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Fostering Nonproliferation in South Asia – An Integrated Systems Approach

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ABSTRACT – *"Achieving International Security through Technical Collaborations"*

"Achieving Global Security through Technical Collaborations" is the inspiration for an integrated systems approach to foster development of next-generation technical experts, policy leaders, and global partnerships on nuclear security, arms control, and nonproliferation topics.

Across the globe, the nuclear and radiological materials used for peaceful purposes such as energy, agriculture, and public health could potentially be subverted by malicious actors and used to produce weapons of mass destruction (WMD). To address this threat, global nonproliferation regimes aim to prevent the spread of capabilities that might enable nation states and terrorist groups to produce or acquire WMD.

As the premier security engineering laboratory for the US nuclear weapons complex, Sandia National Laboratories (Sandia) is uniquely qualified to support nonproliferation activities. Through cooperative engagement with global partners and stakeholders, Sandia's Center for Global Security and Cooperation (CGSC) and its Cooperative Monitoring Center (CMC) support the efforts of the United States Government to strengthen nonproliferation goals and reduce global threats from the misuse of nuclear, chemical, biological and radiological materials. The CGSC and the CMC are engaged in many world regions, with South Asia an important region of activity.

Facing today's global security challenges requires an unprecedented degree of transparency and cooperation between the US and its international partners. Through the CGSC, Sandia brings world-class technical expertise to bear on complex, nonproliferation challenges. The CGSC's cooperative, integrated systems approach enables it to build global capacity in the form of enduring international partnerships, increased policy engagement, and innovative technical solutions that further strengthen Sandia's ability to help make our nation and the world safe from WMD threats.

INTRODUCTION

As the one of the nation's top national security engineering labs, Sandia National Laboratories applies world-class technical expertise to nonproliferation challenges and is uniquely qualified to support nonproliferation activities on a global scale. Sandia's Center for Global Security and Cooperation (CGSC) seeks a safe and secure world through technical engagement, research, development, and applied innovative science and engineering solutions to strengthen nonproliferation efforts and reduce global threats. Within the CGSC, the Cooperative Monitoring

Center (CMC) established a unique, innovative methodology and venue in 1994 enabling technical and policy experts to meet and jointly explore how science and technology can assist countries implement confidence-building measures, policies, treaties, and nonproliferation agreements.

The CMC fosters technical cooperation, developing constructive relationships, and reinforcing diplomatic initiatives and verification regimens. Over time, using their unique expertise and experience, the CGSC and CMC developed a novel Integrated Systems Approach to build global security capacity in the forms of innovative technical solutions, enduring international partnerships, and policy engagement.

INTEGRATED SYSTEMS CONCEPT & CAPABILITIES

Technical solutions in the Integrated Systems Approach incorporate sensors, monitoring systems, authentication, modeling, and simulation to secure nuclear and radiological materials at points of production and use, and detection at ports of entry and transit. Enduring partnerships are developed via technical collaborations, training, seminars, workshops, and analysis. And an active visiting research scholar program brings together international policy and technical experts to explore and promote balanced solutions encouraging increased engagement and trust between countries. Classroom and hands-on demonstrations, testing, training, and exercises and a variety of technical engagements, exchanges, studies, experiments, demonstrations, and installations increase technical understanding and proficiency both domestically and internationally.

The CGSC is engaged in many world regions, with South Asia an important region of activity. Here, the Integrated Systems Approach fosters development of next-generation technical experts, engagement and partnerships, and policy leaders on nuclear security, arms control, and nonproliferation topics. Visiting research scholars develop and catalyze ideas and technical applications including verifiable military disengagement and monitoring along the lengthy India-Pakistan border, Indian Ocean commerce and security of nuclear and radiological materials, implementing the India-Pakistan Nuclear Accidents Agreement, delimitating maritime and Sir Creek boundaries, and policy and strategic thinking on the role of the nonproliferation treaty and nuclear issues.

In addition to technology, Sandia supports human capacity development projects enabling long-term sustainability and capacity building of the next generation of nuclear safeguards and security experts. Through university curriculum development, internships, and professional training courses, Sandia is dedicated to the sustainability of the next generation of nuclear experts worldwide. In addition, Sandia's radiation protection, environmental monitoring, and risk management capabilities contribute important components of capacity building.

The make-up of the Integrated Systems Approach is further described, below.

International Nuclear and Radiological Security

The International Nuclear and Radiological Security Program's primary mission is to protect potentially vulnerable nuclear and radiological material from malevolent use. The program supports the DOE/NNSA Global Threat Reduction Initiative (GTRI) program to improve the protection of

both radiological and nuclear materials in civilian locations that could be used in either a radiological dispersal device (RDD) or an improvised nuclear device (IND). The program operates both domestically and internationally in over 25 countries on five continents to ensure that proven technologies are deployed in a comprehensive manner to reduce the likelihood of theft or malevolent use of nuclear and radiological materials.

The program applies Sandia's broad expertise in a systematic life-cycle approach including analysis, design, implementation, training, operation and sustainment, and disposal and disposition. Additionally, the program provides expert training in how to effectively search and secure orphan or lost radioactive sources. This methodical approach ensures that the materials that could threaten domestic and global security are protected throughout the world.

Secure Commerce and Border Systems

The Secure Commerce and Border Systems Program conducts global technical engagement to identify, develop, evaluate, and deploy engineered solutions in support of Sandia's Global Engineered Security Systems mission. Expertise is applied in a systematic, life-cycle approach including analysis, research and development, design, implementation, training, operation, indigenous sustainability, and disposition.

From border security to international safeguards, the program supports a variety of domestic and international users. Areas of expertise include: information assurance and analysis; intrusion detection sensors, video and communication technologies; containment and surveillance technologies; and systems engineering and integration, assessment, training, and development.

Integrated assessment is performed across a number of testing facilities ranging from materials effects testing to equipment operability, functionality, and vulnerability assessment. Extensive engagement and collaboration across Sandia and other national laboratories, government agencies, and international partners contributes to the success of the program and mission.

Cooperative Monitoring Center

The Cooperative Monitoring Center (CMC) at Sandia National Laboratories assists political and technical experts from around the world to acquire the technology-based tools they need to assess, design, analyze, and implement nonproliferation, arms control, and other cooperative security measures. As part of its mission, the CMC sponsors research on cooperative security and the role of technology in these areas.

Established at Sandia National Laboratories in 1994, the CMC provides a venue in which experts on technology and policy from around the world can explore the use of shareable, unclassified technology and research to implement confidence building measures (CBMs) and to monitor compliance with treaties and other agreements.

As part of Sandia's Global Security Program, the CMC offers facilities, subject matter expertise, and partnerships that enable all stages of international technical cooperation. These include: analyzing security issues and developing options for implementing solutions; training on monitoring and verification methods, technologies, and procedures; testing and evaluating technical approaches; and implementing and operating technical measures.

Visiting Research Scholars

Since 1998 Sandia's Cooperative Monitoring Center has developed and hosted a unique Visiting Research Scholar (VRS) Program that brings together international subject-matter experts to conduct joint research and analyses on policy and technology challenges related to global security concerns of the US government and its international partners. Often, the invited scholars represent differing views with a goal of their research to include openly examining and developing collaborative confidence building recommendations and measures between their countries, and within their region. While at the CMC, the international Visiting Research Scholars work closely with Sandia subject matter experts and others to develop, promote, and implement concepts and technical cooperation on a wide range of international security issues.

Hands-On Demonstration, Training, and Testing

Sandia's Training and Technology Demonstration Area (TTD) – showcases technologies that can be cooperatively applied to a range of monitoring applications across the globe including nonproliferation, combating terrorism, international security, border security, and arms control. The TTD is regularly employed to brief US government officials, academic colleagues, and industry partners. It also serves as a training and demonstration facility. Various training courses and workshops are frequently conducted in the TTD, which is also employed as a space for testing certain technologies in an open environment. For maximum transparency, all of the technologies on display in the facility are unclassified and exportable. Technologies in the TTD were donated by industry or developed internally or as part of NNSA, DOD, and DOE funded projects.

Facility Tours – Sandia's Integrated Security Facility (ISF) and its Sensor Test and Evaluation Center (STEC) are opportunities for highlighting physical protection technology and application.

Both facilities display real-world applications of physical protection systems applied to nuclear facilities. As a former Category-I nuclear material site, the ISF is a unique facility with the highest rigor nuclear-security systems available for training security engineers and technologists and developing state-of-the-art security systems, offering users an integrated approach to resolving the physical security challenges of nuclear security. The STEC tests and evaluates security technologies as both stand-alone components and as integrated security systems. At the ISF, domestic and international users have the opportunity to participate in physical protection system demonstration, training, testing, design, and evaluation activities.

Outdoor Testing – Sandia offers integrated system designs and capabilities for realistic, remote outdoor demonstration and testing of sensors, communications links, display technologies, assessment methods, and other integration issues for border monitoring and other applications in an open, desert environment. Outdoor testing demonstrates remote monitoring of seismic and fiber optic intrusion sensors, electromagnetic, microwave, optical, and long-range thermal imagers, ground-based radar systems, remote video assessment systems, and other open-area sensors. Fenced enclosures provide testing of intrusion detection sensors such as optical break-beams, mono-/bi-static microwave, taut wire, and fiber optic sensors. Visible-light cameras and communication antenna networks can also be demonstrated and tested for simulated facility and border configurations.

EXAMPLES of SOUTH ASIA PROGRAMS & ENGAGEMENTS

In South Asia, misconstrued perceptions or accidents regarding nuclear or radiological materials in India or Pakistan could add to tensions along the sensitive, fragile, and highly militarized Line of Control (LOC). This creates a possibility that could precipitate an unintended, unwanted escalation possibly leading to a nuclear exchange. Sandia has developed and fostered programs and engagements to lessen tensions that have plagued the adversarial India-Pakistan relationship, as well as address the potential of smuggling nuclear or radioactive materials in South Asia. A few examples of Sandia's Integrated Systems Approach as applied in South Asia are highlighted below.

International Nuclear and Radiological Security

Sandia, in collaboration with other national laboratories, commercial entities, and foreign governmental organizations applies technical approaches, methodologies, and equipment that are crucial for protecting nuclear and radiological material from malevolent use. Working collaboratively with foreign governments and operators at key ports in South Asia, radiation detection equipment and associated communications equipment are being installed. Operators, inspectors, and other personnel receive training to detect smuggled nuclear and other radioactive materials entering or transiting these ports with a goal of indigenous adoption and operation of these systems, thus reducing the threat that such materials could be transported and used locally or globally.

Unregulated Nuclear Smuggling in the Indian Ocean Region

As result of the Nuclear Security Summits and other multilateral forums such as the Global Initiative to Counter Nuclear Terrorism (GICNT), countries have strengthened their nuclear regulatory mechanisms to reduce the risk of orphan radiological sources and pilferage of nuclear material. Concurrently, terrorist groups are inflicting maximum material, financial, and human suffering, and have developed a hybrid structure, piggybacking on criminal activity to fund their terror activities. The 2008 Mumbai attack and the attack on the USS Cole in the Port of Aden are prime examples of terrorists using novel ways to carry out unconventional and spectacular attacks. Additionally, pariah states have used the Indian Ocean Region to proliferate materials and delivery components to other states in the Middle East, proving the entire stretch of Indian Ocean from

Southeast Asia to the Red Sea as a challenge to identify and interdict vessels engaged in proliferation smuggling.

Other than port monitoring programs, there has been a dearth of activities or research published on the motivations of terrorist groups and the availability of radioactive sources in the Indian Ocean Region as a viable security threat via trafficking. Therefore, to better understand the issues and develop potential solutions, the CMC invited subject matter experts from India and Pakistan to conduct a study on the potential for detection of maritime nuclear and radiological trafficking via unregulated ports and vessels. The research focused on issues, motivations, pathways, and methods to detect and interdict nuclear and radiological trafficking. It also presented recommendations for states and multinational nonproliferation advocacy organizations to address the threat. These include non-technical approaches such as involving local fishing communities to assist in the detection and deterrence of nuclear and radiological smuggling in the Indian Ocean Region.

Nuclear Security Training Series

Human capacity development is crucial for the next generation of global nuclear experts. Sandia has hosted between 25 and 30 graduate students and faculty annually from India for a summer program with participation of nearly one-hundred individuals over the last few years. The program, which began with a single university, continues to expand to additional universities each year. Students learn about nuclear security, international nuclear safeguards, and related issues for civilian nuclear energy programs and also visit facilities around the laboratory to observe first-hand the kind of work in which Sandia is engaged. Sandia collaborates with Texas A&M University and Oak Ridge National Laboratory, with students visiting the institutions for approximately one week each. The four-week program ends with the students attending the annual meeting of the Institute for Nuclear Materials Management. The Sandia-hosted curriculum includes lectures, in-class exercises, Sandia site visits & tours, as well as a guided tour of the nearby National Museum of Nuclear Science and History. The program is supported by a number of Sandia subject-matter experts who serve as lecturers and guides and exercises that introduces participants to some crucial aspects of sensor operation and testing that helped to increase their appreciation of facility tours.

MIIS Fellows and Capstone Project

Since 2012 Sandia has been the host of a Capstone Project in conducted in collaboration with the Middlebury Institute of International Studies (MIIS) and the Civilian Research and Development Foundation (CRDF) Global. CRDF invites and arranges Pakistani fellows to participate in a semester of study at MIIS followed by a nuclear security, safety, and safeguards workshop and capstone project at Sandia.

At Sandia, the fellows attend lectures and tours, interacting with a number of Subject Matter Experts (SME) on topics that include Confidence Building and Transparency Concepts, Managed Access and Onsite Inspection, IAEA Nuclear Security Recommendations on Physical Protection of Nuclear Material and Facilities, Nuclear Safety and Security Culture, and a tour of the Integrated Security Training Facility. The technical exchange with Sandia experts promotes an integrated systems analysis approach to nuclear security, safety, and safeguards exploring both technical and policy aspects. These extended interactions with the fellows build on their semester of study at

MIIS to provide training on a systems analytical framework to analyze and develop solutions to nonproliferation problems with emphasis on both technical and policy aspects.

These projects examine difficult questions and work to accomplish the main aim of the capstone project: building capacity to address nuclear security issues by practicing the analytical process on an appropriate and engaging problem. The fellows' capstone projects provide the basis for future collaborative research and cooperative engagement. At the conclusion of two weeks of research at Sandia, the scholars present their expanded research to Sandia and Washington, DC audiences. Over the course of the program to date, Sandia has facilitated the capstone projects for nearly thirty fellows, hosting two to six fellows a year.

Information Security Seminar Series

Sandia's Center for Global Security & Cooperation, in collaboration with partner universities developed an Information Security Seminar Series for South Asian Scholars. The information and security seminar is for advanced undergraduates and early graduate information technology and cyber students. Interrelationships between technology and policy associated with information and computer security, and potential cyber confidence building measures in the region, are explored to assist the next generation of South Asia information and communications technology (ICT) experts to become more proficient in information security technology measures, and to become aware of the importance of various policy ramifications related to the subject.

The seminar series uses a system approach of technical, policy, and practical learning and interaction opportunities over the course of two to three weeks. During the first week, the students focus on technical issues, vulnerability assessment methodologies, malware mitigation, and red-team training at Sandia. The second week focuses on practical, technical, and policy-related issues for information and cyber security, crime, and terrorism at the university level. This is typically followed by informal meetings with various governmental organizations and NGOs in the Washington, DC area to discuss the current and emerging views and perspectives regarding information and cybersecurity policy issues. The information technology arena is one way to foster collaboration and increase confidence in the region on what as yet seen as a non-controversial topic and to work toward "building cyber bridges" with regional counterparts.

Military and Strategic Issues and Analysis

Over the past 20 years a number of diverse issues have been researched and analyzed by CMC Visiting Research Scholars regarding military, strategic, and policy issues in South Asia, especially regarding India and Pakistan, who are nuclear-armed neighbors. Examples include:

"Missile Control in South Asia and the Role of Cooperative Monitoring Technology" – Nazir Kamal (Pakistan) and Pravin Sawhney (India) analyzed and offered possible suggestions for stabilization that could be applied to India's and Pakistan's missile development and continued peaceful talks for building mutual confidence to avert accidents, misjudgments, and misinterpretations through openness.

"Nuclear Terrorism and South Asia" – Rajesh M. Basrur (India) and Hasan-Askari Rizvi (Pakistan) studied and assessed the character and extent of the threat of nuclear terrorism. They conclude with a series of recommendations on how Pakistan and India might tackle these threats individually as well as through bilateral cooperation based on mutual interests.

"Prospects of Conventional Arms Control in South Asia" – Nazir Kamal (Pakistan) and Amit Gupta (India) researched the status of conventional arms control in South Asia, the dominant Indian and Pakistani perceptions regarding arms control, the benefits that could be derived from arms control, as well as associated prospects and problems. They also evaluated existing conventional arms control agreements at the regional and global levels as well as the potential role of technology in cooperative monitoring.

"How Cooperative Aerial Monitoring Can Contribute to Reducing Tensions Between India and Pakistan" – Air Marshal Mohammed Arshad Chaudhry PAF (retired, Pakistan) and Air Marshal K.C. Cariappa IAF (retired, India) studied the possibility of establishing an understanding between India and Pakistan through "cooperative aerial monitoring." They proposed that cooperative aerial monitoring can be instrumental in constructing bridges of confidence and removing barriers of distrust caused by years of mutual suspicion using a course of military transparency based on minimum intrusiveness, and backed by positive civil and military will.

Nontraditional, Safety, & Environmental Security Examples

Nontraditional and environmental issues present an opportunity to develop confidence building, understanding, and capacity development among contentious neighbors on less contentious issues. Examples include

South Asia Water Analysis Network – To promote cooperation in South Asia on environmental research, and encourage information sharing as a means to build confidence and reduce conflict, the CMC initiated a regional water quality monitoring and data-sharing project as part of the CMC's South Asia regional program on environmental cooperation The project incorporated subject matter experts in the regional countries to study water resources quality and management in the Ganga-Brahmaputra-Meghna river basin, and the sustainability of the Sundarbans mangrove forest area. The participants created and implemented the project and collected water samples, performed analyses of key water quality parameters, and most importantly shared the data with each other via the Internet.

Reducing Risk from Accidents Related to Nuclear Weapons – Visiting scholars and subject matter experts Sitakanta Mishra (India) and Mansoor Ahmed (Pakistan) studied the India-Pakistan Nuclear Accidents Agreement, which rests on the intention that the region could be spared a nuclear exchange as a result of an accidental nuclear weapon detonation that might be misconstrued as a deliberate use of a weapon by the other side. This study brought together two emerging strategic analysts from South Asia to explore measures to support the India-Pakistan Nuclear Accidents Agreement and further develop cooperation around this critical issue. The study outlined the measures in place for the physical protection and safety of nuclear warheads, nuclear materials, and command and control mechanisms in the two countries, and it goes on to identify the prominent, emerging challenges and modernization of the respective strategic forces. The researchers provided

an in-depth analysis and suggested a proposed framework for cooperative measures that might enhance the spirit and implementation of the Agreement.

Cooperation and Confidence Building Measures at Sea – The CMC has been actively engaged on programs, training, and collaboration with other nations on technologies useful in monitoring and verifying international treaties and agreements and building confidence in regions of conflict. A portion of this work has been devoted to assessment and demonstration of the role of technology in monitoring naval and maritime security. The sea presents unique possibilities for confidence building between India and Pakistan that are currently unattainable along the contentious land borders surrounding Jammu and Kashmir. Naval and coastal forces of India and Pakistan possess a common military culture as a result of sea-oriented responsibilities, have a less contentious history of conflict than their land-based counterparts, and recognize that pressing security, economic, and humanitarian needs at sea can best be addressed through operational coordination.

To initiate this program, the CMC hosted a Pakistani researcher, Dr. Ayesha Siddiqa as a visiting scholar in 2000 to analyze the potential for naval and maritime cooperation between India and Pakistan. That study led to a Track II naval dialogue, Confidence and Cooperation in South Asian Waters (CCSAW), sponsored by Canada and subsequent dialogues co-sponsored over the years by the CMC, National Defense University's Near East and South Asia Center, and others.

Following these initial steps, the CMC hosted two retired Navy Rear Admirals, Ravi Vohra (India) and Hasan Ansari (Pakistan) to further research and develop actionable project proposals. Their work moved beyond previous studies to include emerging maritime topic areas of concern, meetings between high-level retired naval officers of the two countries, and outlining requirements for technical projects and political support.

Their joint research and proposed technical projects focused and made recommendations on four specific project areas: technical demonstrations to support boundary delineation discussions, mechanisms to open maritime trade routes and improve port security, creation and monitoring of a fishermen zone of disengagement and repatriation database, and projects to improve communication on issues such as search and rescue between India's Coast Guard (ICG) and Pakistan's Maritime Security Agency (MSA).

Demilitarization of the Siachen Glacier and Creation of a Scientific Research Center – Visiting scholars Brigadier Asad Hakeem (retired, Pakistan Army) and Brigadier Gurmeet Kanwal (retired, Indian Army) noted that Pakistani and Indian militaries have been occupying the Siachen Glacier and surrounding regions for decades and that military analysts in Pakistan and India question the strategic significance of the Siachen Glacier and agree that under the right circumstances, military withdrawal from the Siachen Glacier region would not adversely affect either state and that continued occupation carries the risk of an inadvertent conflict, which could escalate into a full-fledged nuclear-backed confrontation. Furthermore, the withdrawn area from the conflict could be used for high-altitude studies on health and the environment as part of a cooperative Siachen Scientific Research Center. Key to these ideas are developing processes for conducting and

verifying the demilitarization of the region and the important role of technology, monitoring, and verification tools play and their relevance to this border zone of conflict.

CONCLUSIONS

For two more than decades, Sandia has promoted international nonproliferation transparency cooperation. A primary driver has been the rapid growth of nuclear energy development and the need for energy security. With such increases come growing concerns about nuclear proliferation. Robust, transparent, partnerships and international cooperative technical engagements can help address these concerns and Sandia is poised with exceptional experienced and technical capabilities to address current needs and future growth.

When the CMC was founded it was groundbreaking; there was nothing in the world like it. Since then it has inspired other centers domestically and around the world. For over 20 years, the CGSC and the CMC continues to function as a destination for people in the scientific community, a place where they can come together to work on security and treaty-related problems. The CMC has demonstrated that the common language of science and technology helps to break down barriers and to build trust and confidence. Global dangers related to weapons of mass destruction continue to top the list of the most pressing US national security concerns, and Sandia supports numerous programs that seek to reduce these threats. Through the CGSC and CMC, scientists and engineers have been able to identify and develop ways that technology can be brought to bear on pressing security and diplomatic problems. Applying the Integrated Systems Approach multiplies the effectiveness of our efforts. Sandia's innovation and unwavering focus on creating solutions at the nexus of policy and technology is what makes the CGSC and CMC a valued and respected asset to national security, now and in the future.

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