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Technical Cooperation on Nuclear Security between the United States and China

Review of the Past and Opportunities for the Future

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Abstract

The United States and China are committed to cooperation to address the challenges of the next century. Technical cooperation, building on a long tradition of technical exchange between the two countries, can play an important role. This paper focuses on technical cooperation between the United States and China in the areas of nonproliferation, arms control and other nuclear security topics. It reviews cooperation during the 1990s on nonproliferation and arms control under the U.S.-China Arms Control Exchange, discusses examples of ongoing activities under the Peaceful Uses of Technology Agreement to enhance security of nuclear and radiological material, and suggests opportunities for expanding technical cooperation between the defense nuclear laboratories of both countries to address a broader range of nuclear security topics.

CONTENTS

NOMENCLATURE

ATMS	Automated Tracking and Monitoring System
COE	Center of Excellence
CAEP	China Academy of Engineering Physics
CACDA	China Arms Control and Disarmament Association
CACE	China Arms Control Exchange
CIAE	China Institute for Atomic Energy
CNNC	China National Nuclear Corporation
CERC	Clean Energy Research Center
CTBT	Comprehensive Test Ban Treaty
FMCT	Fissile Material Cutoff Treaty
GAC	General Administration of Customs
IAPCM	Institute for Applied Physics and Computational Mathematics
IMS	International Monitoring System
MPC&A	Material Protection, Control and Accounting
MEP	Ministry of Environmental Protection
PUNT	Peaceful Uses of Nuclear Technology
SNL	Sandia National Laboratories
WIPP	Waste Isolation Pilot Plant

1. Introduction

The United States and China are committed to a cooperative partnership to address the numerous challenges of the 21st century. At the end of their summit meeting in Washington, D.C. in January 2011, Presidents Obama and Hu issued a Joint Statement that noted the wide range of existing cooperation on security, economic, social, energy, and environmental issues and called for broadening and deepening cooperative activities to "promote peace, stability, prosperity, and the well-being of peoples throughout the world." [1] They noted several areas meriting greater attention:

- Strengthening China-U.S. Relations
- Addressing Regional and Global Challenges
- Building a Comprehensive and Mutually Beneficial Economic Partnership
- Cooperating on Climate Change, Energy and the Environment
- Extending People-to-People Exchanges

Technical cooperation can play an important role in all of these areas, and there is a strong tradition of technical cooperation between the United States and China. Indeed, one of the first agreements between the two countries was the bilateral Agreement on Cooperation in Science and Technology, signed on January 31, 1979 by U.S. President Jimmy Carter and China's leader Deng Xiaoping.[2] The 1997 Agreement of Intent on Cooperation Concerning Peaceful Uses of Nuclear Technology (PUNT) Agreement, that provides a framework for bilateral technical cooperation in civil nuclear energy and nonproliferation, is another example.[3] The Academies of Science in the two countries also have a long history of cooperation, both on general scientific matters and on issues related to nuclear security and arms control.[4] There also is extensive technical cooperation on energy issues, including the 2009 establishment of a U.S.-China Clean Energy Research Center (CERC).[5] In addition to building technical capacity and producing new scientific knowledge, such cooperation

[1] For the full text of the China-US Joint Statement following the January 2011 summit in Washington, D.C., see http://www.whitehouse.gov/the-press-office/2011/01/19/us-china-joint-statement.

[2] U.S. China: Thirty Years of Science and Technology Cooperation: http://www.state.gov/g/oes/rls/fs/2009/130625.htm .

[3] "Agreement of Intent on Cooperation Concerning Peaceful Uses of Nuclear Technology Between the Department of Energy of the United States of America and the State Planning Commission of the People's Republic of China," 29 October 1997: < http://www.nti.org/db/china/engdocs/sccoop97.htm> .

[4] The Chinese-American Kavli Frontiers of Science Symposium Series <http://www.nasonline.org/site/PageServer?pagename=FRONTIERS_cafos> brings together young scientists to discuss their research and highlight major research challenges. The U.S. National Academies Committee on International Security and Arms Control (CISAC) has had a long-standing dialogue with the Chinese Scientists Group for Arms Control (CSGAC). Most recently, CISAC and CSGAC completed the "English-Chinese Chinese English Nuclear Security Glossary" < http://sites.nationalacademies.org/PGA/cisac/PGA_050966>.

[5] U.S.-China Clean Energy Research Center: http://www.us-china-cerc.org/, and U.S. – China Energy Cooperation: http://www.pi.energy.gov/usa_china_energy_cooperation.htm .

has been an important vehicle for improving political relationships, enhancing security of both countries, and building technological capacity.

This paper focuses on technical cooperation between the U.S. and China in the areas of nonproliferation, arms control and other nuclear security topics. First it reviews cooperation during the 1990s on nonproliferation and arms control under the U.S.-China Arms Control Exchange.[6] Second it discusses examples of ongoing activities under the PUNT agreement to enhance security of nuclear and radiological material, including plans for establishing a Center of Excellence on Nuclear Security in Beijing. Finally, it discusses opportunities for expanding technical cooperation to address a broader range of nuclear security topics as articulated in the January 2011 Joint Statement, and suggests next steps.

2. The U.S. – China Arms Control Exchange

The U.S.-China Arms Control Exchange (CACE) was initiated in 1994 as a cooperative program between the U.S. nuclear laboratories and their Chinese counterparts. United States participants were drawn from Sandia, Lawrence Livermore and Los Alamos National Laboratories. Chinese participants were from the China Academy of Engineering Physics (CAEP) and its Institute for Applied Physics and Computational Mathematics (IAPCM), both part of the Chinese military establishment.[7] The civilian China Institute for Atomic Energy (CIAE) also participated in selected projects. All activities were subject to strict oversight by government agencies in both countries, even though a formal government-to-government legal framework was never established.
After agreement that technical cooperation on nonproliferation and arms control could be mutually beneficial, the Chinese established a steering group, which began meeting with counterparts from the United States 1995. A series of workshops to identify common interests occurred in 1996, followed by the initiation of joint projects in 1997.

Mutually agreed objectives for cooperation included joint development and deployment of modern technology to benefit arms control and nonproliferation, building trust through better understanding of the operations and management of nuclear facilities in both countries, and establishing long-lasting professional relationships. Activities were carried out through formal meetings, workshops, and scientific exchanges such as lab visits and demonstrations. Topics for cooperation fell into several broad categories:

- **Material Protection, Control and Accounting (MPC&A):** The objective of collaboration on MPC&A was to demonstrate the use of modern techniques for nuclear material protection and accounting to strengthen domestic safeguards against sub-national theft. It was the flagship project of CACE. The CAEP and the China Institute for Atomic Energy (CIAE), the research arm of the civilian China National Nuclear Corporation (CNNC), were the primary Chinese participants. The demonstration occurred in Beijing in 1998 at a material storage vault at CIAE's

[6] Nancy Prindle, "The U.S.-China Lab-to-Lab Technical Exchange Program," *The Nonproliferation Review*, Spring-Summer (1998), p. 111.

[7] The CAEP is responsible for nuclear weapons R&D and reports to the General Armaments Department within the People's Liberation Army (PLA). The IAPCM conducts research for the CAEP, including on nuclear warhead design and arms control.

Laboratory of Technical Research for Nuclear Safeguards, using a combination of U.S. and Chinese technologies. In preparation for the demonstration, Chinese staff worked at both Sandia and Los Alamos National Laboratories.[8]

- **Verification Technologies:** The primary objective in this category was to increase understanding of the International Monitoring System (IMS) for the Comprehensive Test Ban Treaty (CTBT) and to build confidence in the ability to host on-site inspections without revealing national security information. The CAEP and the IAPCM were the primary partners. Workshops focused on data analysis and presentation methodologies, and proposals were developed for seismic experiments and simulation of on-site-inspection exercises. In addition, a workshop was conducted to exchange information about atmospheric modeling, which resulted in the transfer of U.S. atmospheric modeling codes, and a demonstration of Chinese turbulence modeling.
- **Cooperative Monitoring Technologies:** The objective was to explore general approaches to treaty monitoring and transparency that were in wide use by the United States, Russia and other countries. The CAEP was the primary partner. After a workshop covering a broad range of topics, remote monitoring emerged as a particularly interesting research area. A scientist from CAEP worked at Sandia for several months on the Automated Tracking and Monitoring System (ATMS), a system for monitoring shipments of nuclear material, to make enhancements for its application in China. There was also significant mutual interest in developing common approaches to monitoring fissile material production and storage, and two workshops were planned for 1999.
- **Export Control:** The objectives were to strengthen export controls through involvement of the scientific nuclear community, to build technical infrastructure for export control, and to develop relevant technical expertise. The partners were CAEP, CIAE and the IAPCM. There were a number of workshops, the first of which focused on the role of U.S. scientists in nuclear export control. The CAEP sought to establish a new role for itself as a provider of technical advice to the Chinese export control establishment and was eager to understand the role that the U.S. nuclear laboratories played in this arena.
- **Energy and Environment:** This broad category included atmospheric modeling for emergency response, nuclear waste management, nuclear reactor safety and clean energy. At the time, the CAEP wanted to establish a wider role for itself in energy technology, and saw the U.S. nuclear laboratories' energy programs as possible models for China. The Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico sponsored a workshop on geologic repositories held in Beijing. In addition, a number of other projects were considered, including probabilistic risk assessment and clean coal technology.

[8] S.T. Hue, *et. al.* "Integrated Demonstration of MPC&A (LALP-98-65)," Los Alamos National Laboratory, (Los Alamos, NM: June 1998).

During the time that U.S. and Chinese nuclear experts were developing plans for increased cooperation under the CACE, a committee from the U.S. House of Representatives was investigating allegations of Chinese espionage. In 1999, it released the Cox Commission Report, which alleged (among other things) espionage on the part of China and lax security on the part of the U.S. nuclear laboratories.[9]

The Cox Committee's allegations were disputed by both U.S. and Chinese experts.[10,11] Nonetheless, there was lasting political damage to the process and cooperation under the CACE slowed and eventually ended.

Despite interest by both sides, cooperation between the U.S. nuclear laboratories and the CAEP has not yet resumed. Informal contacts and discussions between U.S. and Chinese technical experts continue to take place, most notably at the biannual PIIC Beijing Seminar on International Security, which is co-sponsored by IAPCM and attracts significant numbers of participants from the CAEP.[12] In addition, interactions occur through nongovernmental and academic forums.

3. Technical Cooperation under the PUNT Agreement

The PUNT agreement (concerning civilian nuclear cooperation) was signed in 1997 contemporaneously with cooperation under the CACE. It authorized the exchange of information and promoted technical cooperation on specific topics such as export control for nuclear materials and technology, nuclear materials control and accounting, physical protection of nuclear materials and facilities, and technology for enhancing international nuclear safeguards, some of which was already underway under the CACE. Cooperation slowed after the Cox Commission Report and some work stopped. However, efforts on MPC&A resumed in 2004, and technical cooperation with civilian nuclear entities in China has expanded significantly since then. Examples include:

- **Material Protection, Control and Accounting:** Cooperation with the China Institute of Atomic Energy (CIAE) and the China Atomic Energy Authority (CAEA) has focused on nuclear security and emergency preparedness. In 2005 the United States and China held a joint integrated nuclear materials management technology

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[9] The United States House of Representatives Select Committee, "U.S. National Security and Military / Commercial Concerns with the People's Republic of China," (Washington, D.C.: U.S. Government Printing Office, 1999), http://www.house.gov/coxreport.

[10] M.M. May, (Editor), Alastair Johnston, W.K.H. Panofsky, Marco Di Capua, and Lewis Franklin, *The Cox Committee Report: An Assessment* (Palo Alto, CA: Stanford University, December 1999), http://iis-db.stanford.edu/pubs/10331/cox.pdf; Spurgeon M. Keeny, Jr., "Hyping Chinese Espionage," *Arms Control Today*, (April/May 1999). http://www.armscontrol.org/print/475; Ivan Eland, "Chinese Nuclear Espionage: Is the Hysteria Warranted" (3 June 1999), http://www.cato.org/pub_display.php?pub_id=5120.

[11] "Chinese Anger at US Claims," *BBC World News*. (25 May 1999), http://news.bbc.co.uk/2/hi/asia-pacific/352346.stm; John Pomfret, "Beijing Rejects Spying Allegations," *Washington Post* (16 March 1999). http://www.washingtonpost.com/wp-srv/inatl/longterm/china/stories/zhu031699.htm

[12] The PIIC Beijing Seminar on International Security is a biannual meeting focused on arms control and nonproliferation that is co-sponsored by the Rome-based ISODARCO and a number of Chinese organizations. PIIC is an acronym of acronyms: **P** (Program for Science and National Security Studies (PSNSS)), **I** (Institute of Applied Physics and Computational Mathematics (IAPCM)), **I** (International School on Disarmament and Research on Conflicts (ISODARCO)), **C** (Chinese Institutes of Contemporary International Relations (CICIR)).

demonstration in Beijing. The objective was to emphasize the integration of physical protection, material control, and material accounting technologies. The project scope included the demonstration of jointly designed and installed physical protection systems at the Fast Neutron Critical Facility and at an adjacent nuclear material storage facility located at the CIAE. It also included a jointly designed and installed exterior sensor test field at the CIAE Safeguards Laboratory. In addition, there have been multiple workshops on design basis threat, vulnerability assessment, integrated nuclear safeguards and security and insider analysis.

- **Radiological Source Security:** Cooperation with China's Ministry of Environmental Protection (MEP), formerly the State Environmental Protection Agency (SEPA), CIAE, and CAEA has focused on securing nuclear and radiological materials at civilian sites in China and building Chinese capacity to address continuing and future security concerns. Prior to the 2008 Beijing Olympics, physical protection upgrades were implemented at seven sites with radiological sources near Olympic venues. Since 2008 the United States has worked with the Chinese government to provide security upgrades at more than 20 additional facilities and to conduct training courses across the country.
- **Megaports Initiative:** Cooperation with China's General Administration of Supervision, Inspection, and Quarantine and the General Administration of Customs to enhance the ability to detect special nuclear and other radioactive materials in containerized cargo at Shanghai and Hong Kong is currently underway.
- **Nuclear Export Control:** Cooperation with China's General Administration of Customs (GAC), in cooperation with the China Arms Control and Disarmament Association (CACDA) focuses on effective means and ways to recognize and inspect WMD-related goods.
- **Nuclear Fuel Cycle R&D:** China was among the original sixteen members of what was formerly known as the Global Nuclear Energy Partnership (now referred to as the International Framework for Nuclear Energy Cooperation). Construction is underway in China on the first Westinghouse AP1000 nuclear power reactor. It is expected to be operational by 2015. Nuclear experts in the United States are interested in learning from the experience as the reactor has not yet been licensed for U.S. operation.

In January 2011, a Memorandum of Understanding between the United States and China to establish a Center of Excellence (COE) on Nuclear Security in Beijing was signed. This agreement represents a substantial investment by both countries. The COE will have extensive training facilities, analytical laboratories, and facilities to test and evaluate a wide spectrum of nuclear security technologies. The scope of cooperation will include: nuclear safeguards, nuclear material physical protection, control, and accounting; nuclear detection technology; nuclear measurement; and nuclear emergency preparedness and response. It is intended as a forum for exchange of best practices, development of training courses, technical collaboration, technology demonstrations and field testing of physical security and related technology. It will serve as a focal point to promote multilateral nuclear security throughout the Asia/Pacific region as well as the broader international community.

Although ground-breaking for the COE is not expected until 2012, there is extensive ongoing cooperation between experts during the design phase. The facilities for test and evaluation of nuclear security technology will be based largely on similar facilities at Sandia National Laboratories. During the March 2011 meeting of the Joint Coordinating Committee of the PUNT Agreement, U.S. and Chinese officials announced that they would continue expanding cooperative research and development of new technology to guarantee a safe and secure nuclear future. They also agreed to establish a new joint working group on radioactive source security.

4. Opportunities for Expanding Technical Cooperation in the Future

The January 2011 Joint Statement establishes a framework for expanded technical cooperation between China and the United States in the future. In particular, both countries reaffirmed their commitment to the eventual realization of a world without nuclear weapons, the need to strengthen the international nuclear nonproliferation regime, and the need to address the threats of nuclear proliferation and terrorism. They also affirmed their support for early entry into force of the Comprehensive Test Ban Treaty (CTBT) and commencement of negotiations on a Fissile Material Cutoff Treaty (FMCT). Additionally, they agreed that maintaining peace and stability on the Korean Peninsula was critical, and noted the importance of improving North-South relations and of taking concrete steps to achieve denuclearization of the Peninsula.

Achieving these goals will require overcoming both political and technical challenges. Technical experts in both countries can support their governments by careful preparatory work.[13] Should the governments of China and the United States decide to pursue a broader range of bilateral technical cooperation, a number of options could be considered. The following ideas are intended to stimulate discussion.

- **Technical cooperation related to CTBT and FMCT:** Enhancing mutual understanding of each country's perspectives on the challenges posed by a CTBT, including outstanding technical issues surrounding verification, could be a first step. Exchange of views, possibly through site visits, could help build confidence, clarify concerns, and pave the way for additional cooperative measures.

  Although the scope and terms of a potential FMCT remain uncertain, verification measures may pose challenges for both the U.S. and China. There may be opportunities for U.S. and Chinese technical experts to work together to explore technical options or to develop tools to help assess possible monitoring approaches.

- **Analysis and Modeling of Potential Future Nuclear Arms Reductions:** China and the United States are both committed to a world without nuclear weapons while at the same time modernizing their nuclear weapons complexes. Exchanging information about the technical and operational challenges of pursuing these objectives in an integrated manner

[13] A good example is the Group of Scientific Experts that developed approaches to seismic monitoring for a CTBT starting before the treaty was negotiated. By the time negotiations were underway, there was widespread agreement on the specifications for the seismic portion of the International Monitoring System.

could be useful.[14] In addition, joint development of scenarios for future arms control, joint development of modeling tools to allow assessment of impacts of future treaties on nuclear complexes, and joint assessment of monitoring options for future agreements could be considered.

Should joint analysis result in promising approaches, testing and evaluation of monitoring options could be a next step. The facilities at Sandia National Laboratories used for test and evaluation of arms control monitoring options closely resemble those planned for the COE on Nuclear Security in Beijing. Might this be a future role for the COE?

- **Applications of Nuclear Security to Materials in the Defense Sector:** To date, U.S.-China cooperation on nuclear security has focused on the protection, control, and accounting of nuclear materials at civilian sites. However, the same principles apply to material in the defense sector. The COE on Nuclear Security will have facilities and capabilities that are broadly applicable to both. Options for expanding cooperation could be explored within the context of the COE. Exchanging information about best practices and lessons learned for safety and security of materials in the defense sector could be a first step.
- **Korean Peninsula Security:** Denuclearization of the Korean Peninsula is a long-term goal and there will likely be many interim steps. U.S. and Chinese technical experts could facilitate development of measures to provide confidence in interim steps acceptable to all members of the Six-Party talks. Assessing how technical measures could facilitate confidence and security building on the Peninsula could be another topic for joint analysis.[15]
- **Multilateral Cooperation on Nuclear Security:** In addition to bilateral technical cooperation, U.S. and Chinese experts could work together in multilateral environments, e.g., the ongoing P-5 process on nuclear security. In September 2009 the United Kingdom hosted a conference of the P-5 on Verification and Transparency of nuclear arms control. This conference set the stage for countries to discuss a wide range of nuclear issues. As a follow on to the 2009 Conference, the French government has announced that they will host a P-5 conference in Paris in 2011. The United States supports cooperation among the P-5 on nuclear weapons issues and hopes that such conferences will become a regular occurrence.

  Establishing a P-5 technical working group to support the process has been suggested, and could provide another venue for technical cooperation. Possible projects could be to build on the U.S.-Chinese lexicon developed by the U.S. National Academies of Science, conduct joint exercises for nuclear incident response, explore the concept of best

[14] For an exploration of ideas for accomplishing this, see Lani Miyoshi Sanders, Sharon M. DeLand, and Arian L. Pregenzer, "Integrating Nuclear Weapons Stockpile Management and Nuclear Arms Control Objectives to Enable Significant Stockpile Reductions," *The Nonproliferation Review*, November 2010, pp. 475 – 489.

[15] Such analysis could build on previous work conducted by resident and visiting scholars at the Cooperative Monitoring Center (CMC) at Sandia National Laboratories. For example, "Confidence Building Measures at Sea: Opportunities for India and Pakistan," Rear Admiral Hasan Ansari and Rear Admiral Ravi Vohra, 2004, SAND2004-0102. This paper as well as many others can be found on the CMC website: http://www.cmc.sandia.gov/papers-reports.htm.

practices or common standards for nuclear weapons security, and if appropriate, evaluate technical approaches to monitoring future nuclear arms reductions. Nuclear forensics also could be a topic for discussion.

- **Research and Development on Unclassified Nuclear Science and Technology:** Joint research and development on unclassified nuclear science and technology can help establish and sustain long-term relationships. Topics for research that would be relevant to a broad range of nuclear security topics include: nuclear detection technologies, nuclear forensics, information assurance, and risk and safety analysis. Depending on mutual interests, other topics in materials science, computational techniques, and plasma physics could be explored. Cooperation could range from exchange of information, to visiting researchers, to joint experimental teams working at both Chinese and U.S. facilities.[16]

5. Conclusion

China and the United States have a broad base of shared interests and a long history of cooperation on science and technology. Technical cooperation under the PUNT agreement has played an important role in achieving common goals for material protection, control, and accounting, securing radiological sources, detecting special nuclear materials at ports, and controlling nuclear exports. It has also promoted joint nuclear fuel cycle R&D. The planned Center of Excellence on Nuclear Security will significantly expand the scope of cooperation between the two countries.

Should the United States and China agree to renewed cooperation among their defense nuclear laboratories, there are numerous opportunities to expand technical cooperation. These include exploration of issues relevant to the CTBT and FMCT, analysis and modeling of future nuclear arms reductions, applications of nuclear security to material in the defense sector, and Korean Peninsula security. Basic research on nuclear materials, high-energy environments, and other topics could also be pursued.

Expanded cooperation on nuclear security would represent a major step in U.S.-China relations. However, commitment at the government level, including a clear legal framework for technical cooperation, will be required. The PUNT agreement has played this role in cooperation on civilian nuclear issues. If governments decide to pursue a broader agenda for technical cooperation, exchange of information about mutual interests, followed by site visits to discuss specific topics for cooperation, could be first steps.

[16] The CMC at Sandia National Laboratories has a long history of hosting international experts from around the world for projects ranging from developing new safeguards technology, to designing border monitoring systems, to analyzing requirements for regional confidence and security building measures. It also provides access to a wide range of test and evaluation facilities, including test-beds for physical security, radiation detection, and border security.

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