Chapter 4

Nuclear Power and the Proposed Cooperation Agreement

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China has a strong interest in developing nuclear power to supplement its coal and hydroelectric resources. The severe power shortages, described in the previous chapter, suggest that all major options for additional electrical generating capacity should be considered, and nuclear energy has several important advantages, Nuclear plants can be located anywhere in the country where suitable sites can be found. The major population centers are near the coast, far from the great hydroelectric sites and larger coal deposits. Both electricity and coal can be shipped long distances, but that would require large additional investments in transmission *or* transportation networks which may be inefficient, unreliable, and vulnerable in case of war. Nuclear plants can be located relatively close to the points of demand with few requirements for transportation or transmission.

In addition, China has severe problems with air and water pollution. Much of this pollution is due to coal mining and combustion. Nuclear power is almost completely free from such problems except for waste heat emissions which can be managed reasonably well. Accidental radioactive releases and waste disposal, problems which have been of concern to many in this country, appear to be seen in China as manageable, acceptable risks. Thus if nuclear plants replace old polluting coal plants or even substitute for new coal plants with less than the best available control technology, the environment should be improved. Compared to coal, hydropower seems to be relatively benign, but it too can cause environmental problems (health effects from schistosomiasis and malaria, loss of land, interruption of natural flow patterns, catastrophic flooding from dam breaks). Reservoirs are also subject to siltation, limiting their lifetimes, and large hydropower projects can cause major social dislocations. For instance, it is estimated that the Three Gorges project would involve the relocation of from *300,000* to 1 million people. Thus, while there are certain risks associated with nuclear power, China's nonnuclear power options also have substantial costs.

China already has a significant nuclear expertise because of its weapons, submarine propulsion, and research programs. The military nuclear program, like the defense sector generally, is under policy instructions to use its relatively abundant technical resources to serve the civilian economy. Should this expertise not be used in the civilian nuclear sector, it would have to be redirected to entirely different fields. In the Chinese system, massive shifts of personnel are difficult to accomplish. Therefore, these people are more likely to contribute to the growth of the Chinese economy if a civilian nuclear power industry is created than by leaving them in the military or trying to retrain them to ease the shortage of engineers elsewhere.

Overall, nuclear power is an energy option at least as reasonable for China as it is for many nations that already have reactors. However, some of the causes of the worldwide slowdown in the growth rate of nuclear power may affect China's plans. First, reactors are extremely capital-intensive. Even when economic analyses show the final power costs to be lower than coal plants because of the low fuel costs for nuclear plants, a large amount of capital must be supplied before there is any return on the investment, In particular for importing countries, considerable foreign exchange must be spent for the reactor and major components (the cost of the nuclear steam supply system is about 20 percent of the total plant cost), even if attractive financing terms are included. The operation of reactors in some developing countries has been a disappointment. Some have operated well, particularly if a high level of services from supplier countries has been included, but most countries (including the United States) have found reactors considerably more complex and demanding than expected. Concerns over costs and safety have led to opposition in some countries.

China's ability to operate civilian nuclear reactors safely and reliably is, of course, untested. While general industrial workplace safety practices often appear to the foreign observer as very lax, it is also true that with regard to nuclear technology, China is not a typical developing country. Its nuclear industry has more than 25 years of experience, and has operated with few reports of accidents,[1] although there has been some concern expressed about low-level radiation exposure at the workplace.[2] China shows signs of taking issues of reactor safety seriously. It established the National Nuclear Safety Administration in October 1984, it has enacted new legislation for nuclear safety, it has sought the assistance of foreign governments (including the United States, see below) for establishing a regulatory framework, and it has begun to train a national team of nuclear safety officers with the assistance of the International Atomic Energy Agency (IAEA).[3]

Plans have been announced to build a total of 10,000 megawatts (MW) of nuclear power in China by 2000, a goal that is ambitious but not impossible.[4] Currently, China has 81,000 MW of generation capacity from all sources. To meet expected demand, this capacity will have to increase to 250,000 MW by 2000.[5] The addition of 169,000 MW in 15 years, however, would be a substantial achievement. This tripling of supply would match expected economic growth. Since most developing countries have experienced electrical growth considerably higher than economic growth (as was the case in the United States prior to 1973), a considerable increase in the efficiency of use is implied in the projections.

The only firm commitments for nuclear plants at present are for a 300 MW plant under construction near Shanghai (the 728 project), and for an imported plant in Guangdong. The former, growing out of China's naval propulsion program and analyses of foreign units of similar size, will be produced largely indigenously. The first large plant is to be built at Daya Bay in Guangdong province near Hong Kong using two 900 to 1,000 MWe units. Most of the power would be sold to Hong Kong, and the plants would be financed largely by foreign investors. It was expected that the nuclear components for the plant would be supplied by France (with the generators coming from the United Kingdom). However, despite protracted negotiations and reported near agreement, no contract has been signed, and recently, China solicited competing bids from West Germany. It is not yet clear if this indicates a major problem with the French bid or is a tactic to wring more concessions. Sites have been chosen for two follow-on projects in Jiangsu and Liaoning provinces. Proposals for the former are being considered. Again, the French and the Germans are expected to be the main competitors. Japanese firms are also anxious to participate, and free to bid on projects since the two countries signed an agreement on nuclear cooperation in August 1985. U.S. companies cannot compete unless a nuclear cooperation agreement is in force.

China's dual approach of developing indigenous capabilities and importing foreign equipment and technology is intended to minimize the time needed to master nuclear power technology by incorporating the best available on the world market, while ensuring that the program does not get too dependent on foreign sources, China could develop reactor technology on its own if it had to, but that approach would take considerably longer and cost considerably more before reaching the present level of western nuclear technology.

[1]For an exception, see Mark Baker, "Peking Admits Accident at Atomic City," *The Financial Times*, Dec. 9, 1983,

[2]Zhang Yongxiang, "Radiation Protection Assessment of the past 20 Years of Operation of the First Heavy Water Reactor in China," *Fushe Fanghu (Radiation Protection), No. 5*, September 1983, in Joint Publications Research Service JPRS-CST-84-016.6-20.

[3]*Xinhua*, May 18, 1985, in Foreign Broadcast Information Service, *China Report*, May 23, 1985, p. A2.

[4]Jiang Xinxiong, "China's Nuclear Industry in the Last 30 Years and Its Future," *industrial Equipment & Materials, vol.* VI, No. 4, Hong Kong.

[5]*Dianli Jisha* #11, November 1983, JPRS-CEA-84-026.

PRESENT CAPABILITIES

China has a substantial nuclear industry which was created originally for military purposes. This industry developed nuclear weapons (both fission and fusion) in a remarkably short time (the first fission bomb was tested 4 years after the break with the Soviet Union, the first fusion bomb less than 3 years later). Since then, China has produced at least several hundred warheads. It has also built plutonium production reactors, enrichment plants, and various research facilities including other types of reactors. In addition, it developed, largely independently, the pressurized water technology (which the United States uses in its navy and commercial power industry), and has built at least four nuclear-powered submarines. These programs are discussed in more detail below. The important point to note here is that China is not at all a typical developing country in terms of nuclear technology. Total employment in the nuclear industry is estimated at 100,000 to 150,000 people.[6] The Chinese Nuclear Society has over 20,000 members, a rough indication of the number of scientists and engineers with nuclear skills. Figure 2 shows an organizational chart of the Chinese nuclear industry.

[6]Personal communication with the American Nuclear Society

The 728 or Qinshan project has emerged from the military sector in an effort to convert this expertise to civilian use. According to one report, as many as 4,000 people were transferred from military work to the 728 project.[7] Recently, a spokesman for China's Atomic Energy Industrial Co. estimated that the nuclear industry is in the process of shifting from 80 percent military work to 80 percent civilian.[8] There are conflicting reports of the progress of the 728 project, but the officially announced goal for operation is 1989. Preliminary site work has been completed, major components have been ordered, and construction of the main buildings started. Most compounds will be made in China. However, the reactor pressure vessel has been ordered from Japan, and its delivery was given a one time special approval by the Japanese Government in the absence (at that time) of a nuclear cooperation agreement between Japan and China.[9]

[7]Gerard Gourievidis, "Nuclear Power in China," *Revue Generale Nucleare*, July-August 1984, pp 358-368, in Joint Publications Research Service JPRS-CST-85-005, pp. 103-124.

[8]*Zhongguo Xinwen She*, May 3, 1985, in Foreign Broadcast Information Service, *China Report*, May 7, 1985, p. K 11

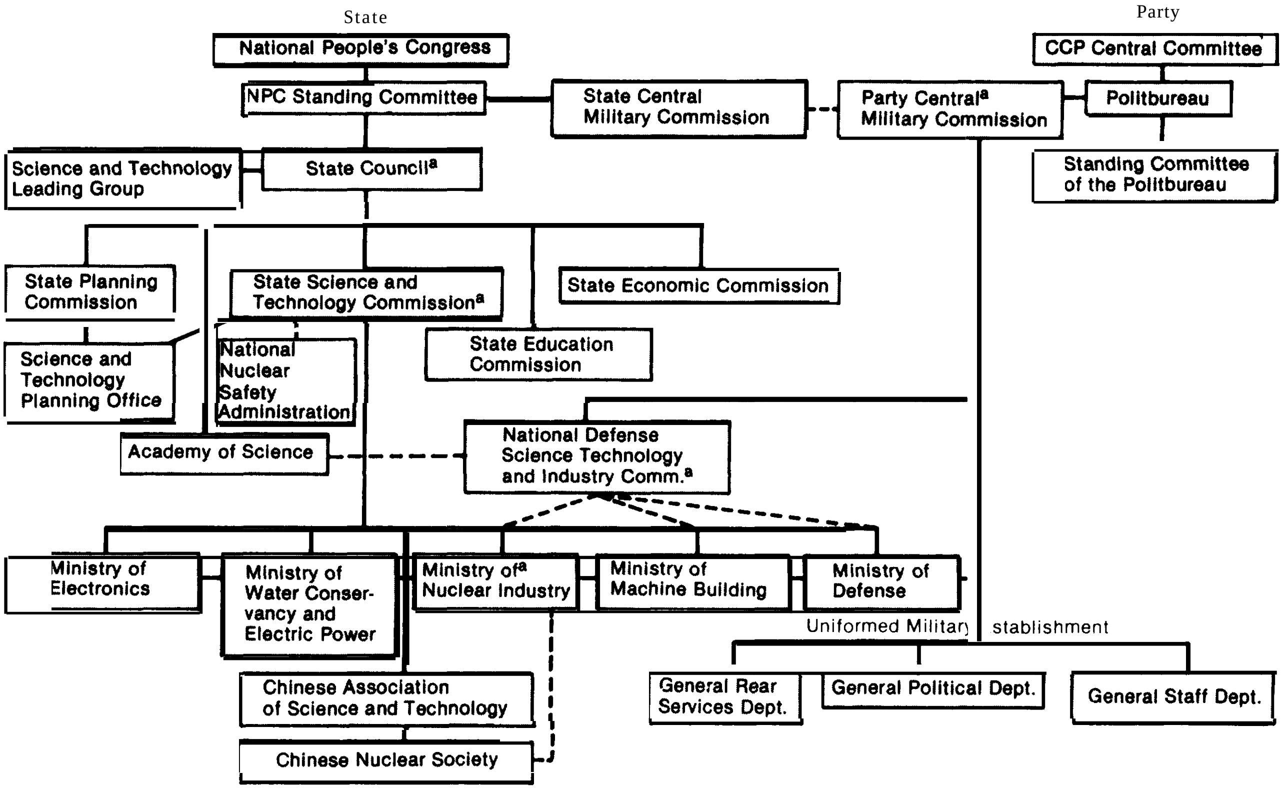
[9]China and Japan have now signed an agreement. (See *Chia Daily*, Aug. 1, 1985.)

THE ROLE OF IMPORTED TECHNOLOGY

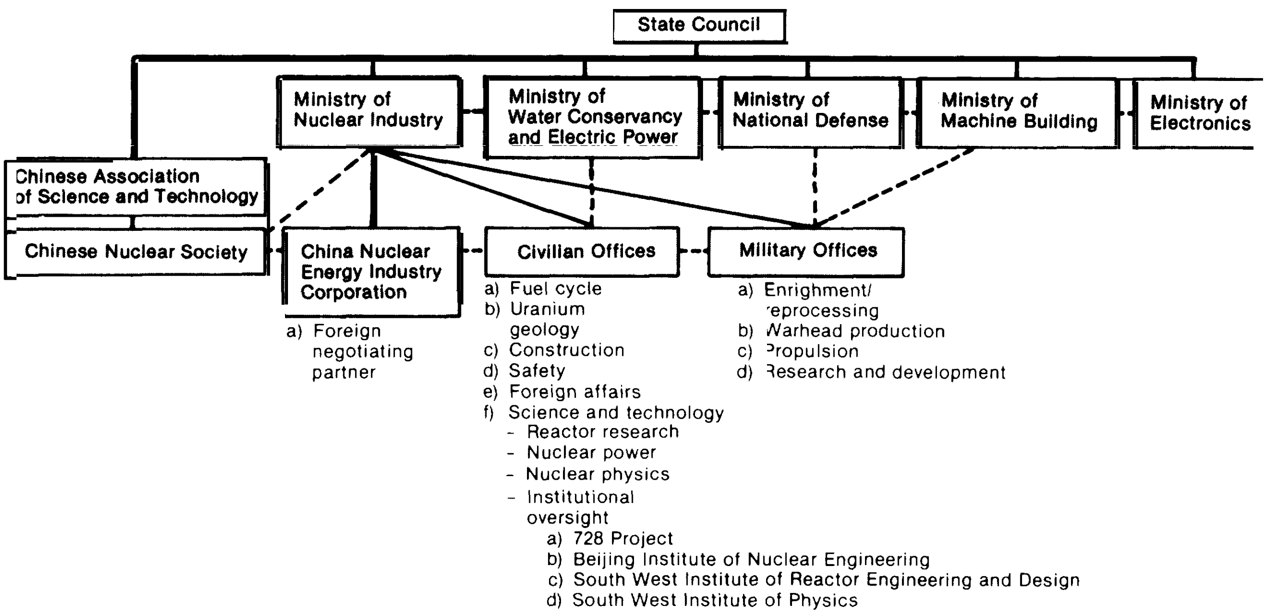
China has started work on scaling up the 300 MW design of the 728 project to 600 MW, but the domestic industry will not have the designs or the manufacturing capability to meet the 10,000 MW goal by 2000 without foreign technology. Several countries would like to sell complete reactor systems: the United States, France, West Germany, Japan, and the U.S.S.R. all could export the pressurized water reactors (PWRs) favored by China. Other types of reactors are heavy water (Canada), gas cooled (Great Britain, Germany, and the United States) and boiling water (United States and Sweden). The differences among the various PWRs are technologically important in detail, but not very significant from an economic, safety, or policy standpoint. The United States, however, is the only country that has actually transferred the complete technology, as distinct from selling the equipment. The French, German, and Japanese designs are derived from U.S. PWR technology, and royalties have been paid to American companies.

This record in technology transfer is one of the main reasons that China would still like to deal with American companies despite delays in the nuclear cooperation agreement. China has made it clear that it intends to absorb the technology and develop its own capability to manufacture large reactors. By the fourth project, the Chinese hope to be able to supply *80* percent of the parts themselves, although this may be an unrealisti-

Figure 2.—Nuclear Policy Decisionmaking Organization



Nuclear Policy Implementation



[a]Represents the most important nuclear affairs decisionmaking organizations.

SOURCE: Office of Technology Assessment.

cally high goal, Even Japan does not supply all components for its reactors. Considering their great need for new generating capacity, their limited foreign exchange (sizable relative to most developing countries, but small relative to their overall needs and the cost of a nuclear program) and their existing nuclear capability, eventual self-sufficiency is probably a realistic and necessary goal.

The first project, Guangdong, would involve the import of all important components. As noted above, the nuclear island (reactor, primary pumps, and steam generators) was expected to come from France, and the generating components from Great Britain. The recent German bid received from Kraftwerk Union, however, has reportedly led the Chinese to rethink their decision. The German bid is for four 1,000 MWe units—two for Guangdong, and two for the follow-on project ("Sunan") in Jiangsu—and provides for the Chinese to supply 20 percent of the components for the first project and 80 percent for the fourth. China would have to pay a surcharge for the technology if the fourth plant is not ordered within 6 years after the order for the first.[10]

There is far more to a nuclear plant than equipment, however. Even if there is no attempt to transfer the technology to design and manufacture nuclear plants, a considerable amount of expertise must accompany the sale of equipment. For instance, quality control is a crucial concept: much of the plant will be built domestically, so it is necessary to understand plant safety and economic requirements and how to determine the specifications for various components and materials to meet these requirements. Operator training must be extensive to ensure that the plant will operate smoothly and that accident sequences can be terminated. Workers must be taught how to refuel and perform other kinds of maintenance. Health physicists must know how to determine exposures and how to minimize them. Computer programs must be supplied to determine fuel management programs, while chemists and metallurgists must understand the effects of radiation on materials.

If a manufacturing capability is included in the transfer, much more information must be made available. Even if a complete design is to be duplicated, each reactor will be a little different depending on site-specific characteristics and customer needs. Designers must know how these differences will interact with the full system. They also must know the manufacturing capabilities available, and possibly modify the foreign designs for components accordingly, Therefore they must know why components are designed the way they are and how they are expected to be manufactured. China has reverse engineered some technologies (duplicated them without access to manufacturing information), but the process is very difficult and uncertain of success, even for technologies much simpler than nuclear reactors. Designing and manufacturing reactors also requires scientists and engineers with a solid grasp of core physics, metallurgy, safety analysis, and all the other disciplines that go into designing a reactor. Even if the receiving country intends to manufacture only the fuel, a considerable amount of nuclear and metallurgical expertise must be transferred.

Specific areas where the Chinese feel foreign technology could improve their own capabilities significantly include advanced fuel fabrication, instrumentation, and construction management. Foreign participation in the 728 project includes in-core monitoring equipment from France and coolant pumps from Germany in addition to the pressure vessel from Japan.

[10] *Nuclear Engineering International*, June 1985, p. 3.

PROLIFERATION CONCERNS

Preventing the spread of nuclear weapons has been a major objective of this country's foreign policy for many years. We have shown that we are prepared to forego attractive commercial opportunities and expend diplomatic capital as part of this commitment. It is a basic tenet of U.S. policy that American technology not be used by any other country to produce nuclear weapons, although the policy has not always been applied consistent y.

One proliferation concern is that some spent fuel from commercial power reactors could be reprocessed to separate the plutonium, which is the key material in nuclear explosives. Studies of proliferation, including OTA's, have concluded that this is a possible, though relatively unlikely route to nuclear weapons under most conditions. The plutonium generated under normal PWR operation is far from ideal to work with, and as long as safeguards are applied, a country runs a considerable risk of being detected if it diverts spent fuel, thereby opening itself to sanctions or even hostile action. A circumstance that could lead to diversion (as opposed to building facilities such as a small reactor and reprocessing plant dedicated to producing plutonium, possibly clandestinely) might be a desperate military situation which required a very rapid introduction of nuclear weapons.

Since the technology could be used in a weapons program, importing countries must agree to certain terms in order to obtain U.S. equipment and other forms of assistance. Typical terms are signing the Non-Proliferation Treaty or accepting equivalent safeguards, and agreeing not to retransfer the technology to other countries or reprocess fuel supplied by the United States or irradiated in U.S.-supplied reactors without prior U.S. permission.

China, however, is a special case. One argument against the likelihood of the diversion route is that the plutonium contained in spent fuel, reactor grade plutonium, would result in low yield, unreliable weapons unless the bomb designers were very good. China obviously has very good bomb designers; therefore, unlike practically every other developing country, it could make reliable, high yield weapons (at least in the kiloton equivalent range) from reactor grade plutonium. Furthermore, with a substantial nuclear power program, it could easily produce some fuel which had only a short exposure in a reactor, resulting in weapons grade plutonium. Not only can much higher yields from smaller weapons be obtained with weapons grade plutonium, but the material is easier to handle, and it generates much less internal heat, thereby increasing the shelf-life of the weapon, and making maintenance of the weapon easier.

Diversion of weapons grade plutonium would be easier if China builds liquid metal fast breeder reactors. The Chinese are not known at this time to have any specific plans to build breeder reactors, but they do have an interest in the technology, and have a research program which could enable them to start building in the next century. Considering their relatively small proven reserves of uranium, enough after military uses to fuel 15,000 MW for a normal plant lifetime,[12] this interest is consistent with their projections for the growth of light water reactors. Uranium prospecting continues (with foreign participation), and it appears likely that considerably more uranium will be discovered. China thus may find breeders uneconomic for many more years.

Despite the relative ease with which China could use commercial nuclear power technology to facilitate the acquisition of fissionable materials for weapons purposes, it is unlikely that China's interest in nuclear technology transfer is based on a desire to do so. It already has several hundred nuclear weapons and all the dedicated facilities it needs: over a dozen reactors for research and plutonium production, and reprocessing plants and enrichment plants that can produce high enriched uranium for weapons. Fissile material does not seem to be a constraint on their weapons production: if anything they have excess capacity. Effective delivery systems are a more likely constraint. China has already tested at least 26 fission and thermonuclear warheads (see table 7). Presumably, this is only a small fraction of the number it has stockpiled. Therefore, China already has a significant arsenal and the ability to produce as many more as it is likely to be able to use. What China does not have is civilian nuclear power technology.

[11]U. S, Congress, Office of Technology Assessment, *Nuclear Proliferation and Safeguards* (New York: Praeger Publishing Co., June 1977).

[12]W. P. Geddes, "The Uranium and Nuclear Industries in China," *Resources Policy*, vol. 9, No. 4, December 1983, p. 243.

Table 7.— Nuclear Test Chronology, October 1964 to January 1981

Test	Date	Yield	Location	Delivery system	Remarks
1	16 Oct 64	20kt	Lop Nor	70 meter tower	U-235 produced yield
2	14 May 65	20-40kt	Lop Nor	TU-4 type A/C	U-235 produced yield
3	9 May 66	200 + kt	Lop Nor	Hong 6 Bomber[a]	U-235 + Li-6 produced yield
4	27 Oct 66	20kt	Lop Nor	CSS-1 MRBM	U-235 produced yield
5	26 Dec 66	300-500kt	Lop Nor	Tower	U-235 + Li-6 produced yield
6	17 June 67	3mt	Lop Nor	Hong 6 Bomber	U-235, U-238, heavy hydrogen + Li-6 for yield
7	24 Dec 67	15-25kt	Lop Nor	Hong 6 Bomber	U-235. U-238+ Li-6[b] produced yield
8	27 Dec 68	3mt	Lop Nor	Hong 6 Bomber	U-235 fuse; Li nucleus; U-238 crust; traces of plutonium in fallout
9	22 Sep 69	25kt	Lop Nor	Underground	
10	29 Sep 69	3mt	Lop Nor	Hong 6 Bomber	Fusion device
11	14 Oct 70	3 + mt	Lop Nor	Hong 6 Bomber	Fusion device
12	18 Nov 71	29kt	Lop Nor	High tower	Nuclear device
13	7 Jan 72	20kt	Lop Nor	CSS-2 IRBM	
14	18 Mar 72	100-200kt	Lop Nor	CSS-3 ICBM	Limited range
15	27 Jun 73	2-3mt	Lop Nor	Hong 6 Bomber	
16	17 Jun 74	200kt-1 mt	Lop Nor	Unreported	"not good"[c]
17	28 Oct 75	2-5kt	Lop Nor	Underground	
18	23 Jan 76	2kt	Lop Nor	Atmospheric	
19	26 Sep 76	10kt	Lop Nor	Atmospheric	Special weapon
20	17 Oct 76	20kt	Lop Nor	Underground	
21	17 Nov 76	4 + mt	Lop Nor	CSS-4 ICBM	Full range[d]
22	17 Sep 77	20kt	Lop Nor	Atmosphere	
23	15 Mar 78	6kt	Lop Nor	Atmosphere	
24	14 Oct 78	20kt	Lop Nor	Underground	centered 44.5 N, 88.6 E
25	14 Dec 78	20kt	Lop Nor	Atmospheric	Nuclear bomb
26	16 Oct 80	200kt-1 mt	Lop Nor	Atmospheric	

aPRC production model of the Soviet TU 16/Badger medium range for bomber
bUnsuccessful–only the fission stage completed
cUnsuccessful — PRC and France had detonations the same date
dHydrogen warhead for a long range ICMB

SOURCE Strategic Digest, June 1983

While it seems reasonable to dismiss concerns that the Chinese would misuse American technology to make nuclear explosives, U.S. policymakers are rightly concerned about the proliferation implications of possible future Chinese nuclear exports, particularly the reexport of technology of U.S. origin without rigorous safeguards. This reexport issue has been of particular concern to some because of reports of past Chinese exports of enriched uranium and heavy water, without requiring safeguards, to countries which have not signed the Nuclear Non-Proliferation Treaty. Although the United States has a special responsibility for guarding against unsafeguarded reexports of U.S.-supplied technology, it should be noted that the question of China's exports pertains to China's own technology and to technology supplied by other countries, as well as to that supplied by the United States. In addition, the technologies of greatest concern from a proliferation perspective are enrichment and reprocessing plants. China is already proficient in these technologies, which presumably would not be transferred from the United States in any case.

The concern over reexport, therefore, is less over the technology itself-than over the political damage to the entire nonproliferation norm should the terms of U.S.-China cooperation be lax on this point. U.S. interests would be served not only by having strong protections in the agreement against the reexport, without rigorous safeguards, of technology of U.S. origin, but also by China's moving toward a nuclear export policy which is in line with that of other suppliers. It is not clear whether China is moving towards such a position, but proponents of the nuclear accord believe both that it is, and that the existence of such an agreement will aid in bringing China more closely in line with U.S. nonproliferation interests. This belief is reflected in the ACDA Nuclear Proliferation Assessment Statement (p. 1-4) submitted to Congress along with the recently signed U.S.-China nuclear agreement. (A copy of the agreement, and the supporting documentation, is included in the appendix.) Critics believe that the evidence supporting this view is too limited to justify the risk of an agreement without strict protections. This issue and other implications of a nuclear agreement are discussed further below.

OTHER MILITARY CONCERNS

PWR technology was developed for the U.S. submarine program. It was seen later that this technology could also be used for commercial powerplants. Reactors much larger than those in submarines but conceptually quite similar now produce most of the nuclear power around the world. Since powerplants were derived from propulsion units, it has been suggested that the process could be reversed: a nation with power reactors could use the technology in hand to design and construct a naval reactor,

China already has at least four nuclear submarines. There are two types: attack submarines (SSN), the first of which was launched in *1972,* and missile submarines (SSBN), first launched in 1981. The latter is capable of carrying about 16 missiles, but is still in the testing stage. China tested its underwater launched ballistic missile for the first time in 1982 from a nonnuclear submarine. This missile was reported to have a range of about *2,000* miles. The next generation missile could have a range of about 4,000 miles.

These submarines are not now a major element in China's strategic strike capability, although they could be in the mid to late 1990s. Even without leaving the Chinese coastal regions, they can strike almost all of the Pacific coast of the Soviet Union. The advanced missiles could strike Moscow. As of now, the Chinese seem to have no intention of sending submarines on distant operational patrols. Considerably more support services would be required to go even as far as the Indian Ocean. That means that they are not taking advantage of the extended range of nuclear reactors. The additional cost of the nuclear power presumably was justified by their ability to stay submerged for long periods to avoid detection. Developing a fleet of nuclear submarines would be a necessary step if China intends to become a world power.

As discussed above, China seems to be following the U.S. example of developing power reactors from the naval technology, but there is some reason to believe that having access to the latest power technology could help them improve their submarines. It has been reported that their submarines are relatively noisy, making them easy to detect .14 They do not venture far from ports, possibly because of concerns over reliability and guidance system adequacy. U.S. submarines have improved dramatically over the past *30* years in speed, range, reliability, and quietness. While the development programs in this country for naval and power reactors have been quite separate, some of the technological improvements would have been common to both, such as quality assurance, materials, and analytical techniques.

No one has yet suggested to OTA a specific improvement that would derive directly from modern power reactor technology and make a substantial difference in the performance of Chinese submarines, but there is a general feeling among engineers that this access would be useful. Reactor cores could be made more powerful and efficient if designers could use the latest information and computer codes; components, such as control rods and pumps, could be made more reliable, quieter (though the U.S. Trident submarine has a natural circulation reactor, eliminating the need for the large and noisy primary coolant pump), and less subject to corrosion; systems analysis can improve integration of the entire design; quality control would improve, thus increasing reliability. Many of China's best performing factories have been stimulated by exposure to Western practices. Nuclear power should be no different even though

[13] David G. Muller, Jr., "China's SSBN in Perspective, " *Naval Institute Proceedings: Professional Notes,* March 1983, p. 126.

[14] Defense Intelligence Agency, *Handbook of the Chinese People's Liberation Army,* November 1984, p. 57.

power reactors and naval reactors are quite different in size, power density, mission requirements and economic criteria.

It must also be noted, however, that it makes little difference whose PWR technology is transferred. There is significantly less difference among PWRs from the United States, France, Germany, or even the U.S.S.R. than between any of these and a naval reactor. Thus if the Chinese buy any modem PWRs, they will have essentially the same expertise that they would have had from the United States. The only significant difference, as discussed above, is that the United States has unique experience in transferring the technology to manufacture nuclear reactors and assisting another country to develop a nuclear industry. Other countries now stand ready to try, and will if the price is right, but China probably would prefer to rely on the United States.

Furthermore, in so far as the valuable commodity to be transferred is exposure to modem nuclear industrial practices, it makes little difference which type of reactor is transferred. Thus boiling water reactors or even gas reactors, which would not themselves be used in nuclear powered ships, would provide some of the same advantages to the Chinese in improving their submarine PWRs.

NUCLEAR COOPERATION AGREEMENT

The U.S. and Chinese governments have cooperated on an agency-to-agency basis in the field of nuclear *safety* since the signing of a protocol to that effect in October 1981. Under the protocol, the Nuclear Regulatory Commission has transferred to China a basic set of NRC safety documents, including regulatory rules, safety guides, technical reports, and safety assessment computer codes.

A government-to-government nuclear cooperation agreement, which among other things would permit the U.S. nuclear industry to participate in China's nuclear development program, was initialed during President Reagan's visit to China in April *1984.* It was signed in Washington on July *23*, *1985*, and forwarded to Congress with supporting documentation on July 24. The text of the agreement and the supporting documentation is appended to this technical memorandum. Included in a separate volume is a discussion of the issues raised following the initialing of the agreement (Background Paper 2). Congressional policy considerations are also discussed in chapter 5 below. In addition, the Issue Brief from the Congressional Research Service, "Nuclear Energy: Consideration of the Proposed Agreement for U.S. Nuclear Cooperation with China" by Warren H. Donnelly is included in the background papers because of its thorough treatment of the issues and the congressional role in the agreement. This section reviews some of the issues raised in the debate prior to the signing of the agreement, and discusses how cooperation, or its rejection, might affect international proliferation control and relations between the two countries.

As discussed above, China is unlikely to divert nuclear material produced from U.S.-supplied technology, but there are several other aspects to the proliferation *issue.* The first is based on concerns over China's past nuclear export behavior. It has been widely reported that China has aided a Pakistani effort to design and construct a centrifuge enrichment plant (and perhaps, nuclear weapons), but OTA has not obtained classified information to verify this charge. Such actions would indicate a serious disregard for the goal of stopping the spread of nuclear weapons. Even the less serious allegations of unsafeguarded shipments of enriched uranium and heavy water to Argentina and perhaps South Africa would still be major breaches of the international nonproliferation regime, although these alleged actions may be more indicative of past Chinese insensitivity to proliferation problems than a conscious disregard for nonproliferation objectives.

China's nonproliferation policy appears to be getting closer to that of the United States and other suppliers. China joined the IAEA in January 1984, and there have been no reports of contracts for unsafeguarded exports since then. China's leaders have pledged to require safeguards on all future exports and to refrain from assisting any other country to proliferate. If one believes that the allegations of previous assistance to potential proliferators are true, but no longer reflect the position of the Chinese leaders, then one might be willing to dismiss them in thinking of future relations. In the 14 months between the initialing of the agreement and its signing, the executive branch has attempted to ascertain the details of China's nuclear export policies and behavior, and has concluded that China's current export policy is consistent with U.S. nonproliferation objectives. (See, ACDA Assessment Statement, attached.) Nevertheless, some observers have held that since the alleged exports were so recent and so inimical to U.S. interests, and since they may in fact be continuing even now, a heavy burden should lie on China to show that it is complying and will continue to comply with nonproliferation norms before the United States extends any nuclear cooperation. Since conclusive evidence on past and present behavior, if it exists, has not been made available, OTA is unable to determine which view is best supported by the facts.

In the period since the initialing of the agreement, and in light of the fact that China has not signed the Non-Proliferation Treaty, there has been considerable discussion about the nature of China's nonproliferation pledges. The concern has been that China's pledges have only been verbal. Some analysts have felt that a pledge is uncertain unless it is put in writing with explicitly agreed upon wording. They point out that written assurances can be made with more explicit detail; spoken words can always be reinterpreted or disavowed later. Other analysts, however, believe that a verbal pledge has as great a force if made in the appropriate diplomatic context.

Premier Zhao Ziyang has stated publicly that China does not favor proliferation and will not help other nations. One such occasion was a toast at a state banquet, another was before the Second Session of the Sixth National People's Congress, which approved of Zhao's statement. Vice Premier Li Peng has been more explicit in elaborating on Zhao's statement in an interview with the press in January 1985. In light of the role and powers of the National People's Congress (which is a forum for announcing and ratifying policy, but which does not have the power to constrain the Communist Party leadership), and the fact that the Chinese press is a vehicle for advancing state policy, there is little reason to doubt that China meant to go on record with the nonproliferation statements of Zhao and Li. This, however, does not alleviate the concerns of those who wish to see pledges in writing, preferably committing China to adhere to the terms of the Non-Proliferation Treaty.

For historical reasons, the Chinese are extremely sensitive about infringements on their national sovereignty. However, since the Chinese also have been relatively isolated from the international community until recently, they have not been parties to the various international regimes, including the nonproliferation regime, established since the end of World War II. These regimes, in effect, proscribe national sovereign rights to achieve multilateral collective benefits, and the Chinese are only slowly coming to accept this principle. In light of this, the provisions for safeguards and reprocessing, as lenient as they may appear to be relative to other cooperation agreements, represent a significant concession by China.

With China's entry into the IAEA, and with the signing of an agreement with the United States (as well as with other countries earlier), China is now much more committed, in writing, to nonproliferation norms than was the case as recently as 2 years ago. Assessing the value of these written commitments for the furthering of nonproliferation objectives awaits detailed analysis of the language of the agreements.

The second major issue is over the safeguards to be applied directly on U.S. exports to China, which if the agreement were put in force, would be the first nuclear weapons state with whom the United States had a bilateral agreement. Such safeguards are required in all our other nuclear agreements, and are normally applied by the IAEA. Functionally, such safeguards are somewhat irrelevant in the case of weapons states such as China, and IAEA safeguards are not required by U.S. law. Symbolically, however, they have importance. The United States and Great Britain have accepted safeguards on all civilian facilities (although they are in effect applied to only a few) in order to subject themselves to the same burden as nonweapons states, and recently the U.S.S.R. has entered into an agreement with the IAEA for safeguards on certain civilian facilities selected by the Soviets. There is already a considerable feeling of discrimination on the part of some nonweapons states, especially among the developing countries, over their treatment by the supplier states. Granting lenient terms to China, itself a developing country, could lead to demands by these nations that they be accorded equal treatment. This point is disputed by some who find that developing countries do not regard safeguards in weapons countries (including China) as meaningful in any case.

Other supplier countries might also seek to take advantage of lenient terms in a U.S.-China nuclear agreement. The United States has a record of insisting on strong safeguards and has had some success in getting other suppliers to go along. If the U.S.-China agreement is seen as inconsistent with this position, it could be more difficult in the future to bring pressure on other suppliers.

The safeguards provisions of the U.S.-China nuclear accord reflect the fact that the agreement is between nuclear weapons states. The language *is* quite different from other recent agreements, and no provision is made for IAEA inspections. IAEA inspectors check operating records and the spent fuel, and keep records to ensure that the fuel has not been removed from authorized locations. Spent fuel is rather easy to safeguard in this manner, but it does call for diligence and continuity. Visits without careful materials accountancy would have little credibility from a safeguards perspective. The agreement does provide for negotiations through diplomatic channels to establish visits by U.S. personnel to Chinese facilities employing U.S. technology and/or possessing U. S.-supplied materials. The ACDA Assessment Statement reflects a U.S. understanding that the terms of the visits will be linked to the approval of export licenses (p. II-4). The language of the agreement itself is less clear on this point. The agreement also calls for the exchange of information on materials accountancy, but it is not clear how detailed this information would be. This lack of specificity may lead to misunderstandings or problems from differences of opinion.

The safeguards issue became politically more complicated after the agreement was initialed: China signed nuclear agreements with Brazil and Argentina that call for the reciprocal application of IAEA safeguards on nuclear materials and technology (reportedly, with specific reference to "moderator materials" in the agreement with Argentina), and agreement has been reached with Japan for IAEA safeguards as well. Such provisions may reflect the growing realization of the importance of nonproliferation. The recently signed agreement with the United Kingdom, however, does not require IAEA safeguards (on nonsensitive nuclear technology), nor do the earlier agreements with Belgium and Germany. However, in light of the precedent set in the agreements with Brazil and Argentina, some Members of Congress have expressed the belief that as part of a continuing effort to strengthen the nonproliferation regime, the U.S. agreement should provide for nothing less.

In a closely related issue, U.S. nuclear agreements with other countries also contain "consent rights" provisions, according to which fuel supplied by the United States or irradiated in U. S.-supplied reactors cannot be reprocessed without our permission. Reprocessing plants are far harder to safeguard than spent fuel pools, and if separated plutonium is available, there would be many more opportunities for diversion or theft by terrorist groups. It has been U.S. policy to discourage reprocessing, particularly in developing countries, for these reasons.

The consent rights provisions of the agreement may be the most controversial section of the accord. The agreement does not state explicitly that U.S. permission is required. Instead, it states that neither party has any plans to reprocess fuel supplied under the terms of the agreement and makes provision for a two-stage consultation process should the plans of the parties change. The two parties agree to enter into a 6-month period of negotiations to reach a long-term agreement for reprocessing. If, at the end of the 6-month period, no long-term agreement has been reached, the two parties agree to consult on measures that would allow reprocessing on an interim basis, During these consultation phases, the parties pledge not to take any action that would prejudge the long-term agreement or adversely affect cooperation under the nuclear agreement. The agreement is vague, however, as to what would happen in the event that consultations do not produce mutual agreement. Implied, is a right for either party to cease cooperation if an agreement is not reached. As with the provision on safeguards, ambiguity in the agreement may create problems of interpretation later.

As noted in the discussion of proliferation concerns above, it is unlikely that China would wish to divert spent fuel from civilian power reactors to its weapons program. Nevertheless, the consent rights provision is unorthodox, and is likely to spur debate on two issues. The first is whether U.S. consent rights are upheld to the extent required by Section 123 of the Atomic Energy Act as amended. The second is whether the language of the agreement with China will compromise U.S. efforts to strengthen consent rights provisions in agreements with other countries. Further complications are the facts that China already has reprocessing experience (although not with spent fuel from commercial power reactors) and that it has expressed an interest in reprocessing eventually, including possibly spent fuel it accepts for disposal from other countries. Thus, reprocessing need not involve fuel of U.S. origin, or fuel irradiated in U.S. reactors, but if the commercial promise of the agreement is realized, China would have a significant supply of fuel subject to U.S. consent rights.

Nuclear cooperation with China could result in a significant amount of business, perhaps several billion dollars over the next few years, for an industry that has little prospect for U.S. orders. If carried out unskillfully, it could make our nonproliferation efforts with other countries more difficult. The nonproliferation regime might be undercut directly if China does not honor its pledge to require safeguards on exports, and its naval reactor program could get an unintended assist, but these problems could occur with technology from other suppliers as well. On the plus side, cooperation can also help draw China into the nonproliferation regime, and could help build ties between the two countries.

These are risks and benefits that cannot be well quantified, but are nonetheless real. Rejecting the agreement would have implications that are even harder to define, Obviously U.S. firms, who have already lost commercial opportunities, would continue to lose the economic benefits of large-scale nuclear trade with China. A rejected agreement would be a major irritant to U. S .-China relations, but analysts disagree over whether rejecting the agreement, in itself, would cause lasting damage to bilateral relations. We would, however, lose most or all of our influence on China's nonproliferation policy and nuclear development program, including areas such as international spent fuel storage where we may wish at some later date to have maximal influence. We might also create dissension in the IAEA. We would further distance ourselves from our allies who believe that the risks of nuclear cooperation with China can be managed. Refusal to cooperate might even make nuclear cooperation with the Soviet Union more attractive to China. Thus, there are risks in not cooperating with China. Whether a stronger agreement could be negotiated, if it became certain that this one would not be accepted by Congress, is not clear.

Having an agreement in force also has risks. Should relations between the two countries sour, transferring nuclear technology might be regarded in the future as a serious mistake (although the threats to U.S. interests are only likely to be felt over the longer term—sometime after the year 2000).” There are several potential risks that should be considered under such a scenario. If Chinese nuclear-powered submarines and eventual surface ships become good enough, they could venture as close to our shores as Russian ones do; U.S. defense expenditures might have to rise more than the value of the postulated sales in order to counter this additional threat. Even if China remains a regional power, adding to its strength may threaten U.S. allies such as South Korea. Improved nuclear technology could also enhance their capacity for destabilizing behavior elsewhere in the world, for instance by selling nuclear submarines to Brazil or Argentina.

People holding this perspective note that China is still a nondemocratic, one party state with a history of political instability, whose interests are not identical to ours, even strategically vis a vis the Soviet Union. Nuclear cooperation now would be seen as a significant vote of confidence in a political relationship which has not been proven, and could create a "carte blanche" atmosphere for export controls generally.

It should be noted, however, that other technologies being considered for transfer to China carry national security risks as well. Judgments as to the severity of the risks of nuclear, and other high-technology transfers are contingent in part on assessments of the nature of the political relations between the two countries (a subject not treated in great detail in this technical memorandum, but one to be taken up in greater depth in the full assessment). If political relations are regarded as good, and susceptible to improvement, then the risks of nuclear cooperation, and other technology transfers, can be seen as manageable in a process of building enhanced political understandings and commercial ties. If the relationship is seen as fragile, and inherently limited, then the risks are less tolerable.

While there has been widespread support (although by no means unanimity) for improved relations with China if they are based on a congruence of interest and a compatibility of thinking, opinion on nuclear cooperation is more complex. At least four general perspectives can be identified.

The first sees the development of U.S.-China relations since 1978 as a major achievement in overcoming nearly *30* years of hostility. Not only has hostility been overcome, but mutual interests have been identified, and friendship has developed. The possibility for building on those mutual interests is good and nuclear cooperation is part of that process. U.S. access and influence will help China towards a fuller understanding of and commitment to the international nonproliferation regime, and both economies will benefit.

The second view, though not necessarily unfriendly to China, places highest priority on nonproliferation. In this view, China's past behavior has been unacceptable, and its current stance, adopted only recently, is highly suspect. Therefore, approving any agreement without the strongest provisions on safeguards and assurances would be a blow to nonproliferation control. China should be called on to demonstrate its compliance before it is granted cooperation, and any significant doubt should be grounds for rejection.

The third perspective sees little use for nuclear power anywhere, especially in a developing country. China should be encouraged not to waste its limited money on highly expensive and risky reactors when other energy sources could fill the need at less cost. Thus nuclear cooperation would be a digression at best and possibly much worse.

Finally, there is the perspective which is very suspicious of China but not necessarily of nuclear power. China is likely to misuse our technology to our eventual dismay. As in the nonproliferation perspective, the burden of proof should be on China before it is aided, but the nature of the proof here would involve a broader set of issues, such as a closer adherence to U.S. diplomatic positions generally.

These perspectives are based on differing assessment of the risks and opportunities involved with trade with China as discussed above, as well as specific views on nuclear power. Definitive support or rebuttal is not possible at this time. Questions that Congress could ask include:

1. How well does the agreement comply with U.S. statutory requirements, particularly with regard to safeguards and reprocessing consent rights?
2. What is the evidence that China has helped Pakistan and other countries in ways we would find unacceptable? What is the evidence that this behavior is not now taking place?
3. How soon, and in what ways could the U.S. nuclear assistance effect China's industrial base as it pertains to the ability to produce improved nuclear weapons and warships? Would assistance from other major nuclear suppliers be any different?
4 What access does China now have to our national laboratories, companies involved in military work, and production facilities, and how would that change if we approve the nuclear cooperation agreement?

5. What financial assistance, if any, should the U.S. Government supply through the Export-Import Bank for the sale of nuclear reactors to China?
6. What will be the specific procedures for safeguards? What safeguarding arrangements do other major nuclear exporting countries have with China? Why has China not volunteered to submit its civilian facilities to IAEA inspections?
7. How do other Asian countries feel about improving China's nuclear capabilities?
8. How would other developing countries view U.S. nuclear assistance and financial aid to China when the United States may not provide either to some nonnuclear weapons states?
9. How does the fact that China now has nuclear cooperation agreements with all the major western suppliers (France, Germany, Britain, Japan), and with lesser suppliers (Brazil, Argentina, Belgium) affect the calculation of the costs and benefits of a U. S.-China agreement?