

Power loop

China provides nuclear reactors to Pakistan

China's decision to supply Pakistan with further power reactors has raised concerns that Beijing is breaching nuclear trade rules. Mark Hibbs examines the deal's impact on Pakistan's nuclear capabilities and the global governance of nuclear technology.

▶ KEY POINTS

- China has agreed to provide Pakistan with its fifth Chinese-designed nuclear power reactor, with the provision of a sixth reactor also a possibility.
- Although the reactors are unlikely to pose a significant proliferation risk, their agreed provision presents a challenge to non-proliferation arrangements, such as the Nuclear Suppliers Group, that aim to regulate nuclear exports.
- Furthermore, the China-Pakistan reactor agreement may increase the pace of strategic co-operation between the two countries and add weight to Chinese diplomatic calls for Pakistan to receive greater access to the global nuclear market.

China has agreed to supply Pakistan with its fifth and possibly sixth Chinese-designed nuclear power reactor since the first joint reactor project was launched in the mid-1990s. The deal, reached in mid-2013, will mark the first time China has exported its new ACP-1000 pressurised water reactor (PWR), which is capable of producing 1,000 megawatts (MW) of electricity. Despite the civilian nature of the project, the deal for additional Chinese-built power reactors has raised concerns among international observers that it may contribute to Pakistan's nuclear weapons programme and

increase the risk of proliferation in the region. The agreement between Beijing and Islamabad also feeds into a wider debate about the future of the global nuclear non-proliferation regime, as it will almost certainly exacerbate a conflict over the global terms of nuclear trade between the world's leading nuclear supplier states – including France, Japan, Russia, South Korea, and the United States – and most of the 190 members of the nuclear Non-Proliferation Treaty (NPT).

Beginning in 1985, advanced nuclear countries agreed to refrain from exporting nuclear-related items to states not party to the NPT or without comprehensive International Atomic Energy Agency (IAEA) safeguards. Nevertheless, in 2008 the US managed to persuade all other advanced nuclear exporters in the Nuclear Suppliers Group (NSG), the world's most important multilateral nuclear trade control mechanism, to lift nuclear trade sanctions against India – one of only four nuclear-armed states (along with Israel, North Korea, and Pakistan) that has developed a nuclear arsenal outside the NPT. For Islamabad, its nuclear partnership with Beijing helps to counterbalance the 2008 US-India nuclear agreement, which is regarded by Pakistan as providing India with an unfair advantage in the strategic development of its nuclear capabilities. A majority of NPT members (mostly developing countries, as well as some Western European states) have also expressed reservations about the NSG exemption that enabled the US-India nuclear trade agreement to go ahead.

Yet most of the 47 advanced nuclear countries participating in the NSG, and nearly all NPT parties, view China's indefinitely expanding nuclear commerce with Pakistan as inconsistent with Beijing's commitment – under NSG trade guidelines and in the formal NPT review process – to refrain from forging any new agreements for the supply of nuclear equipment and material to states outside the NPT. China, on the other hand, claims that its ongoing nuclear exports to Pakistan are enabled by the terms of a bilateral nuclear agreement that predates the 2004 advent of Beijing's participation in the NSG, implying that current exports to Pakistan are 'grandfathered' and not forbidden by the NSG guidelines. Ultimately, the resolve of both China and Pakistan to go ahead with this latest reactor project may be designed to apply pressure on NSG members to open the way for Pakistan to achieve a global nuclear market access agreement similar to that achieved by New Delhi in 2008.

Proliferation concerns

All four of the power reactors that China has already supplied to Pakistan are currently operating under IAEA safeguards. As such, the four reactors are subject to inspections to verify the non-diversion of nuclear material for military purposes. It is certain that the operation of planned units five and six would also come under IAEA safeguards, which would significantly reduce the proliferation risks associated with the facilities.

It is unlikely that Pakistan would ever attempt to divert plutonium produced in the spent fuel from any of its China-supplied power reactors for use in nuclear weapons, as its eventual detection would lead to international condemnation and would jeopardise any ongoing and future nuclear co-operation with Beijing. Rather, Pakistan operates a separate fleet of three military reactors at Khushab in Punjab province that are dedicated to plutonium production for the country's nuclear arsenal. Not subject to IAEA safeguards, the Khushab complex operates in secrecy, and spent fuel from the military reactors is reprocessed at separation plants outside IAEA safeguards at Nilore and Chashma.

With the construction of a fourth military reactor dedicated to plutonium production currently ongoing, Pakistan is clearly investing in the Khushab complex to meet its military requirements, and the Khushab heavy water reactors are better suited to plutonium production than the Chinese-supplied light water-type civilian reactors. Furthermore, given the severity of Pakistan's energy crisis, there is little incentive for the new Chinese-made PWRs to be diverted from power generation to weapons-related activities.

Intellectual property

If Pakistan's fifth and sixth Chinese-made power reactors are built as planned, these construction projects will represent a technological step-up to a more advanced 'three-loop'

1,000-MW reactor design. This is a significant advance over Pakistan's four 300-MW 'one-loop' PWR model reactors built at Chashma, since additional reactor cooling system 'loops' (each consisting of a reactor coolant pump, a steam generator, and the piping that connects these components to the reactor vessel) permit greater thermal energy production for conversion into electric power. According to online news service World Nuclear News, the new reactor design to be employed by China is based upon French PWR technology that has been shared with China since the 1980s.

In 1985, China began construction of its 'one-loop' Qinshan-1 PWR, which represents the country's effort to synthesise a variety of foreign technology inputs – largely from France, Japan, and Germany – in a composite project that could serve as the basis for future co-operation on bigger units featuring two and three circuits, and in turn, two and three times the electricity output. China has since progressed to build four units of a 'two-loop' model rated at 650 MW at its Qinshan site, and has designed, but not yet constructed and operated, an indigenous 'three-loop' PWR.

According to senior management at the Pakistan Atomic Energy Commission (PAEC) and Pakistan's nuclear regulatory authority in 2008, Pakistan has sought to obtain a Chinese-designed 1,000-MW PWR since at least the early 2000s. To this end, the PAEC, which is responsible for all construction and operation of nuclear power plants in the

country, purchased and earmarked a site near Karachi during the 2000s for one or more of these advanced PWRs.

In 2011, a Pakistani consultant for the nuclear programme said that intellectual property considerations inhibited China from exporting a 'two-loop' PWR unit to Pakistan. Beginning in the 1990s, Westinghouse Electric Company in the US and Framatome (now Areva) in France began working with the Shanghai Nuclear Engineering Research and Design Institute to design a 1,000-MW 'three-loop' PWR, designated the CNP-1000 in China. According to Pakistani officials in 2008, the export of these reactors to Pakistan was put on hold for reasons including intellectual property considerations.

In early 2013, China announced it had "developed independently" an "advanced third-generation" 'three-loop' PWR designated the ACP-1000, having "entirely independent intellectual property rights". This is the reactor design that Pakistan now intends to import, most likely at the site earmarked near Karachi. Separately, China intends to build this design on its mainland as units Fuqing-5 and Fuqing-6, and has also offered the reactor to Argentina. Details concerning commercial interactions or disputes related to intellectual property rights over civil nuclear power technology are generally considered commercially sensitive and are rarely made public or confirmed by the parties involved. In some cases, firms facing such challenges have been known



Chinese and Pakistani troops take part in a joint war exercise in Jhelum, Pakistan, on 14 November 2011. Joint counter-terrorism exercises and the exchange of intelligence on non-state armed groups operating along the shared border area demonstrate the growing relationship between the two countries.

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to modify the design of components slightly to avoid allegations that they are violating a competitor's intellectual property rights.

Officials in Western industry and government organisations have expressed concern to *IHS Jane's* since 2012 that China's ACP-1000 reactor design may not be free of French intellectual property. However, it is not known whether French companies or the French government have objected to Beijing on the grounds that, without the consent of French nuclear firms, the export of the ACP-1000 to Pakistan might constitute a violation of French intellectual property rights.

Because Areva and other French companies are not interested in exporting nuclear power plants to Pakistan, it is possible that any French concerns in this regard might not be raised with Beijing. If French firms are indeed concerned that their intellectual property is built into the design of the ACP-1000, it is more likely that France would raise this issue should China conclude a contract for export of the reactor to other markets in which French state-owned company Areva is competing for business. This action could be put off by overriding French commercial or diplomatic concerns in relation to Beijing, or if China were to provide compensation to French firms for the use of any French intellectual property in the reactor design.

However, Pakistani commentaries about the planned export of the ACP-1000 to Pakistan routinely repeat Chinese claims that the reactor design is indigenous.

Expanding nuclear trade

China has, most prominently on the basis of a bilateral nuclear co-operation agreement dating from 1987, long assisted Pakistan's nuclear development. Before China joined the NPT in 1992, it was free to assist Pakistan's nuclear weapons development programme, and according to statements by US officials and US government documents since the 1980s, China contributed to infrastructure that currently serves as part of Pakistan's nuclear defence complex, including the first plutonium production reactor at Khushab, the country's primary nuclear weapons production site.

Declassified US intelligence files attest that in the early 1980s, the US believed that China had provided nuclear weapons design information to Pakistan, and that in return Pakistan had provided China with gas centrifuge design information obtained by Pakistani metallurgist Abdul Qadeer Khan, although this remains unconfirmed. AQ Khan was the

Pakistani nuclear scientist implicated in 2004, by his own admission to Pakistani authorities, in an illicit proliferation network.

More recent Western and Indian media allegations that Beijing continued to assist Pakistan's nuclear weapons programme after 1992 have not been verified. Pakistani officials deny that China is providing Pakistan with any assistance related to ongoing research and development to produce battlefield or tactical nuclear weapons. Western diplomats are also sceptical that Beijing would provide such assistance as it would constitute a violation of China's NPT commitments.

On the basis of the 1987 bilateral nuclear agreement, the first Chinese nuclear power plant in Pakistan was set up during the late 1990s at Chashma, in the Punjab region, where all three succeeding Chinese-built nuclear power reactors have also been sited. Chashma-1 is a 300-MW PWR based on the design of China's first nuclear power reactor, Qinshan-1, which was built in the late 1980s and began operating in 1991. This reactor is a 'one-loop' model fuelled with low-enriched uranium and featuring a single steam generator that drives a turbine to produce electricity.

After Chashma-1 was finished and began operating in 2000, Pakistan and China agreed to

build a twin unit known as Chashma-2. Construction started in 2005 and the project was finished in 2011. Construction of two more units – Chashma-3 and -4 – representing an upgraded version of the 'one-loop' model and rated at 340 MW, began in May and December 2011 respectively, and remains ongoing.

China's assertion that its current exports to Pakistan are "grandfathered" under an agreement that predates Beijing's participation in the NSG is disputed by virtually all Western states in the group, which argue that any additional power reactors beyond the supply of Chashma-2 were not included on a list of intended nuclear transfers to Pakistan that China provided to the NSG upon joining in 2004. Furthermore, during the discussion of this issue with China, it was agreed by the NSG that after 2008 any NSG participant claiming that its nuclear trade with a non-NPT state was "grandfathered" by a previous trade arrangement must provide documentation to confirm that the specific transaction was covered by a legally binding agreement between the two parties.

Because Chashma-3 and -4 are not scheduled to be finished until 2016–2017, the decision by China and Pakistan to build a fifth and possibly a sixth reactor, most likely

Investment costs

Should Pakistan proceed with the import of Chinese ACP-1000 PWRs, the total investment required will be considerable. The price tag for two units is officially set at USD9.6 billion. Additional infrastructure needed to direct a large amount of the plant's output to consumers in northern Pakistan could also cost several billion US dollars, according to foreign energy project financing consultants working in Pakistan.

At a price of USD4,800 per installed kilowatt for the power plant alone, the two Karachi PWRs would cost more than other power generating assets – nearly twice as much as new hydropower stations – that Islamabad plans to establish to overcome a national electricity supply crisis that has become acute over the past 20 years.

Because Pakistan's economic crisis has depleted the country's foreign exchange reserves to record low levels, the commercial terms for Islamabad's pending new investment in nuclear power generation have not yet been settled, as Pakistan is

seeking ways of lowering the cost.

Speaking to *IHS Jane's* in September, a Pakistani expert on the deal said that Pakistan has urged China to essentially award the Pakistan Atomic Energy Commission (PAEC) with what amounts to a nuclear safety risk discount on the basis that there is currently no ACP-1000 reference plant in operation.

Separately, *IHS Jane's* sources report that Pakistan has proposed that China consider entering the project as a shareholder, thereby lowering the cost of the project to Pakistan. The cost to Pakistan of previous Chinese-supplied projects has been reduced by China's provision of soft loans to finance Chinese construction, equipment supply, and supporting engineering and services. It is likely that similar terms will be arranged for this new project, although Pakistan also wants to reduce substantially the cost of nuclear services and spare equipment for which China would charge the PAEC during the lifetime of the power plant.

near Karachi, represents a forcing of the pace of this bilateral co-operation. This is in part on the basis of China's greater accumulated nuclear expertise since Beijing dramatically accelerated its own nuclear power plant construction from 1998 onwards.

Exemption prospects

The Chinese project to build one or two more power reactors in Pakistan comes at a time when the NSG's participating governments are examining how to move forward in the aftermath of their 2008 decision to grant India access to the world's market for uranium, nuclear equipment, and expertise. Although New Delhi continues to press NSG participants for membership in the group (with the backing of nuclear trade partners such as the US and Australia, as well as France and the United Kingdom), a number of NSG governments appear wary of how such collaboration with a non-NPT member might affect the robustness of the international non-proliferation regime.

Notably, nuclear commerce between China and Pakistan has intensified in the five years since India was granted an exemption from NSG rules, probably due in part to Pakistan's perceived need to keep pace with its longtime nuclear rival. During the same five years, and within the framework of its outreach programme with non-NSG states, the NSG has intensified discussions with Pakistan to encourage Islamabad to commit itself formally to abide by the NSG export guidelines.

Conclusion

As long as Pakistan is perceived as both relatively unstable and generally ambivalent about non-proliferation issues, the granting of a Pakistani exemption to NSG rules is likely to remain a distant prospect – particularly given that, with the exception of China's largest state-owned nuclear enterprise, no commercial vendors appear prepared to assume the political and commercial risks associated with exporting nuclear technology and equipment to Pakistan.

Furthermore, any move to lift nuclear sanctions against Pakistan would complicate efforts by NPT members to encourage timely disclosure and transparency in Iran's nuclear programme from Tehran. Iran continues to face sanctions for non-compliance with its NPT obligations, although some of these are to be lifted as part of the



Chinese premier Li Keqiang and Pakistani prime minister Nawaz Sharif meet in the Great Hall of the People in Beijing, China, on 5 July 2013. The bilateral talks underlined increasing strategic and economic co-operation between China and Pakistan.

There remains the possibility that intensified NSG co-operation with Pakistan could develop into a formal arrangement concerning Pakistan's access to the global nuclear market. However, unlike India, NSG membership for Pakistan has not been advocated by the US. Granting Pakistan an exemption to the NSG's guidelines similar to the one India obtained would pose both opportunities and risks for the non-proliferation and nuclear trade regime. An agreement that requires Pakistan to uphold the NSG's export control guidelines would positively serve to capture the sensitive nuclear activities – namely uranium enrichment and plutonium separation – of a nuclear-armed state which, as a non-NPT member, has

no formal non-proliferation commitments, as well as a reputation for harbouring nuclear technology and equipment smugglers involved in the AQ Khan proliferation network.

However, the risks associated with forming such an agreement with Pakistan include the prospect that NPT parties might object to the decision taken by NSG members – as a select group of advanced nuclear countries – which arguably diminishes the status of the NPT as the world's leading non-proliferation norm-setting treaty. NSG participants generally support enlisting Pakistan to adhere to the group's guidelines, although there is currently no consensus in favour of granting Pakistan access to the world's nuclear market.

deal over its nuclear programme brokered on 24 November 2013 with the P5+1 group of negotiating countries (China, France, Germany, Russia, the United Kingdom and the United States).

A scenario in which both Pakistan and India were permitted access to nuclear markets that have, in recent decades, only been open to NPT members in good standing, could prompt Tehran to reconsider its NPT membership – a scenario that key negotiating countries such as France, Germany, the UK, and the US would be keen to avoid. While the new agreement between China and Pakistan for the provision of additional nuclear reactors does little to increase the risk of proliferation in the region, it further cements the partnership of Islamabad and Beijing in the trade of sensitive goods and increases the likeli-

hood that their strategic collaboration will intensify in the years to come. ■

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