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HEARING ON CHINA'S HIGH TECHNOLOGY DEVELOPMENT
BEFORE
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Introduction

Mr. Chairman and Members of the Commission, I appreciate the opportunity to appear before you today on behalf of the Bureau of Oceans and International Environmental and Scientific Affairs of the U.S. State Department to discuss the U.S.- China Science and Technology Report, the contents of which we coordinated with numerous federal agencies and recently submitted to Congress. This report satisfies the requirements of a provision of law that calls for a comprehensive review of activities under the U.S.-China Science and Technology Agreement of 1979. I understand that the Commission worked closely with the Congress in developing the reporting requirement.

The Administration believes that advancing common interests in peace and prosperity with China is key to achieving our long-term national security goals. As noted in the President's 2002 National Security Strategy, "[t]he United States' relationship with China is an important part of our strategy to promote a stable, peaceful, and prosperous Asia-Pacific region. We welcome the emergence of a strong, peaceful, and prosperous China." One of the requirements of this report is an "assessment of how the Agreement has influenced the foreign and domestic policies of the People's Republic of China and the policy of the People's Republic of China toward scientific and technological cooperation with the United States." Through government, scientific, and academic contacts with a large number of Chinese officials and citizens, we are exerting a critical influence over their views, their path of development to a market-based system, and policies toward the United States.

Turning to science and technology cooperation, a key component of any nation's economic and social development is the effort to advance scientifically and technically. China has long endorsed the view that there can be no true economic or social growth without such advancement. Since January 31, 1979, China and the United States, under the S&T Agreement, have carried out a diverse and mutually beneficial commerce of ideas through scientific cooperation, education, and dialogue across the entire spectrum of human knowledge. Although there are areas where we likely will compete, as there are areas where we must protect both information vital to our national security and the intellectual property of our citizens, the benefits of our scientific and technological cooperation with China far outweigh the costs of this relationship. Achieving a candid, constructive, and cooperative relationship with China is the task set before our diplomatic

and scientific communities by the President. In response, the goal of the federal agencies now engaged in the efforts highlighted in the report is not only to tap into and help shape China's growing scientific and technological resources, or to help China handle pressing problems like environmental damage or HIV/AIDS, but to influence China's development into a country with whom we can share common interests that align our nations together against poverty, international crime and terrorism, and other global threats to human welfare, health, and dignity.

The Science and Technology Agreement

The principal objective of the Agreement is to provide broad opportunities for cooperation in scientific and technological fields of mutual interest, thereby promoting the progress of science and technology for the benefit of both countries and of mankind. Cooperation under the Agreement includes activities in the fields of agriculture, energy, space, health, environment, earth sciences, and engineering. The Agreement provides for exchanges of scientists, scholars, specialists and students, and of scientific, scholarly, and technological information and documentation. It also provides for joint planning and implementation programs, courses, conferences, seminars and projects, joint research, development and testing, and the exchange of research results and experience between cooperating U.S. and Chinese entities. Facilitation of scientist-to-scientist collaboration under this agreement has been a key to the success of the bilateral S&T relationship.

The S&T Agreement itself is a broad "umbrella" agreement that provides for some of the more general conditions for cooperation, but which cannot anticipate all of the subjects for cooperation that may arise over the years. The U.S. technical agencies and their Chinese ministry counterparts therefore develop subsidiary, subject-specific agreements for their cooperation that are "Protocols" or "Memoranda of Understanding." Some of these protocols refer to single specific joint S&T activities, while other protocols cover a broader subject area and may contain a set of related sub-agreements (project annexes) to further define cooperation in specific areas. The number of protocols has grown over the years, and there are now more than 26 active protocols and over 60 annexes.

Benefits of the Agreement to Both Countries

Science and technology cooperation with China has benefited the United States in many areas. The following are examples:

- Access to an increasingly large cadre of low-cost, well-trained and well equipped researchers with whom U.S. scientists can do cooperative research to meet U.S. scientific goals.
- Access to a significant high energy physics research facility built at Chinese expense, with much technical assistance from the U.S., and collaboration in its scientific program has resulted in many important measurements of elementary particle properties.

- Obtaining current information on the evolution of the Chinese nuclear power industry and the state of its technology. Cooperation in the nuclear power industry opens potential markets for advanced U.S. nuclear power technology.
- Adoption of clean coal and clean burning fossil fuel technologies in China opens a huge potential market for clean energy technologies and equipment in which U.S. industry is a world leader. Collaborative projects have set the stage for Chinese support of U.S. energy businesses.
- Chinese exchanges with the National Institute of Standards and Technology (NIST) help promote the use of U.S. measurements and standards in China. The development of a measurement infrastructure is necessary to support international trade and help increase U.S. exports.
- Joint research into Chinese mineral resources, including oil and gas, has given the U.S. an advantage in a number of areas. Increases in China's oil and gas potential provide both nations with alternatives to Middle East oil. U.S. cooperation in discovering and developing China's fossil energy reserves also creates large potential markets for U.S. oil industry equipment suppliers, as well as joint venture opportunities for U.S. oil companies.
- China has invested heavily in remote sensing and mapping research and a large number of Chinese scientists are international leaders in the field. USGS-China cooperation leverages Chinese expertise to provide global data valuable in monitoring transboundary environmental phenomena.
- A multi-year U.S.-China study of almost 250,000 women in China demonstrated conclusively that folic acid supplementation during early pregnancy can prevent Neural Tube Defects such as spina bifida and anecephaly.
- Cooperation brought substantial benefits to U.S. agriculture. Much of the grass growing on U.S. rangelands is derived from Chinese varieties acquired by USDA.
- In projects of mutual interest, like DNA sequencing of the cotton and rice genomes, cooperation provides access to the DNA sequencing data in a shorter timeframe and at much less expense than if the U.S. were working alone.
- Cooperation in marine resources benefits the U.S. scientific and commercial sectors by providing access to large-scale fisheries and aquaculture production practices used in China.
- Cooperation has brought mutual benefits to both the U.S. and China with new data on climate to develop improved, predictive models for use in understanding how climate may change.

Some areas where China has gained include:

- Collaboration (mostly) with the U.S. has facilitated China's becoming a participant in the worldwide high energy physics research enterprise.
- The overall public health of China's population has been improved through collaboration in the fields of medicine and public health. The U.S. government funded Global Aids Program and Comprehensive International Program of Research on AIDS is but one example of this cooperation.

- Safety of China's growing nuclear power industry has been enhanced by cooperation with the U.S. Nuclear Regulatory Commission and the Department of Energy.
- Chinese agricultural production has increased as a result of collaborative programs with USDA. New crops, new varieties, and improved irrigation and farming techniques were introduced through S&T collaboration.
- China's efforts to clean up industrial pollution and prevent further environmental degradation have been aided by cooperation with NOAA and EPA.
- Access to U.S. labs has helped Chinese scientists address disease, genetic and biotechnology issues and develop environmentally-friendly fish farming techniques.
- China has become more efficient in the use of energy. Alternative energy technologies have been introduced.
- The development of China's mining and petroleum industries has been facilitated by joint projects in mineral research, geology and deep-ocean drilling.
- China's efforts to investigate fusion as a potential energy source for the future, including participation in the negotiations to construct a major international fusion facility called ITER, have been aided through technical collaborations with Department of Energy sponsored laboratories and universities.

Assessment of the Influence of the Agreement

The U.S.-China S&T Agreement has provided China with some benefits that have helped close some of its scientific and technological development gaps. At the same time, the Agreement has helped moderate the bilateral relationship, given the U.S. access to the Chinese market and labor pool, and supplied the U.S. with significant amounts of high tech research talent and labor. As a result, both countries have benefited from the Agreement, though in different ways. The report's analysis of various aspects of the Agreement's implementation has not identified any signs of significant diversion of high-tech information that would be of use to China's military and defense industries.

The S&T Agreement has facilitated a deep and ongoing dialogue between the U.S. and Chinese science communities. This dialogue occurs between U.S. technical agencies and their Chinese ministry counterparts at the policy level, but is probably most intensive at the level of individual scientist-to-scientist communication, either face-to-face at conferences, meetings, and in the laboratory, or through the internet. Such communication would undoubtedly occur regardless of the presence of a diplomatic agreement, but the cooperative activities undertaken as a result of agency memoranda of understanding (MOU's), signed under the Agreement and its protocols, provide a structural basis for individual scientists to develop partnerships with colleagues living in other countries with similar research interests.

The Administration also believes that U.S.-China S&T cooperation has played a consistent stabilizing role in U.S.-China relations. While the overall U.S.-China relationship may swing up or down as a result of political and economic developments, changes in leadership and other factors, the U.S.-China S&T relationship has remained a

largely stable pillar of the bilateral relationship, allowing a continuance of cooperative activities in science and technology at levels determined more by scientific accomplishment, interest and available budget than by geopolitical interest.

In addition to promoting good will, trust, and openness, U.S.-China science and technology cooperation has contributed to PRC domestic policy reforms by providing the PRC government with information that helps guide the ongoing reform process. For example, in the area of remote sensing, cooperation between USGS and the Chinese Academy of Sciences has involved joint research and exchanges in the rectification, enhancement, classification, and interpretation of remote sensing images. As an example, using this information, the Chinese leadership concluded that China was losing cultivated land to development at a rate faster than previously thought. In response to this information, Chinese leaders ordered a one-year freeze on all agricultural land conversions not specifically authorized by the State Council and imposed strict new measures to intensify land management initiatives to protect China's cultivated land. In another example, remote sensing information revealed that local governments, intending to maximize their disaster relief assistance, exaggerated the amount of land affected by the 1998 Yangtze flood by ten times. Both of these examples illustrate how U.S.-China cooperation in remote sensing can provide information that helps redress local government misreporting and corruption.

China is a rapidly developing science and technology center in Asia. Several areas in China's S&T base warrant close U.S. attention, including information technology, software development, and the budding biotechnology and nanotechnology sectors. As China progresses toward catching up with Western industrialized nations, continued U.S.-China research cooperation allows the U.S. to monitor China's technological advancements. But U.S.-China cooperation can also help leverage U.S. research investments in key high tech areas by using the contributions of Chinese scientists to attain U.S. research goals. China's developing science and technology capabilities suggest that future U.S.-China cooperative activities could yield even more benefits to the U.S. than ever before.

This win-win scenario of science and technology cooperation is not unique to the U.S.-China relationship, but is part of a much wider trend in the way science is advancing globally. Multinational corporations, seeking to tap into emerging markets and low-cost, highly skilled labor in developing countries, have led the internationalization of research and development worldwide. In China and other countries, the rise of the internet and the increasing mobility of humans and financial capital have led to the global dispersion of well-educated engineers, scientists and researchers, laying the foundation for international research cooperation opportunities in both the private and public sectors.

Now, more than ever, government-funded science has become a unified global effort. For the past two decades, the most challenging science and engineering problems have been tackled by international teams of researchers with common interests and complementary expertise. In an increasingly global world of open information and collaboration, scientific cooperation is not a zero-sum enterprise. Generally, scientists only cooperate if

they share complementary resources that can be leveraged to achieve mutually beneficial goals. Today's team-centered, global approach to science and technology provides tremendous potential for advances and discoveries in international "big science" cooperative projects. Bearing these trends in mind, tomorrow's technological leaders will not be the countries that restrict the sharing of knowledge and technology, but those which can effectively use international scientific resources to create innovative new solutions through cooperation.

An example of this global cooperation is the proposed ITER project whose mission is to demonstrate the scientific and technological feasibility of fusion as an energy source. Six Parties, including China and the U.S., are currently involved in negotiations for the construction, operation, and decommissioning of ITER. If these negotiations are successful and the project proceeds, all of the Parties will have excellent opportunities to work together on ITER construction and to share the benefits of such collaboration as well as the subsequent research results gained during operation.

Four specific areas in science and technology development are of particular interest to the United States: information technology, software development, biotechnology, and nanotechnology. China's information technology sector (IT) now forms the core of China's S&T enterprise. China's IT market is one of the fastest growing markets worldwide and is now the second largest in the Asia-Pacific region, behind Japan. The Chinese market for IT products and services was $22 billion in 2002, and is expected to exceed $40.2 billion by 2006. Chinese companies are matching most if not all of the current trend lines for advanced telecommunications systems and are providing the full range of telecommunications equipment.

China could also become a significant player in software development. As of 1993, China already had more software professionals than any other country aside from the United States. China's Ministry of Information predicts that software and systems integration product sales from China's 2200+ software companies should climb 30% in 2004 to reach U.S. $25 billion. With computer and communications hardware becoming increasingly complex, software developers worldwide are encountering severe problems devising reliable systems. According to experts, U.S.-China cooperation efforts to resolve some of these fundamental difficulties could be highly productive for both parties.

China is making a significant effort in biotechnology, especially in the area of genetic engineering. The Chinese government has promoted biotechnology since the 1980s through ambitious multiple research programs. Current Chinese research areas include agricultural biotechnology, genomic sequencing, biochips, leveraging leads produced by traditional Chinese medicine, bioinformatics, stem cell research, biomanufacturing, and toxicology testing. Biotech research, which was traditionally concentrated in universities and state research facilities, has also spun-off startup companies comprising a booming Chinese biotech market. China's biotech market is currently about $3 billion, and is forecasted to grow at 13.5% annually to reach $9 billion in 2010.

While China is globally competitive in genome sequencing, agricultural biotechnology, and gene therapy, its biotech industry as a whole struggles to commercialize new products and produces relatively few exports. Experts predict that it will take at least a decade for China to develop a world-class biotech industry. Major barriers to commercialization include a weak venture capital industry, poor patent protections, and difficulties in adopting Chinese products to fit stringent regulations in major world markets.

China is starting to become a global player in nanotechnology, which Chinese leaders view as one of the nation's most important scientific fields for future research and development. While still a nascent industry, China is investing heavily in nanotechnology, with the central government budgeting approximately $240 million and local governments contributing $240-360 million from 2001-2005. China already ranks third in the world, behind the United States and Japan, in the number of nanotechnology patent application cases. Its 2,400 patents represent 12% of the world's total. China is also seeking to establish a national nanotech infrastructure and has established the China Nanotechnology Center facility in Beijing, a center dedicated to nanotechnology research and development. China's current research in nanometric materials and their applications, tunnel microscope analysis and monatomic control, has approached internationally advanced levels, but domestic studies in nanometric electronics and nanometric biomedicine still lag behind the developed countries.

Advances in Chinese S&T capabilities in key research areas can provide important opportunities for the U.S. S&T enterprise. Using the expertise, initiative and money of foreign partners like China can help the U.S. retain its competitive advantage and technological superiority. The free exchange of scientific information and the growing S&T capabilities of developing countries will mean that the key to future U.S. science and technology leadership will not depend upon hoarding high-tech secrets from other countries. Instead, it will depend upon creating with foreign partners a distributed information network from which spring global innovation and discovery.

China is rapidly developing and becoming a major user of fossil energy resources. The S&T Agreement has provided key data and training to Chinese scientists to understand how China's energy growth may impact climate in the future.

Assessment of Impact of S&T Activities on China's Industrial Base and Economic Capabilities

Over the period in which the S&T Agreement has been in force, China has made enormous economic strides. Certainly cooperative activities under the agreement have provided some economic benefit to China including helping to develop China's minerals, mining and petroleum industries, increasing agricultural production, enhancing energy efficiency, reducing pollution and improving public health. Economic benefits to the U.S. derived from this cooperation and highlighted in an earlier section, have also been considerable .

The extent to which cooperative S&T activities conducted under the Agreement may have contributed to China's economic growth is difficult to assess. China's dramatic economic transformation has been the result of macroeconomic decisions by the PRC that allowed market forces and capital to operate in China, and stimulated massive foreign and domestic capital investment. Advances in China's science and technology capacity have also played a critical role in driving China's economic growth. High-technology exports from China and Hong Kong exceeded $100 billion a year and 19% of China's total exports are now high-technology products. Although the high-tech industry has been the leading edge of China's economic growth, the driving force behind China's scientific and technological advances has not been technology transfer from the U.S.-China bilateral S&T activities, but rather:

- Market-based reforms of China's science and technology infrastructure
- The large supply of domestic S&T research talent
- Foreign capital investment from multinational companies
- Technology transfer from foreign companies
- Chinese government investment in strategic high-tech technologies

A 1985 Chinese Communist Party Central Committee report on "The Reform of the S&T Management System" provided guidance for restructuring the Chinese S&T system. The restructuring reformed funding allocations and cut state budgets for research institutes and universities; it also encouraged them to launch their own commercial ventures. These initial reforms opened the door for many more institutional reforms that were modeled on the S&T policies of advanced nations, resulting in improved coordination between government bureaus, universities, research institutes, and companies. Following these structural reforms, China embarked on multiple long–term S&T research and development plans. These programs set national S&T targets, encouraged cooperation between research and production units, and significantly increased funding for the development of key technologies critical to economic development and national security.

Foreign direct investment has been another significant factor in China's scientific and technological advancement. In exchange for access to China's growing market, foreign companies, many from the U.S., have poured capital, technologies and know-how into China's commercial sector. From 1994-2001 the cumulative investments of U.S. multinational corporations in China more than quadrupled, from $2.6 billion to $10.5 billion, growing at an average annual rate of 20.1%, adjusting for inflation.

Multinational companies are encouraged to invest in R&D activities in China by attractive tax-based incentives. Many Chinese research institutes and companies now form joint ventures with multinational companies to achieve specific research or technology development objectives.

Another important factor in China's technology transformation is the availability of a large pool of cheap, technologically sophisticated workers. The lure of well-educated engineers, researchers and scientists has drawn many foreign companies to invest in research and development activities in China. What sets China apart from advanced

nations is its ability to produce such large numbers of scientists, engineers, and researchers. Furthermore, while China has long suffered from a "brain drain" to the U.S., an increasing though limited number of China's top students are choosing to return to China after receiving graduate degrees abroad. The Chinese government attracts talented, foreign-educated Chinese students by offering them higher salaries, generous housing packages and even putting entire research teams at their disposal.

Supported by the government's emphasis on technology commercialization, market-based reforms, strategic research programs and a highly-skilled S&T labor force, high-tech nongovernmental enterprises have flourished in the Chinese economy. While S&T Agreement-related joint activities may have provided some ancillary economic benefits to China, the trendlines of its economic transformation would have been largely in place regardless of whether an S&T Agreement with the U.S. had been in place during this period. Against the overall context of market-driven economic growth in China, the role of government-to-government cooperation appears to have had, at best, a minor and ancillary role in contributing to the build-up of China's economic, industrial and military capabilities. It is clear that China's remarkable economic development occurred largely independent of cooperative agreements with other governments. The U.S. S&T Agreement is only one of many that China has with advanced industrialized nations.

Another factor in the rapid rise of Chinese S&T abilities is the PRC's continuing effort to acquire technologies from the West. The Chinese have employed a variety of methods to accomplish this objective including attracting foreign investment, particularly in R&D areas; sending large numbers of students abroad to study scientific and technological disciplines; industrial partnerships; joint ventures and offset deals; placing significant numbers of Chinese scientists, technicians, and engineers in key private sector firms abroad; scientific and military cooperation with countries where advanced technologies are developed; and covert means. Another valuable source is information mined from open S&T journals and websites.

China's Investment Strategy

The rapidly growing U.S. business investment in China is vital to the development of bilateral commercial ties, and reflects the eagerness of U.S. firms to position themselves in China. A Department of Commerce study highlights China's policies concerning investment by overseas firms, American companies in particular. According to this report, China has used the lure of its enormous emerging consumer market to induce firms wanting to get into the Chinese market to sign investment agreements that systematically include some form of technology transfer. Chinese investment policies encourage foreign investment in high technology industries in particular, with a system of preferential tariff and tax rebates designed to create incentives for high-tech industries as contrasted with lower-tech industries. Among the industrial sectors in which China is seeking investment are information technology, aerospace and electronics, including telecommunications. Some IT multinational companies have even agreed to transfer core technologies, such as source code, in order to gain market position. Although under the World Trade Organization (WTO) obligations, China is not allowed to require

technology transfer as a condition of doing business, state-owned enterprises and local government bodies in particular are still widely believed to continue the practice.

An increasing source of technology transfer from U.S. private sector companies is the increasing use of offset deals which include the creation of a laboratory, center or institute intended for joint research and development in key industries such as IT, telecommunications, electronics, chemicals, and automobile manufacturing. There are estimated to be more that 400 research and development branches of multinational corporations in China, including companies like Motorola, IBM, and GM. U.S. companies attempting to gain a foothold in the Chinese market are often reluctant to complain about the difficulties of doing business in China, the Commerce study reports. However widespread complaints have been received from U.S. firms investing in China about de-facto coercion by Chinese officials to transfer technology as the price of admission to the Chinese market. This Chinese investment strategy, designed to extract technology from American firms as a condition for entering the market, in State's estimation has been the principal source of technology transfer from the United States to China. The minor transfers of technology that may have taken place within the context of S&T cooperation carried out under the Agreement, are in State's estimation, inconsequential in comparison.

Conclusion

Examination of the S&T relationship between the U.S. and China under the 1979 S&T Agreement, shows that cooperation undertaken in the context of this Agreement has been of significant value to both countries. The cooperation undertaken by the USG agencies is, as intended, in the benign civilian domain. Although it is impossible to rule out unintended benefits to the military sphere, such side effects are almost impossible to document or substantiate and any benefits to China's military would have been small compared to the overall benefits of cooperation. As a vehicle for acquiring technology useful in the military or industrial area, the Agreement is of miniscule importance in the overall perspective of China's abilities and means to gather scientific and technological information. The U.S.-China Agreement is useful, mutually beneficial, promotes stability in the bilateral relationship, and should be maintained. S&T cooperation under the Agreement brings significant benefits to both countries and should be continued.