safety of Multi-Unit Nuclear Power Plant Sites against External Natural Hazards", in October 2012, at Mumbai.[31] There was a free exchange of ideas and information among the international participants on the desired response mechanisms related to scientific and technical safety of multi-unit nuclear power plant sites during an earthquake, tsunami and fire. The workshop was attended by experts from regulatory authorities and plant operators from different countries as well as the IAEA.[32] Another regional training

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[30] GCNEP, "Regional Training Course on 'Preventive and Protective Measures against Insider Threat'", organised in Mumbai, December 9–13, 2013, available at http://www.gcnep.gov.in/programs/details/RTCPPMDec2013 Report.pdf, accessed on December 15, 2016.

[31] IAEA, "Safety of Multi-Unit Nuclear Power Plant Sites against External Natural Hazards", International workshop held in Mumbai, October 17–19, 2012, available at http://www-pub.iaea.org/iaeameetings/44399/International-Workshop-on-the-Safety-of-Multi-Unit-Nuclear-Power-Plant-Sites-against-External-Natural-Hazards, accessed on December 13, 2016.

[32] "Statement by Dr. Ratan Kumar Sinha, Chairman of the Atomic Energy Commission and Leader of the Indian Delegation", IAEA 57th General Conference, Vienna, September 18, 2013, p. 2, available at http://dae.nic.in/writereaddata/gc2013_stmt.pdf, accessed on December 13, 2016.

course, by GCNEP in collaboration with the IAEA, on "Vulnerability Analysis of Physical Protection System", was held in September 2014, in Mumbai.[33] Participants from India and abroad were trained to comprehend the various approaches to conduct a vulnerability analysis through quantitative and/or qualitative means and evaluate whether the existing system satisfies the effectiveness of physical protection measures designed to protect nuclear materials and nuclear facilities against theft and sabotage. The training course provided an important platform for exchange of ideas and best practices among the course instructor experts and the partcipants for a comprehensive understanding and evaluation of conducting vulnerability assessment. The School of Nuclear Security Studies organised a workshop on "Vulnerability Assessment for Nuclear Material Security" in October 2014, in Mumbai, in cooperation with the NNSA, DoE, the US.[34] The school is currently building a "hypothetical nuclear facility" as part of the facility that will include all elements of physical protection, including a barrier technology and vehicle access control test facility and a sensor evaluation test bed.[35] This school plays a crucial role in organising workshops and symposiums periodically for the purpose of generating awareness on the importance of nuclear security and physical protection system.

Radiological Security

Unlike nuclear terrorism, a dirty bomb attack or radiological dispersal device (RDD) is considered to be a more plausible threat worldwide. A radiological attack does not cause mass destruction; nonetheless, it

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33 GCNEP, "Regional Training Course on Vulnerability Analysis of Physical Protection System", organised in Mumbai, September 15–19, 2014, available at http://www.gcnep.gov.in/programs/details/2014/RTCVAPPSSept 2014.pdf, accessed on December 13, 2016.

34 GCNEP, "Report on Workshop on Vulnerability Assessment for Nuclear Material Security", organised in Homi Bhabha National Institute, Mumbai, October 27–31, 2014, Mumbai, available at http://www.gcnep.gov.in/programs/details/2014/ReportVAWorkshopOctober2014.pdf, accessed on December10, 2016.

35 In discussion with officials from the BARC and GCNEP in Mumbai, October 19–21, 2016.

can trigger mass disruption. Radioactive sources have extensive use in a large number of applications in industry, healthcare and research. The wide application of radioactive sources makes them easily available. These sources are used and transported under stringent regulatory control, but a possibility of their intentional diversion by terrorists always exists. To enhance radiation source security, the School of Radiological Safety Studies, under GCNEP, is designed to carry out R&D on radiation detection systems and dosimetry. The school sensitises human personnel to threats of nuclear and radiological terrorism through assessment of radioactivity releases; addresses emergency preparedness and response, as well as medical management of radiation emergencies; and conducts fixed field exercises on radiological safety and emergency response. The school is expected to man an ERC. There are currently 23 ERCs across India; and they are monitored by the Indian Environmental Radiation Monitoring Network (IERMON), with modules for mobile and aerial searches, monitoring at ports and a facility for air monitoring of stand-alone detectors, which communicate using the Global System for Mobile Communications (GSM) or Code Division Multiple Access (CDMA) networks.[36] A 24th ERC will be build within the GCNEP site in Bahadurgarh, Haryana.[37]

Cybersecurity

As mentioned earlier, the GCNEP is striving for excellence in several aspects related to nuclear security, like nuclear forensics, cyber risks and insider threats, through training courses, programmes and discussions both at national and international levels. There are ongoing programmes with an aim to safeguard digital assets and the information they contain against sabotage or malicious use. In consonance with this aim, the IAEA, in cooperation with the BARC, held a technical meeting on the "Guiding Principles on Applying Computer Security Controls to Instrumentation and Control Systems at Nuclear Facilities", under the

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36 There are an estimated 500 monitoring systems located at more than 80 locations all across India.

37 In discussion with an official from the BARC in Mumbai, October 19-21, 2016.

aegis of the GCNEP, in September 2013.[38] The purpose of the meeting was to develop and review areas that should be addressed in the IAEA guidance on computer security for digital instrumentation and control (I&C) systems at nuclear facilities to include the integration of safety and security considerations during the lifecycle of digital control systems.[39] The agenda was to review and update a draft document entitled, "Applying Computer Security Controls to Instrumentation and Control (I&C) Systems at Nuclear Facilities" (to be issued as a technical guidance publication within the IAEA Nuclear Security Series), and provide technical comments.[40] The document focuses on cybersecurity matters that are crucial in the "lifecycle of digital I&C security associated with nuclear power facilitites systems applied at nuclear facilities." On the basis of the week-long discussions, 25 guiding principles and 145 detailed guidelines for security were discussed and finalised.[41]

Promoting Nuclear Security Culture

India has an excellent nuclear security record as not a single serious security incident has taken place in the five decades of its nuclear programme. This achievement can be credited, to a large extent, to the human element and the strong culture of nuclear security that permeates

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38 IAEA, "Technical Meeting on Guiding Principles for Applying Computer Security Controls to Instrumentation and Control Systems at Nuclear Facilities", Office of Nuclear Security, Department of Nuclear Safety and Security, September 23–27, 2013, p. 2, available at http://www.ujd.gov.sk/ujd/web.nsf/0/a311e8a825a3217ac1257bcf0030a73f/$FILE/viesm0021.pdf, available when written.

39 GCNEP, "Technical Meeting on 'Guiding Principles for Applying Computer Security to Instrumentation and Control Systems at Nuclear Facilities'", organised in Mumbai, September 23–27, 2013, p. 1, available at http://www.gcnep.gov.in/programs/details/TMGPICSept2013.pdf, accessed on December 10, 2016.

40 IAEA, "Technical Meeting on Guiding Principles for Applying Computer Security Controls to Instrumentation and Control Systems at Nuclear Facilities", n. 37.

41 GCNEP, "Technical Meeting on 'Guiding Principles for Applying Computer Security to Instrumentation and Control Systems at Nuclear Facilities'", n. 38.

all the departments of India's nuclear establishment. This task is being further advanced by the GCNEP through its activities in collaboration with international partners.

The author attended an "Indo-UK Workshop on Nuclear Security Culture" in October 2016, in Mumbai.[42] The course comprised 17 lectures and four tabletop exercise sessions and several case studies.[43] The objective of this workshop was to familiarise participants with the importance of security culture and roles and responsibilities of personnel involved in organisations involving nuclear or radioactive material. The workshop designed a dedicated lecture on personnel reliability programme and explained its efficacy to reduce potential threats to nuclear security. The author was educated about the various aspects of the personnel reliability programme system as it operates in India. The course lecturers from BARC and GCNEP emphasised that the efficacy of a personnel reliability programme system lies in its competence to test security personnel manning sensitive posts. An effective personnel reliability programme system must be able to successfully evaluate human sources in terms of their trustworthiness, dependability, psychological soundness and professional competence. The system must be a continuous process and involve a layered approach.[44] The personnel reliability programme system, as it exists in India, refrains from any ideological screening of employees in terms of amorphous terms like religion and ideology. The primary objective is to develop a good security culture that supports nuclear security.

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42 "Indo-UK workshop on Nuclear Security Culture", GCNEP, in Mumbai, October 19–21, 2016, available at http://www.gcnep.gov.in/programs/details/2016/NSCulture%20Workshop2016%20Prospectus.pdf, accessed on December 10, 2016.

43 Course material on "Indo-UK Workshop on Nuclear Security Culture", Global Center for Nuclear Energy Partnership (GCNEP) and Bhabha Atomic Research Centre and Global Threat Reduction Program, Department for Business, Energy and Industrial Strategy (BEIS), UK, October 19–21, 2016.

44 In a discussion with concerned officials from India's nuclear establishment, the author found that the persons manning sensitive nuclear posts must be subject to a rigorous personnel reliability programme system. The system must be relatively less rigorous for security personnel holding less sensitive posts. The discussion was held in Mumbai, October 19–21, 2016.

The workshop also sensitised participants on the safety–security interface in promoting security culture in nuclear installations.[45] A cordial relationship between the manager and employees within a nuclear facility is critical. This will lessen the chances of disgruntlement among the employees and mitigate insider threats. The experts emphasised that improved manager and employees' ties is the cardinal requirement for a robust nuclear security culture. Focusing adequate attention on human resource development through education and training programmes is indispensible for a strong security culture. This is an essential requirement for developing and supporting the infrastructure entrusted with the responsibility of promoting high-level nuclear security standards at regional and international levels. Recently there have been some instances of security breaches in sensitive areas in India. In September 2016, a serious security lapse was witnessed at the Indira Gandhi International Airport just two days after the Uri attacks.[46] Though nothing serious was detected on investigation, yet the incident was an eye-opener to implement further stringent security standards at sensitive installations.

Sharing Best Practices

In nuclear security, sharing of best practices is essential for continuous progress and improvement. It also helps to develop awareness about the standards of security practices being followed in different countries. This helps to identify the best practices that are being adhered to and how efficiently they contribute in enhancing nuclear security at national levels. India's progress in nuclear technology is sought after by several

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45 In a discussion with Anil Kumar, Additional Director General (Criminal Investigation Department [CID]), Police Headquarters, Bhopal, Madhya Pradesh, in the workshop by GCNEP, "Nuclear Security Culture", n. 42.

46 Anvit Srivastava, "Security lapse at IGI Airport, man scales perimeter wall to reach runway," Times of India, September 23, 2016 available at http://timesofindia.indiatimes.com/city/delhi/Security-lapse-at-IGI-Airport-man-scales-perimeter-wall-to-reach-runway/articleshow/54472968.cms, accessed on December 10, 2016.

nations like France,[47] Russia,[48] Republic of Korea,[49] the UK,[50] Australia,[51] and Kazakhstan.[52] China has also expressed a desire to open talks on cooperation in a sector that New Delhi sees as the solution to its chronic power problems. Recent nuclear cooperation agreements entered into by several nations with India are an indicator of the belief that New Delhi's advanced nuclear technology and experiences are advantageous to their enhanced security. In November 2012, India and Canada announced the conclusion of negotiations for the administrative arrangement that will allow the implementation of the Nuclear Cooperation Agreement (NCA), signed between the two countries in June 2010. The NCA will allow Canadian firms to export and import controlled nuclear materials, equipment and technology to and from

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47 "Declaration by India and France on the Development of Nuclear Energy for Peaceful Purposes (20-02-2006)," *Department of Atomic Energy,* Important Agreements, February 20, 2006, available at http://www.dae.nic.in/?q=node/59, accessed on December 10, 2016.

48 "Agreement between Government of the Republic of India and Government of the Russian Federation on Cooperation in the Use of Atomic Energy for Peaceful Purposes", *Department of Atomic Energy,* Important Agreements, March 12, 2010, available at http://www.dae.nic.in/writereaddata/indorus%281%29.pdf, accessed on December 10, 2016.

49 "Agreement between Government of India and the Government of the Republic of Korea for Co-operation in the Peaceful Uses of Nuclear Energy," *Department of Atomic Energy*, Important Agreements, July 25, 2011, available at http://www.dae.nic.in/writereaddata/korea.pdf, accessed on December 10, 2016.

50 "Joint Declaration by India and United Kingdom on Civil Nuclear Cooperation", *Department of Atomic Energy*, Important Agreements, available at http://www.dae.nic.in/writereaddata/indouk.pdf, accessed on December 10, 2016.

51 DAE, "Agreement between Government of India and Government of Australia on Cooperation in Peaceful Uses of Nuclear Energy", *Department of Atomic Energy*, Important Agreements, February 11, 2010, available at http://www.dae.nic.in/writereaddata/aus_nca.pdf, accessed on December 10, 2016.

52 "Agreement between Government of the Republic of Kazakhstan and the Government of the Republic of India for Co-operation in the Peaceful Uses of Nuclear Energy", *Department of Atomic Energy*, Important Agreements, April 15, 2011, available at http://www.dae.nic.in/writereaddata/kazak.pdf, accessed on December 10, 2016.

India to facilities under safeguards applied by the IAEA.[53] The NCA will "further build on Canada and India's relationship and allow both countries to share expertise in areas such as research and development, safety, and next generation nuclear facilities."[54] India and Bangladesh have agreed to enhance cooperation in nuclear science and technology.[55] India has also agreed to enhance bilateral cooperation with Sri Lanka in the fields of civil nuclear energy and science and technology.[56] In October 2014, India and Finland signed 19 agreements, including one for peaceful use of nuclear energy, as well as radiation safety regulations related to nuclear installations, emergency preparedness and radioactive waste management associated with the operation of nuclear power plants.[57] Interestingly, India's expertise in civilian nuclear technology and radiation safety has not only been provided to its neighbouring states but other nations as well.

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53 "PM Announces Conclusion of Negotiations on Canada–India Nuclear Cooperation", Prime Minister of Canada, November 6, 2012, available at http://pm.gc.ca/eng/node/21950, accessed on December 10, 2016.

54 Canadian Nuclear Safety Commission, "Statement by Canadian Nuclear Safety Commission President on the Nuclear Appropriate Arrangement Reached between Canada and India", November 6, 2012, available at http://www.nuclearsafety.gc.ca/eng/resources/news-room/news-releases/index.cfm?news_release_id=430, accessed on December 10, 2016.

55 Ministry of External Affairs, "Joint Statement on the Third Meeting of the India–Bangladesh Joint Consultative Commission", September 20, 2014, available at http://mea.gov.in/bilateral-documents.htm?dtl/24024/Joint+Statement+on+the+Third+Meeting+of+the+IndiaBangladesh+Joint+Consultative+Commission, accessed on December 10, 2016.

56 Ministry of External Affairs, "Joint Press Statement on the Eighth India–Sri Lanka Joint Commission Meeting", January 22, 2013, available at http://mea.gov.in/press-releases.htm?dtl/21115/Joint+Press+Statement+on+the+Eighth+IndiaSri+Lanka+Joint+Commission+Meeting, accessed on December 10, 2016.

57 "India, Finland to Cooperate in Civil Nuclear Energy", *The Times of India*, October 15, 2014, available at http://timesofindia.indiatimes.com/india/India-Finland-to-cooperate-in-civil-nuclear-energy/articleshow/44827311.cms, accessed on December 10, 2016.

Conclusion

India's recognises the critical importance of strengthening nuclear security at both national and international levels. The series of measures undertaken by the GCNEP are expected to enhance coordination of efforts at the national, sub-regional, regional and international levels. Expectedly, these measures can strengthen a global response to the serious challenge of proliferation of nuclear weapons and related materials threating international security. However, just as there is no room for complacency in nuclear security, India's CoE has certain challenges to meet. The first of this is addressing the nuclear problem that is closer home. India has been successful in entering into collaboration with several countries for exchange of ideas and exploring international best practices. It would be a challenge for India to negotiate a similar outreach programme with Pakistan. Collaborative programmes between the Indian and Pakistani CoEs would definitely reinvigorate nuclear security not only in South Asia but at the global level too. Being apolitical in nature, the CoEs can be an effective confidence-building network to strengthen nuclear security in the region.

Chapter 6

Conclusion

Nuclear Security

The Next Steps

> *Responsible national actions and effective international cooperation should be pursued together to prevent non-state actors and other malignant forces from threatening the lives of innocents on a mass scale, destabilizing regional stability and international peace.*
>
> —M.J. Akbar[1]

Nuclear terrorism is an "unconventional threat" that "requires an unconventional response". Several dramatic events of the last decade demonstrate the necessity for enhancing nuclear security on a sustainable basis. The catastrophic September 2001 attacks in the US were only the beginning of a series of heinous terrorist attacks committed in several parts of the world. Each terrorist attack has resulted in increasing devastation, and fear validating the terrorists' penchant for inflicting extreme violence and terror on their chosen targets. The threat of nuclear terrorism is continuously evolving and terrorists are exploring new ways to defeat nuclear security capabilities. There is apprehension that the threat of nuclear terrorism might not cease anytime soon. What is most difficult is that there is no effective method to calculate the probability of nuclear terrorism, thereby making it a dangerous challenge to prepare for. The stakes are huge as the consequences of a nuclear attack are very high. This necessitates the adoption of urgent steps to operationalise nuclear security measures.

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1 Statement of India by Minister of State for External Affairs, Shri MJ Akbar at IAEA Ministerial Conference on Nuclear Security, December 5, 2016, available at http://www.mea.gov.in/Speeches-Statements.htm?dtl/27753/Statement_of_India_by_Minister_of_State_for_External_Affairs_Shri_MJ_Akbar_atnbspIAEA_Ministerial_Conference_on_Nuclear_Security, accessible on December 23, 2016.

The NSS process, spanning over four summits, has been an effective method to address the ways to mitigate the threat of nuclear terrorism. It has presented an opportunity to the global leaders to collaborate through coordinated institutionalised mechanisms to mitigate this threat. The initiative has resulted in achieving substantive progress in strengthening global capabilities to prevent, detect and respond to acts involving the danger of nuclear terrorism. The NSS process has achieved significant progress in generating essential global political support for securing nuclear materials and facilities from potential terrorist attacks. It has focused on rendering wider importance to the adherence and implementation of principal international legal instruments to mitigate the threat of nuclear terrorism. The commitment from the participating states to establish CoEs has already borne fruition out of this implementation process. The CoEs are, in fact, already functioning in several countries and contributing towards upgradation of the existing nuclear security regime. The US has also given a spurt to the process of strengthening nuclear security by ratifying ICSANT. The NSS process has successfully laid the foundation of institutionalising nuclear security measures through germane mechanisms for establishing a robust nuclear security regime.

Achievements of the NSSs

The major achievement of the NSS process has been the high-level political and diplomatic attention it has attracted during the last four summits. The increasing participation from important heads of states and government officials not only increased the profile of the summit process but also influenced the structural framework of responding to the threat of nuclear terrorism. The summiteers mainly being political heads of state, and high-level officials, tended to encourage unity of purpose and policy among participating governments, producing in many cases, more ambitious outcomes at the widely publicised gatherings than would otherwise have been the case.[2] The summit

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2 "Effective and Sustainable Global Nuclear Security: Looking beyond the Horizon", Stanley Foundation, October 26, 2012, p. 5, available at http://www.stanleyfoundation.org/publications/pdb/GNS_BeyondHorizonSPC1212.pdf, accessed on December 23, 2016.

process has thus set the momentum for generating sustainable support from participants for making and upholding unilateral commitments towards a strengthened nuclear security regime. These efforts have resulted in tangible advancements in nuclear security. The NSS process has been effective because it has successfully coalesced world leaders together and generated awareness about the importance of collective national and international efforts towards an upgraded nuclear security regime. There is a degree of unanimity on the view that even though nuclear security is a sovereign responsibility, it does not preclude the need for multilateral cooperation and collaboration for strengthening it. In fact, in 2012, a report published by two non-governmental organisations (NGOs) showed that approximately 80 per cent of the 67 national commitments made by 30 heads of states at the 2010 NSS were completed by the 2012 NSS.[3]

The NSS process has facilitated the identification of several issues that endanger nuclear security worldwide. The risks emanating from the enormous stockpile of both civilian and military fissile materials have been profiled. There is an ongoing effort to build momentum by high-level organisations, highlighting the critical necessity of invigorating security measures for military fissile materials similar to civilian stockpile.[4] These efforts have been welcomed by the summiteers, and some have extended cooperation to enhance the nuclear security performance. Since 2009, 12 nations have been declared free from HEU. The process of minimising and eliminating HEU has been welcomed by other states like Kazakhstan and Singapore. In fact, at the IAEA's 59th General

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3 Michelle Cann, Kelsey Davenport and Margaret Balza, "The Nuclear Security Summit: Assessment of National Commitments", Arms Control Association and Partnership for Global Security, March 2012, p. 14, available at https://www.armscontrol.org/files/ACA_NSS_Report_2012.pdf, accessed on December 23, 2016.

4 See "*Improving the Security of All Nuclear Materials:* Legal, Political, and Institutional Options to Advance International Oversight", Report by the IISS, the James Martin Center for Nonproliferation Studies and the Vienna Center for Disarmament and Non-Proliferation, September 2016, available at http://www.nonproliferation.org/wp-content/uploads/2016/09/160920_improving_security_of_all_nuclear_materials__iiss_cns_report.pdf, accessed on December 23, 2016.

Conference in 2015, securing HEU and other radioactive materials was voted as the most important nuclear security issue. Additionally, the conference acknowledged that the NSS process has significantly contributed in strengthening various aspects of the nuclear security architecture. The NSS series has generated international awareness about probable nuclear risks and that has resulted in an increased number of countries ratifying the 2005 CPPNM Amendment. There has also been a spurt in funding for IAEA activities and enhanced collaboration with regulators. In the period 1 July 2015–30 June 2016, the IAEA accepted pledges to the Nuclear Security Fund from Belgium, Canada, China, Estonia, Finland, France, Indonesia, Italy, Japan, Kazakhstan, Republic of Korea, New Zealand, Norway, Russian Federation, Spain, Sudan, Sweden, United Kingdom, United States of America, and Zimbabwe.[5] Additional countries including India have committed to contribute to the Agency's Nuclear Security Fund to improve and strengthen physical security upgrades worldwide.[6] The NSS series has facilitated in institutionalising national progress reports, developed an interface between civil society and industry, empowered government representatives (sherpas), and encouraged nuclear diplomacy among nations through a network of dialogues and communications. The NSS process encouraged several countries to conduct series of tabletop exercises over various critical issues like transportation risks, nuclear detection and forensics, and securing nuclear and other radiological materials.[7] These exercises have been phenomenal in identifying critical gaps and addressing weak links threatening nuclear security.

Another result that has been achieved by the NSS process is that their agenda has found appeal among numerous civil society organisations, research think tanks and several other non-governmental institutions.

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5 "Nuclear Security Report 2016," IAEA, GOV/2016/47-GC(60)/11, August 24, 2016, p.19, available at https://www.iaea.org/About/Policy/GC/GC60/GC60Documents/English/gc60-11_en.pdf, accessed on December 23, 2016.

6 See "Highlights of National Progress Reports," Nuclear Security Summit, April 05, 2016, available at http://www.nss2016.org/news/2016/4/5/highlights-from-national-progress-reports-nuclear-security-summit, accessed on December 23, 2016.

7 Ibid.

The process has impacted upon these organisations and institutes for further disseminating awareness about critical issues concerning nuclear security. This process has been successful in assembling a group of committed stakeholders comprising of sherpas, international organisations, leaders from the nuclear industry and representatives of civil society organisations, which is dedicated towards fostering global support for enhancing nuclear security oversight and governance.

Shortcomings of the NSS Process

The NSS process was a short-term course and as expected, came to an end with the conclusion of the 2016 NSS. Despite the tangible achievements of the four summits, there remains an urgent need for enhanced political and diplomatic cooperation to mitigate risks to nuclear security. The nuclear security regime is still afflicted with serious weak links and is far from being a robust architecture. The momentum that was built by the NSS process in terms of political support and awareness of nuclear security issues faces the risk of being frittered away if the benefits are not substantially institutionalised. Noteworthy, the NSS proceedings are fraught with these limitations due to some inherent shortcomings of the summits. The main flaw in the NSS proceedings is that the commitments made and obligations undertaken are not of a binding nature. The declarations made by the summiteers lack political and legal authority. Thus, the commitments undertaken by the summit participants are at best voluntary in nature, and can be reversed at any time.

The NSS series has also failed to establish a mechanism for developing strong nuclear security culture worldwide. Effective nuclear security culture can be achieved with enhanced understanding about credible threats and improved coordination on nuclear security, criterions for performance, implementation and progress. Such a framework requires increased sharing of information and knowledge to design appropriate response to any probable threat to nuclear security. This is also critical for developing confidence and trust among the key stakeholders and the international community. Nuclear security involves sensitive information and a possible way to meet the requirement of sharing relevant information is to establish a balance between sharing information and protecting the confidentiality of delicate knowledge from release.

Despite the high-level political and diplomatic impact of the NSS process, it has been unable to utilise the momentum appropriately, for enhancing maximum collaboration on cardinal issues concerning nuclear security. There still remains serious lacunae concerning crucial issues like peer review process, cooperation with the nuclear industry and improving/upgrading the "safety–security interface" factor. Further, the uncertainty surrounding the NSS commitments has left the efficacy of the summit process in question. It is not enough to make ambiguous pledges of unilateral commitments; it is equally important to ensure that the process needs to be institutionalised within an effective framework. This framework must essentially be comprised of active implementation mechanisms that can assess, monitor and verify the progress made from time to time. It must also include, in its agenda, measures to address the existing challenges to nuclear security, as enunciated earlier.

Beyond the NSS Process

Given the shortcomings of the NSS process, more work needs to be done to strengthen and upgrade the nuclear security regime. The 2016 NSS provided the essential legacy for continued efforts towards a sustainable nuclear security in future. The paybacks of the NSS series must definitely be maintained and disseminated to further strengthen efforts against the probable occurrence of any incident involving nuclear and radiological materials.

Role of IAEA

The IAEA holds the potential to carry forward the legacy of the NSS process and should be entrusted with the responsibility of extending the benefits of the NSS series beyond 2016. The IAEA has a wide-ranging mandate that includes global nuclear governance, verification of non-proliferation measures, promoting peaceful uses of nuclear energy and nuclear security and safety. The IAEA can provide meaningful contribution in enhancing global nuclear security. It can play a pivotal role in providing the highest standards of physical protection to all nuclear materials. The IAEA has coded highly relevant recommendations and guidance on the physical protection of nuclear materials and facilities in its Nuclear Security Series, INFCIRC/225/Rev.5.[8] Post the Twin Tower attacks, the IAEA information circular was revised in 2011, keeping in view the changes in the emerging threat security environment. The objective of the revised provisions is to seek greater cooperation from state authorities to comply with obligations under the amended CPPNM of 2005 and the UNSCR 1540. Additionally, the IAEA's Office of Nuclear Security is entrusted with the responsibility for planning, implementing and evaluating nuclear security activities as specified in the Nuclear Security Plan for 2010–13. A new plan covering 2014–17 was approved by the Agency's Board of Governors in September 2013.[9]

The IAEA also periodically publishes the Nuclear Security Series guidelines that address issues related to the prevention, detection and response to theft, sabotage, unauthorised access and illegal transfer or other malicious acts involving nuclear and radiological materials and their associated facilities. The Agency has already published 20 such series and further documents[10] are in various stages of development that will be eventually published as part of the IAEA Nuclear Security Series. The IAEA also provides nuclear security advisory guidance, which includes INSServ missions, which essentially assist concerned states to establish and maintain effective nuclear security. The IAEA-supervised State Systems for Accountancy and Control Advisory Services (ISSAS) provides critical inputs for upgrading a state's nuclear

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8 IAEA, "Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Revision 5)", IAEA Scientific and Technical Publications, available at http://www-pub.iaea.org/MTCD/publications/PDF/Pub1481_web.pdf, accessed on December 23, 2016.

9 The plan focuses on protection, detection and response, and information coordination and analysis. See IAEA, "Nuclear Security Plan 2014–2017", GOV/2013/42-GC(57)/19, August 2, 2013, available at https://www.iaea.org/About/Policy/GC/GC57/GC57Documents/English/gc57-19_en.pdf, accessed on December 23, 2016.

10 IAEA, "Forthcoming IAEA Nuclear Security Series Publications", available at http://www-ns.iaea.org/security/nuclear_security_series_ forthcoming.asp?s=4&l35, accessed on December 23, 2016.

material accountancy and control systems. The IAEA also conducts IPPAS missions as voluntarily requested by concerned states to assess their existing physical protection measures. Given the mandate and the wide-ranging responsibilities handled by the IAEA, the Agency must be conferred appropriate decree to facilitate effective implementation and enhanced progress on nuclear security. For better-defined nuclear security, provisions must be made for IAEA to have the requisite mandate to assess state performance in applying or complying with its guidance.

Promoting Nuclear Security Diplomacy

The IAEA can play a cardinal role in promoting nuclear security diplomacy. The Agency comprises of multiple forums that assess and evaluate myriad issues concerning nuclear security. These forums include the Annual General Conference, the 35-member Board of Governors and various subsidiary bodies like the Advisory Group on Nuclear Security and the Nuclear Security Guidance Committee. The forums contribute to proactive nuclear diplomacy by stimulating crucial support for implementation of conventions, treaty negotiations, review process of existing treaties and hosting summits. These efforts coalesce state heads and other officials in particular forums that facilitate debates, discussions and dialogue for strengthening the nuclear security regime. In the mid-1990s, the IAEA convened a group of legal and technical experts to determine whether the CPPNM should be amended to close a major weak link within the domestic use, storage and transport of nuclear materials.[11] Post-September 2001 terrorist attacks, the IAEA reiterated the proposal for amendment of the CPPNM. The Agency reconvened the experts group in October 2001, but it took further arduous negotiations and a diplomatic conference hosted by the Agency in 2005 before agreement on the amendment was reached.[12]

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11 Fabrizio Nocera, *The Legal Regime of Nuclear Energy: A Comprehensive Guide to International and European Union Law*, Antwerp: Intersentia, 2005, pp. 646–47.

12 Trevor Findlay, "Beyond Nuclear Summitry: The Role of the IAEA in Nuclear Security Diplomacy after 2016", Belfer Center for Science and International Affairs, March 2014, p. 13, available at http://belfercenter.hks.harvard.edu/files/beyondnuclearsummitryfullpaper.pdf, accessed on December 23, 2016.

Additionally, the IAEA promotes nuclear security diplomacy by hosting conferences on several important issues. In 2009, it convened an "International Symposium on Nuclear Security" in cooperation with the European Police Office, Interpol and other international organisations.[13] The symposium focused on the threat of nuclear terrorism that required dedicated action by the international community, states, industry and others. In 2013, the IAEA held the "International Conference on Nuclear Security: Enhancing Global Efforts" that aimed to "provide a timely global forum in which the progress made in strengthening nuclear security worldwide could be reviewed and future developments discussed."[14] The conference was attended by high-level government heads and other representatives from NGOs, and provided a platform to frame future guidelines to improve nuclear security.[15] The results of this conference served as important inputs in the preparation of the IAEA's *Nuclear Security Plan* for 2014–17. The enormous popularity of IAEA-conducted conferences attracts worldwide participation and attention of the international community to prevent nuclear and other radioactive materials from being stolen and used maliciously. The IAEA thus has the potential to play a global role in addressing the gaps and weaknesses in the nuclear security system at different levels.

Nuclear security diplomacy is also actively being promoted by the CoEs. These centres encourage sharing of best practices and dissemination of knowledge for strengthening global nuclear security. The CoEs

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13 IAEA, "International Symposium on Nuclear Security", March 30–April 3, 2009, available at http://www-pub.iaea.org/mtcd/meetings/Announcements.asp?ConfID=36576, accessed on December 23, 2016.

14 IAEA, "International Conference on Nuclear Security: Enhancing Global Efforts", July 2013, available at http://www-pub.iaea.org/iaeameetings/43046/international-conference-on-nuclear-security-enhancing-global-efforts, accessed on December 23, 2016.

15 IAEA, "IAEA Ministerial Meeting Concludes with Stronger Focus on Nuclear Security", July 5, 2013, available at https://www.iaea.org/newscenter/news/iaea-ministerial-meeting-concludes-focus-stronger-nuclear-security, accessed on December 23, 2016.

provide meaningful avenues for diplomatic and technical cooperation among states for developing a robust nuclear and radiological security agenda. The CoEs provide opportunities to surmount conflicting approaches and facilitate greater coordination on nuclear issues both at bilateral and multilateral levels. Such collaboration promotes nuclear security diplomacy by providing useful mechanisms for strengthening the emerging global nuclear and radiological security frameworks worldwide.

Role of Global Initiative to Combat Nuclear Terrorism (GICNT)

The GICNT is another forum which can keep the momentum on strengthening nuclear security and nuclear security diplomacy ongoing. The GICNT is a voluntary international partnership of 86 nations and five official observers,[16] committed to strengthening global capacity to prevent, detect and respond to nuclear terrorism.[17] The objective of the GICNT is to integrate collective capabilities and resources to strengthen the global nuclear security architecture to combat nuclear terrorism. It also provides a forum which encourages sharing of information, knowledge, expertise and best practices from the non-proliferation, counter-proliferation and counter-terrorism disciplines. These inputs are collated and shared with partner countries within a non-binding framework. This facilitates in raising awareness on nuclear security issues. It also facilitates in developing a global community of experts and practitioners that have a consistent and rational approach in combatting the threat of nuclear terrorism. The GICNT strives towards its objectives by conducting periodic multilateral events that improve the plans, policies, procedures and interoperability of partner

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16 These official observers include the IAEA, European Union (EU), International Criminal Police Organization (Interpol), United Nations Office on Drugs and Crime (UNODC) and United Nations Interregional Crime and Justice Research Institute (UNICRI).

17 GICNT, "Global Initiative to Combat Nuclear Terrorism Partner Nations List", available at http://www.gicnt.org/content/downloads/partners/GICNT_Partner_Nation_List_June2015.pdf, accessed on December 23, 2016.

nations. Partner nations and official observers of the GICNT gathered in Helsinki, Finland, June 16–17, 2015, for the GICNT's 9th senior-level Plenary Meeting.[18] Finland's leadership and commitment to nuclear security is an exemplar of nuclear security diplomacy to mitigate nuclear risks. The GICNT has held 15 multilateral activities over the past two years, including workshops, tabletop exercises, a field training exercise and the GICNT's first mock trial.[19]

In February 8-10, 2017, the Implementation and Assessment Group (IAG) of the GICNT met in New Delhi. This was also the first meeting of the IAG in South Asia. India recognized that if access to nuclear technology changes State behaviour, it would expectedly also impact on non-state calculations.[20] India believes that with expanding globalization, it would be a futile effort to combat the threat of nuclear terrorism in isolation. The GICNT provides an effective forum to build a cadre of nuclear security experts who can contribute in developing agreed strategies and benchmarks specifying the varying degrees of security for nuclear and radiological materials and enhance the physical protection of nuclear facilities. The 2017 IAG meeting held seminars on important topics like international assistance requests

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[18] The US State Department, "Global Initiative to Combat Nuclear Terrorism 2015 Plenary Meeting: Joint Co-Chair Statement", June 17, 2015, available at http://www.state.gov/r/pa/prs/ps/2015/06/243947.htm, accessed on December 23, 2016.

[19] Thomas M. Countryman, "Remarks to the 2015 GICNT Plenary Meeting", US Mission Geneva, June 16, 2015, available at https://geneva.usmission.gov/2015/07/09/remarks-to-the-2015-gicnt-plenary-meeting/, accessed on December 23, 2016.

[20] Welcome address by Foreign Secretary, S Jaishankar at Implementation and Assessment Group Meeting Global Initiative to Combat Nuclear Terrorism (GICNT), New Delhi, Ministry of External Affairs, Government of India, February 08, 2017 available at https://www.mea.gov.in/Speeches-Statements.htm?dtl/28012/Welcome+address+ by+Foreign+Secretary +at+Implementation+and+Assessment+ Group+Meeting+Global+ Initiative+to+Combat+Nuclear+Terrorism+GICNT+ New+Delhi , accessed on February 13, 2017

that primarily concentrated on the outcomes of the "Kangaroo Harbour"[21] and deliberated on the challenges associated with requesting and receiving international assistance. A seminar on the legal framework was held that focused on the hurdles encountered in adapting national legal codes to address criminal activities involving radioactive materials.[22] The IAG meeting also discussed the existing challenges to source security and assessed if the GICNT should support related activities.[23] The meeting emphasized on the importance of creating sustainability programmes for national nuclear security frameworks for training, strengthening knowledge management programmes and challenges associated in adopting and implementing national legislation involving radioactive and nuclear material.[24] An important aspect of the February 2017 IAG meeting was the emphasis made by Dr RB Grover, Member of Atomic Energy Commission of India on the importance of developing proliferation resistant technological options that strengthen nuclear security.[25] It is equally important to improve and upgrade the security of radioisotopes that could be separated from spent fuel as a measure to mitigate the threats to nuclear security.

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21 "In May 2016, Australia will host a GICNT nuclear emergency planning and response workshop and exercise "Kangaroo Harbour" which will demonstrate best practices in issuing and responding to notifications and assistance requests to increase nuclear detection, nuclear forensics and emergency response involving the threat and use of radioactive materials in a terrorist attack." See "National Progress Report: Australia", Nuclear Security Summit 2016, March 31, 2016 available at http://www.nss2016.org/document-center-docs/2016/3/31/national-progress-report-australia-1, accessed on December 23, 2016.

22 Conference Agenda and Information for the 2017 Implementation and Assesment Group Meeting Global Initiative to Combat Nuclear Terrorism New Delhi, India, 8-10 February 2017.

23 Ibid.

24 Ibid.

25 "GICNT meet discusses nuclear, radioactive source security", Bussiness Standard, February 10, 2017, available at http://www.business-standard.com/article/pti-stories/gicnt-meet-discusses-nuclear-radioactive-source-security-117021000880_1.html, accessed on February 11, 2017.

The GICNT has continued to play a consistent role in supporting the aim of the NSS process by focusing on the interfaces between nuclear detection, response and forensics. It assesses regional nuclear security challenges and suggests measures for building dialogue and cooperation across governments and agencies. However, the non-binding aspect of the GICNT makes the step short of ordaining legally binding directives to strengthen the nuclear security architecture. The GICNT will hold its 10th Plenary meeting in Tokyo, Japan, on June 1-2, 2017.

Regional Nuclear Security Summit

After the phenomenal success achieved by the four NSS, there is concern how to carry forward the legacy of the process further. A possible way would be to consider hosting regional NSS in different geographical zones. For example, India, China and Pakistan may take steps initiating a regional NSS process. It could provide a forum to share best practices, exchange ideas and forge cooperation to combat risks to nuclear security in the region. India is already sharing its competence on peaceful uses of nuclear energy, cyber security, physical protection, transport security and nuclear forensics with other nations through the GCNEP. Given, the high standards of nuclear security measures undertaken and practiced, within India authorities may deliberate whether New Delhi should take play a proactive role in initiating a regional nuclear security summit process in the region. This will provide an opportunity to involve all the stakeholders includes individual states to fulfil their national responsibility of strengthening nuclear security at the regional levels. If the practice of holding regional nuclear summit were exemplified by other regional powers it would resonate in developing robust nuclear security architecture at the global level.

Conclusion

The NSS process has brought the world community at an important crossroad. Political leaders must now to determine how to carry forward the achievements of the multilateral process towards a highly secured framework for the protection of nuclear and radiological materials. The international community has the opportunity to renew and reinforce their commitments to secure all nuclear materials and facilities to the highest standards. The nuclear security regime must develop mechanisms for periodic review process of implementation measures to assess and evaluate the progress made in strengthening nuclear security. Mechanisms must also be developed to institutionalise a peer review process without compromising on any state's sensitive information relating to its nuclear security. The benefits hitherto reaped by the NSS series can be sustained and further advanced through boosting nuclear security diplomacy. This can be done by disseminating best practices and knowledge sharing. This can eventually contribute towards building a vigorous nuclear security culture that will permeate all aspects of the nuclear security regime. Consistent efforts are required to reap the hitherto achieved benefits of the NSS process by generating maximum political will from participating states to foster nuclear security. Increasing commitments from more summiteers can highlight the importance of regime cohesion, information sharing and acceptable standards of sensitive peer review and best practices. This approach would enhance important confidence-building steps and evaluate new mechanisms for dealing with difficult nuclear governance methods. Efforts are needed to promote more proactive diplomacy through means of debate, discussion and dialogue among nations. Consistent debate, discussion and dialogue would aid expanded cooperation and colloboration resulting in building greater international confidence in the nuclear security system.

The nuclear security regime must ensure accountability through independent oversight and build a strong security culture that includes peer reviews, best practice exchanges and realistic security exercises and assessments. It must also persevere towards strengthening nuclear diplomacy and cooperation to combat the threat of nuclear terrorism. Nuclear security must continuously improve by expanding cooperation among states on issues related to detection and recovery of stolen or diverted nuclear materials, so as to mitigate any radiological consequences of possible sabotage and to prevent and combat related offences.

Despite being a short-lived process, the NSS series has managed to focus high-level political attention on the danger of nuclear terrorism. It has also generated significant awareness among other international and non-governmental organisations on the urgent need to step-up efforts for reducing risks to nuclear security. Noteworthy, the NSS series has been successful in sustaining the global attention, and that can be discerned from the increasing participation in every consecutive summit since the 2010 Washington event. It has thus promoted multilateralism, which is essential for dealing with the threat of nuclear terrorism and strengthen global nuclear security worldwide. However, despite the overwheming efforts, the nuclear security regime requires to be more cohesive. The process of securitising nuclear and radiological materials needs to be further expanded and made more effective in terms of implementation. The process must strategise beyond focusing on the dangers of nuclear terrorism, and develop policies and framework of a comprehensive, accountable, consistent and sustainable nuclear security regime. The summits held in Washington, Seoul, and the Hague have laid the essential foundation of improved nuclear security. It remains to be seen how successful the achievements made in the NSS process help establish a standardised nuclear security regime that will effectively meet the existing challenges to nuclear security and bring about improved nuclear governance.

Annexure I *

Levels of Physical Protection to be Applied in International Transport of Nuclear Material as Categorized in Annex II

1. Levels of physical protection for nuclear material during storage incidental to international nuclear transport include:

   a. For Category III materials, storage within an area to which access is controlled;

   b. For Category II materials, storage withinan area under constant surveillance by guards or electronic devices, surrounded by a physical barrier with a limited number of points of entry under appropriate control or any area with an equivalent level of physical protection;

   c. For Category I material, storage within a protected area as defined for Category II above, to which, in addition, access is restricted to persons whose trustworthiness has been determined, and which is under surveillance by guards who are in close communication with appropriate response forces. Specific measures taken in this context should have as their object the detection and prevention of any assault, unauthorized access or unauthorized removal of material.

2. Levels of physical protection for nuclear material during international transport include:

   a. For Category II and III materials, transportation shall take place under special precautions including prior arrangements among sender, receiver, and carrier, and prior agreement between natural or legal persons subject to the jurisdiction and regulation of exporting and importing States, specifying time, place and procedures for transferring transport responsibility;

b. For Category I materials, transportation shall take place under special precautions identified above for transportation of Category II and III materials, and in addition, under constant surveillance by escorts and under conditions which assure close communication with appropriate response forces;

c. For natural uranium other than in the form of ore or ore-residue; transportation protection for quantities exceeding 500 kilograms uranium shall include advance notification of shipment specifying mode of transport, expected time of arrival and confirmation of receipt of shipment.

* "Amendment to the Convention on Physical Protection of Nuclear Material", IAEA INFCIRC/274/Rev.1/Mod.1, May 9, 2016, Annex 1, p. 16, available at https://www.iaea.org/sites/default/files/infcirc274r1m1.pdf, accessed on December 16, 2016.

The Nuclear Security Summit process was an unprecedented event that achieved phenomenal success in drawing global attention to the danger of nuclear terrorism. The Summit process panning from (2010-2016) focussed on the urgency to secure nuclear materials and facilities. It highlighted the need to develop newer mechanisms that can help mitigate nuclear risks. The development of the concept of nuclear centres of excellence is one such aspect. Despite the phenomenal success of the Summit process, newer threats continue to challenge the security of nuclear materials and facilities. Emergence of new threats like the Islamic State; continuing nuclear proliferation trends; increasing incidents of nuclear thefts; weak links in transport security, existing legal instrument of nuclear security and protection of our fissile materials pose serious threats to nuclear security. It is important that the international community addresses the existing threats to nuclear security not only to mitigate the dangers of nuclear terrorism but also to strengthen the achievements of the Summit process.

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