Civil Nuclear Energy Programs and the Nonproliferation Paradox in South Asia

Dr. Mansoor Ahmed[i] and Maimuna Ashraf[ii]

Abstract

Civilian nuclear energy programs in India and Pakistan benefited from international cooperation until India's 1974 nuclear test that led to the genesis of the Nuclear Suppliers Group and nonproliferation efforts led by the United States. While Pakistan's civilian nuclear energy program (under IAEA safeguards) was slowed down under the impact of nonproliferation sanctions between 1974-1989, India was able to secure an exceptional waiver from the NSG in 2008 and much of its dual-use civilian nuclear energy program remains outside safeguards. This has led to an exponential increase in India's latent nuclear capabilities, primarily due to the selective application of nonproliferation norms by the nuclear supplier states.

Keywords

Safeguards, Nuclear, Fissile materials, Civil nuclear energy, Reactors, Nuclear fuel cycle

Introduction

The primary goal of the nuclear nonproliferation regime has been to promote nuclear energy while curbing nuclear proliferation through the nuclear nonproliferation treaty (NPT), the Nuclear Suppliers Group (NSG), and the International Atomic Energy Agency (IAEA)

[i] Dr. Mansoor Ahmed is a Senior Research Fellow at the Center for International Strategic Studies (CISS) Islamabad, Pakistan.

[ii] Ms. Maimuna Ashraf is working as a Research Officer at the Center for International Strategic Studies (CISS) Islamabad, Pakistan.

safeguards system.[1] Civilian nuclear fuel cycles and nuclear energy programs in non-nuclear weapon states have equipped several countries with the capabilities that contribute to nuclear latency such as Japan and South Korea.[2] South Asia is home to two non-NPT nuclear weapon states (India and Pakistan). This region is witnessing the largest expansion in unsafeguarded fissile material stockpiles and production capabilities outside the NPT states over the past two decades, primarily due to India's exponential expansion in latent nuclear capabilities outside IAEA safeguards. South Asia is also a unique example of discrimination in the influx of civil nuclear technology from nuclear supplier states, but with varying consequences for vertical proliferation and the growth of civilian nuclear energy programs in India (outside safeguards) and in Pakistan (under safeguards). The generous technological collaboration by western supplier states first enabled India's 1974 nuclear test. The 2006 India-US nuclear deal and the waiver granted by the NSG in 2008 has fueled and legitimized India's nuclear weapon ambitions.[3]

This paper examines how the paradox of selective application of nonproliferation norms scuttled the development of Pakistan's civilian nuclear program (under IAEA safeguards) after India's 1974 nuclear test. It also traces the exponential growth of India's unsafeguarded civilian nuclear program over the past two decades—especially in the wake of securing the NSG waiver in 2008—that has directly contributed to the expansion in India's stockpiles and production capabilities for weapon-usable fissile materials.

Supply Side Politics and Indian and Pakistani Nuclear Programs

Pakistan began its civilian nuclear program that was centered on a 5 MWe research reactor (supplied by the United States under the Atoms for Peace Plan) and a 137 MWe CANDU-type power reactor (Karachi Nuclear Power Plant-1 or KANUPP-1) during the 1960s, as part of the Colombo plan. These reactors have operated under IAEA safeguards ever since. Coupled with the commissioning of KANUPP-1 in 1972, Pakistan prepared a long-term nuclear plan to develop the nuclear fuel cycle and a nuclear power program through international cooperation, under IAEA safeguards. In 1973, the IAEA fully supported Pakistan's road-map for nuclear energy and recommended the setting up of 24 power reactors by the turn of the century.[4] Simultaneously Pakistan signed agreements with West Germany, Canada, and France for the supply of a heavy water plant, a fuel fabrication plant, and a commercial-scale fuel reprocessing plant, all under IAEA safeguards.[5] In addition to the two 220 MWe CANDU-type Pressurized Heavy Water Reactor (PHWR) Rajasthan reactors that India received from Canada with full transfer of technology, the U.S. also supplied India with two 160 MWe Tarapur Boiling Water Reactors under safeguards. During the 1960s, Canada gave India a 40 MWt CIRUS Research Reactor and the U.S. supplied heavy water for it. CIRUS could produce 9-13 kg of weapon-grade plutonium per year, sufficient for three or four nuclear devices. This influx of research reactor technology took place without any safeguards when this concept on technology transfers in peaceful uses of atomic energy was in its embryonic stage. India did, however, offer assurances to Canada that it would not use CIRUS for military purposes, and was thus able to obtain the design and fabrication drawings of all the major components of the reactor.[6] CIRUS became fully operational in 1960 which later enabled India to double its size and build the 100 MWt Dhruva-1 plutonium production reactor by 1986. These two reactors have been the source of India's weapons-grade plutonium production for almost five decades. Western nuclear transfers to India also included a nuclear fuel fabrication plant which would enable India to manufacture fuel for the power reactors on its own. A U.S. design was used for India's first reprocessing plant in Trombay, which was commissioned by 1964.[7] India was, therefore, able to operationalize the plutonium route for fissile material production, through U.S. and

Canadian technology and material assistance before China's first nuclear test in October 1964.

Today, India's first-generation nuclear power infrastructure mainly comprised several CANDU type PHWRs of 220 MWe each which are based on the Canadian design of RAPS-1 & 2.[8] Canada, and other western supplier states, took time to realize that they were providing the technology, tools, and materials for producing fissile material for nuclear weapons to India. This was proven when India carried out the so-called Peaceful Nuclear Explosion (PNE) on May 18, 1974, using weapons-grade plutonium obtained from the CIRUS reactor.[9] Even then, none of the nuclear suppliers or the big powers condemned India's violation of its commitments and misuse of civilian nuclear technology for weapons purposes. Even as East Pakistan was separated following the 1971 India-Pakistan war, Pakistan sought security assurances after India's first nuclear test in May 1974. Yet, none of the P5 countries promised any security guarantees. In fact, Pakistan was only able to place the issue of India's PNE on the agenda of the meeting of IAEA's Board of Governors in June 1974 with great difficulty. A senior IAEA official told the chairman of the Pakistan Atomic Energy Commission (PAEC) that although "India had committed the original sin, but Pakistan would have to pay the price."[10] This prediction materialized soon thereafter, and Pakistan began to face the full brunt of international nonproliferation sanctions. Having helped India set up a robust nuclear energy and fuel cycle infrastructure (CIRUS research reactor and Trombay reprocessing plant) before its 1974 nuclear test, the supplier states decided to prevent Pakistan from building its own nuclear power and associated civilian fuel cycle program, even though it was to be under IAEA safeguards.

Even though Canada and other western suppliers ended nuclear cooperation with India in the wake of its first nuclear test in 1974, it only marginally affected India's relatively mature and diverse nuclear program. However international nuclear cooperation with Pakistan was effectively nipped in the bud when each of the supplier states unilaterally cancelled agreements for plants and facilities that were to be built and run under safeguards. These included West Germany, Canada, and France. The first step in this regard was taken by Canada which halted the delivery of equipment for the fuel fabrication plant, just before it was about to be shipped to Pakistan in November 1974, although it was contracted in 1973—before India's first nuclear test. Pakistan had agreed to accept safeguards on this plant but the supplier states demanded that Pakistan sign the Nuclear Nonproliferation Treaty or open its entire nuclear program to international inspections and safeguards.[11] No such pre-condition was attached a decade earlier to civil nuclear collaboration with India.

KANUPP-1 was under IAEA safeguards and under the agreement with the IAEA and the duration of safeguards was linked with the continuation of the bilateral agreement between Canada and Pakistan. Therefore, legally speaking, when Canada broke off the agreement with Pakistan, the IAEA safeguards would have ended. On December 23, 1976, Canada unilaterally decided to terminate all civil nuclear co-operation with Pakistan and abrogated its existing technical co-operation agreement. It unilaterally stopped the supply of any nuclear fuel, heavy water, spare parts, or technical information for KANUPP-1.[12] Consequently, Pakistan embarked on the road to nuclear self-reliance and within two years, produced the first nuclear fuel element for KANUPP-1. Therefore, the embargo on fuel supplies proved to be a blessing in disguise as it drove rapid indigenization. Despite having produced indigenous nuclear fuel for KANUPP-1, Pakistan continued to apply IAEA safeguards on it.[13] Similarly, Pakistan refrained from diverting KANUPP-1's Pakistan-made fuel for reprocessing even though it had completed the New Labs indigenous reprocessing plant outside safeguards by 1981. Instead, it chose to build an indigenous 50 MWth plutonium production reactor (Khushab-1) in 1986 that was completed within ten years. The unsafeguarded New Labs reprocessing plant pre-dated the Chashma reprocessing plant contract by three years and was only commissioned once Khushab-1's safeguards-free spent fuel became available in 1999.[14] This was a measure of Pakistan's responsible behaviour as a state actor.

France was the second major supplier to abrogate a bilateral agreement with Pakistan for the supply of the Chashma commercial-scale fuel reprocessing plant. This project generated a lot of international and domestic controversy for a variety of reasons, but it was only designed to acquire reprocessing technology, and separate spent fuel from six power reactors of 600 MWe each, that were originally planned to be built at the Chashma Nuclear Power Complex. These were to have been under comprehensive IAEA safeguards, as was the Chashma reprocessing plant, according to the 1976 trilateral agreement signed between Pakistan, France, and the IAEA, whose Board of Governors (including the U.S. Ambassador) had approved the safeguards agreement.[15] Pakistan had also agreed, not to build or commission another reprocessing plant, using the same technology, for a mutually agreed period of 20 years.[16] But under intense American pressure and nonproliferation efforts through the Symington Amendment (1977) to the U.S. Foreign Assistance Act of 1961, France unilaterally cancelled the reprocessing plant contract with Pakistan in August 1978. The Americans had also been instrumental in the cancellation of a 1975 agreement between France and South Korea for a small-scale reprocessing plant under IAEA safeguards and duly approved by the Agency's Board of Governors.[17] However, in Pakistan's case, the supplier was asking an IAEA member state to accept the concept of safeguards on the use of a physical process per se, and not just on the materials and facility, even as the solvent extraction method for fuel reprocessing (Plutonium and Uranium Recovery by Extraction—PUREX process which France had originally developed) had already been made public as early as the first U.N. International Geneva Conference on the Peaceful Uses of Atomic Energy in 1955.[18]

Had France honored its commitments and not unilaterally cancelled the Chashma reprocessing plant contract, it would have still been under safeguards. During the past decade, Pakistan completed and commissioned the Chashma reprocessing plant on its own, which is completely free of any safeguards.[19] France, for its part, re-imbursed Pakistan for cancelling the Chashma reprocessing plant in the 1980s and offered to sell a 900 MWe power reactor in February 1990, without any other pre-conditions.[20] Similarly, had other western supplier states not cancelled bilateral agreements for the supply of nuclear fuel cycle plants and facilities to Pakistan, these would have remained under safeguards. While international cooperation would have enabled the timely completion of Pakistan's civilian nuclear power and associated fuel cycle infrastructure for peaceful purposes under IAEA safeguards, it would have served the additional purpose of transfer of know-how and training of manpower. This, according to Pakistan's original nuclear plan of 1972, would have enabled the development of parallel fuel cycle plants and facilities outside safeguards, for both the enriched uranium and plutonium routes to producing fissile material for nuclear weapons, and was a major proliferation concern for western supplier states.[21] Once international cooperation was denied, Pakistani scientists and engineers met the challenge and accomplished what was considered an exclusive domain of a handful of countries in the world—mastery of the complete ten plants and facilities in the nuclear fuel cycle between 1975 and 1981. Moreover, in the wake of India's 1974 nuclear test, as the U.S. cut off supplies of low enriched uranium fuel to India's Tarapur power reactors, it turned to France, among others, to supply this fuel, which it did for at least a decade.[22]

However, Pakistan's nuclear power program, which depended on international cooperation, (given the country's limited industrial base and lack of funds for capital intensive nuclear power plants), faced the full impact of nonproliferation sanctions. The Executive Committee of the National Economic Council (ECNEC) had granted approval for a

600 MWe nuclear power plant in March 1976, that was to be set up at the Chashma Nuclear Complex. However, President Zia-ul-Haq held back political and financial support for the Chashma-1 Nuclear Power Plant (CHASNUPP-1) (due to bureaucratic politics within Pakistan's nuclear establishment).[23] But when in 1982 Pakistan finally invited tenders, it was too late.[24] By this time, Pakistan was under a virtual international embargo on power reactors under IAEA safeguards due to its covert nuclear weapons development program. As a result of intense negotiations between PAEC and China National Nuclear Cooperation, a breakthrough came in September 1986 when Pakistan and China signed a comprehensive civil nuclear cooperation framework, governed by IAEA guidelines.[25] This led to an agreement in November 1989 for the supply of a 300 MWe at Chashma that would be based on China's first power reactor design—the Qinshan-1. The Chinese Prime Minister in his visit to Pakistan remarked that while China's power reactor technology was in its infancy, China was willing to share it with Pakistan for peaceful purposes. This was a unique example of "South-South" cooperation in civil nuclear technology as both countries had faced technology denials and sanctions.[26] China and Pakistan signed the contract for the Chashma Nuclear Power Plant-1 or CHASNUPP-1 in December 1991, only 16 days after China's Qinshan reactor went into operation.[27] The 1986 agreement provided a long-term roadmap for civil nuclear collaboration between China and Pakistan leading to separate contracts for four power reactors that were established at the Chashma Nuclear Power Complex between then and now. These include two 325 MWe CHASNUPP-1 and CHASNUPP-2 reactors and two 340 MWe CHASNUPP-3 and CHASNUPP-4 power reactors. Pakistan is also commissioning two 1100 MWe Hualong-One type the third generation HPR-1000 power reactors, KANUPP-2 and KANUPP-3, in 2021 and 2022 respectively. Pakistan and China also agreed in November 2017 to install a third HPR-1000 power reactor—CHASNUPP-5. Another one is planned to be built at Muzaffargarh and sites have been identified for another four HPR-1000 units. Together,

these will help achieve the nuclear energy production target of 8800 MW by 2030.[28] The Hualong-One power reactors are the latest iteration of Chinese Pressurized Water Reactor (PWR) technology. Just as Pakistan had reposed confidence in the Qinshan-1 designed in 1989, the first Hualong-One PWR was connected to the grid in China on November 27, 2020, only months before the initial fuel loading at KANUPP-2.[29] Pakistan is the biggest export market for Chinese power reactors and nuclear fuel that is supplied under IAEA safeguards. Pakistan's indigenous nuclear fuel cycle is designed to meet the requirements of the nuclear weapons program and only supplies fuel for KANUPP-1 (under safeguards). There is no civil-military overlap in Pakistan's fuel cycle or power reactor programs. In 2007, Pakistan had planned to develop a parallel fuel cycle for a civilian nuclear energy program that was to be placed under IAEA safeguards.[30] Its status and progress, however, is not known.

The Civilian Atomic Energy Program: Driving India's Latent Nuclear Revolution

As international nonproliferation efforts served to slow down Pakistan's civil nuclear energy program between 1974-1989, India's stockpiles and production of civil plutonium and highly enriched uranium have steadily increased under the "Cover of the Peaceful Atom."[31] This civilian energy program outside safeguards gained fresh momentum in the wake of the 2006 India-US nuclear deal.

India's case presents an anomaly as its civilian nuclear energy program and nuclear fuel cycle are "intimately intertwined" with its strategic program.[32] As an official Indian policy paper stated in 2005: "India's nuclear program is unique as it is the only state with nuclear weapons not to have begun with a dedicated military [program]," and is "an offshoot of research on nuclear power [program]."[33] The principles of separation of civilian and military nuclear facilities agreed by the IAEA and the NSG in 2008 also provide an overall framework for designating individual plants and facilities as either serving a purely peaceful (safeguarded) or unsafeguarded civilian nuclear activity linked to India's military nuclear program. The civilian list, therefore, includes only those fuel cycle facilities and power reactors to be placed under IAEA safeguards "that, after separation, will no longer be engaged in activities of strategic significance."[34] In implementing the nuclear separation plan, India has produced three parallel and overlapping streams of nuclear activities and facilities—military, civilian (unsafeguarded), and civilian (safeguarded).[35] However, in 2008, India refused to place its upcoming Fast Breeder Reactor (FBR) program under safeguards. The Chairman of the Indian Atomic Energy Commission and Secretary of the DAE, Dr. Anil Kakodkar stated in a February 2006 interview that, "Both from the point of view of maintaining long term energy security and for maintaining the minimum credible deterrent, the Fast Breeder Program just cannot be put on the civilian list."[36] India's position on the Fissile Material Cutoff Treaty (FMCT) was thus described by India's Prime Minister Manmohan Singh in 2006: "We are not willing to accept a moratorium on the production of fissile material. . . . India is willing to join only a nondiscriminatory, multilaterally negotiated and internationally verifiable FMCT, as, and when, it is concluded in the Conference on Disarmament, again provided our security interests are fully addressed."[37]

The 2008 NSG waiver was a key enabler for India's Department of Atomic Energy (DAE) to keep its fleet of unsafeguarded PHWRs operating at optimum levels. It insisted that India was running out of natural uranium reserves that had to be allocated between the needs of the unsafeguarded civilian power reactors and the CIRUS and Dhurva-1 reactors dedicated to producing weapons-grade plutonium. Immediately after the announcement of the India-US civil nuclear deal in 2005, a DAE official said: "The truth is we were desperate. We have nuclear fuel to last till the end of 2006. If this agreement had not come through, we might as well have closed down our nuclear reactors and by extension our nuclear program."[38] Within a few years, the NSG waiver opened the way for India to secure bilateral agreements with uranium producing countries. As Zia Mian and M. V. Ramana noted in 2006: "New Delhi will be able to purchase the uranium it needs to fuel those reactors it chooses to put under IAEA safeguards. This will free up its domestic uranium for its nuclear weapons program and other military uses and would allow a significant and rapid expansion in India's nuclear arsenal."[39] As India began importing uranium and nuclear fuel for its power reactors that were put under IAEA safeguards, it was also quietly prospecting for new domestic uranium reserves, and in August 2011, Dr. Srikumar Banerjee, the Chairman of India's AEC and Secretary of the DAE announced the discovery of the Tumalapalli mine in Andhra Pradesh, with the potential to yield 150000 tons of low-grade uranium. This is considered one of the largest uranium discoveries in India, and the world.[40] Since 2016, India has signed nuclear cooperation agreements with 14 countries and secured uranium supply contracts with Kazakhstan, Australia, Mongolia, Namibia, among others.[41] India is also aggressively aiming at building a natural uranium reserve of 15000 tons (under safeguards) as a hedge against future shortages for its civilian power reactors[42] and is working towards "massive expansion" of domestic uranium production outside safeguards that is geared to increase it tenfold by 2032.[43]

India's greatest achievement in the nuclear energy program has been the development of PHWR technology—which forms the first stage of India's three-stage nuclear energy program. India's indigenous PHWRs are known to have operated at low levels of efficiency but have produced (by 2019) a vast stockpile (6.9 ± 3.1 tons) of high-quality separated civil or reactor-grade plutonium, which along with these reactors is outside IAEA safeguards. The International Panel on Fissile Materials (IPFM), *The Bulletin of the Atomic Scientists,* and other international experts consider India's reactor-grade plutonium as part of its military plutonium stockpile. This material is also considered as a "strategic reserve" and kept on the military list by

India under the nuclear separation plan approved by the IAEA in 2008. [44] The argument then, and now, that is employed to justify India's stockpiling of unsafeguarded civil plutonium is to fuel the second stage of India's three-stage nuclear energy program consisting of Fast Breeder Reactors—that can produce more fuel than they consume.[45] However, India has so far not been able to commission its first 500 MWe Prototype FBR that has suffered repeated delays in completion since 2010. It is now expected to be commissioned by early 2022.[46] Dr. Anil Kakodkar also argued that India's two production reactors—CIRUS and Dhruva-1—could not meet the fissile material requirements of India's weapons program for which the eight PHWRs and the planned FBR's were kept outside safeguards.[47] The eight unsafeguarded PHWRs can annually produce 1250 kg of weapons-usable civil (reactor-grade) plutonium. If any one of these 220 MWe PHWRs is operated in the military (low burnup) instead of the commercial (high burnup) mode, it can produce 150-200 kg of weapons-grade plutonium each year, at a capacity factor of 60-80 %.[48] Nevertheless, Ashely Tellis offers three arguments against the proliferation potential of India's stockpile of unsafeguarded civil plutonium, i.e. the undesirability of reactor-grade plutonium, fuel requirements of the FBR program, and lack of reprocessing capacity.[49] Civil plutonium produced in power reactors is often considered unsuitable for use in nuclear weapons due to the abundance of undesirable plutonium isotopes. The weapon-usability of civil (reactor-grade) plutonium produced in power reactors has been a subject of intense debate and controversy.[50] While most power reactors are Light Water Reactors that normally operate at a high burn-up of 33,000 MWd/t, and PHWRs "produce and discharge substantially more plutonium" than LWRs, Pressurized Water Reactors, and Gas Cooled Reactors. PHWRs also has "the highest Pu-239 content in the spent fuel discharge, or an incredible 70% Pu-239."[51] India's stockpile of unsafeguarded civil plutonium is exclusively the product of its indigenous PHWRs that are derivatives of the CANDU reactor design. Indian PHWRs typically operate at an average burnup of 6700 MWD/t[52] and "would produce less of the higher and more dangerous and higher plutonium isotopes such as Pu-240 compared to LWRs."[53] Therefore India's civil (reactor-grade} plutonium is weapons-usable and the United States successfully demonstrated the military utility of civil plutonium in a series of tests in 1962.[54] In 1997, the U.S. Department of Energy declassified a detailed technical assessment conducted on the military utility of reactor-grade plutonium, stating that, "virtually any combination of plutonium isotopes" could be used to produce desired yields comparable to weapon-grade plutonium.[55] Weapons designers in nuclear armed states can address problems of excessive heat and risk of pre-initiation resulting in a fizzle yield, emanating from the use of reactor-grade plutonium through deuterium-tritium 'boosting' of fission devices. India is also known to have conducted at least one nuclear test in 1998 using reactor-grade plutonium from one of its PHWRs.[56] The IAEA, for the purposes of safeguards, does not distinguish between various grades of plutonium and considers all isotopic compositions of plutonium as "direct use material" for nuclear weapons.[57] More recently, experts such as Frank von Hippel and others have also convincingly refuted "the claim that plutonium that is reactor-grade, as opposed to weapons-grade, is unusable in an explosive device."[58] Recent developments in India's nuclear program also contradict Tellis's arguments.

India's ambitious FBR program appears to have been put on the backburner, that has implications on how India's unsafeguarded reactor-grade plutonium stockpiles are utilized and India's projected fissile material production capacity. On March 21, 2018, the DAE submitted a detailed answer in the Indian parliament (LOK SABHA) on "Issues Concerning Installation of New] N[uclear] P[ower] P[lant]s," vide Unstarred Question No. 4226. It stated that, "A capacity of 6700 MW comprising nine (09) nuclear power reactors (including Prototype Fast Breeder Reactor (PFBR), 500 MWe being implemented by BHAVINI) is at various stages of commissioning/ construction."[59] Upon completion of these power reactors, including the PFBR, the installed nuclear power generation capacity would total 13480 MWe by 2024. In June 2017, the Government of India approved the construction of 10-12 additional power reactors with a total capacity of 9000 MWe, that is earmarked for progressive completion by 2031. Once implemented, 21 under-construction nuclear power projects, including the PFBR, would give a combined nuclear power generation capacity of 22480 MWe by 2031.

However, the DAE's submission in the Indian parliament suggests that it has revised its nuclear power generation target for 2032 from a total of 63 GWe to 24 GWe, (partly because of the DAE's failure to develop the breeder program as planned). This has resulted in the cancellation of 57 nuclear power plant projects as reported by sections of the Indian media.[60] Earlier, the DAE had called for building another 4 to 5 FBRs, amid statements that the design of the future FBRs would be scaled up to 600 MWe.[61] So, what is the proportion of the separated civil (reactor-grade) plutonium that would be available for use in nuclear weapons after deducting the required amount of start-up fuel for the PFBR? One 500 MWe PFBR requires 1.9 tons of initial fuel loading with an additional 300-400 tons of plutonium for annual re-charge. The DAE has already manufactured 2 tons of start-up fuel for the PFBR in 2016.[62] Glaser and Ramana estimate that India's "annual production of unsafeguarded reactor-grade plutonium would be sufficient for indefinitely operating all the MOX-fueled breeder reactors while diverting the radial blankets for weapon-purposes."[63] India's DAE also asserts that by 2022, sufficient separated plutonium would be available for fueling 6 GWe of FBRs.[64] India's upcoming unsafeguarded PHWR capacity of 9000 MWe is also likely to be a long-standing source of an uninterrupted supply of plutonium, should the FBR program proceed according to schedule.[65]

Alternatively, the 500 MWe Prototype FBR, when and if commissioned, will offer an exponential increase in India's production of weapons-grade plutonium and will be able to add another 135-140 kg of weapons-grade plutonium every year. If another four FBRs of this size are built, it would add another 560 kg weapons-grade plutonium production capacity annually, which "would correspond to a twenty-fold increase in India's current weapon-grade plutonium production capacity. India could sustain this level of production for several decades without building additional heavy-water reactors."[66] Nevertheless, the availability of unsafeguarded reactor-grade and weapons-grade plutonium for India's strategic program would eventually depend on its fuel reprocessing capacity. No other country is actively improving the size and efficiency of its reprocessing capacity for spent fuels produced in its indigenous PHWRs.[67] Unlike other countries engaged in civilian plutonium reprocessing, India has also refrained from making any declarations in compliance with the IAEA's plutonium management guidelines (INFCIRC/549).[68] The Government of India has tried to dispel any proliferation concerns and explained its policy on fuel reprocessing in its National Progress Report at the 2016 Nuclear Security Summit: "India is strictly observing the principle of 'reprocess to reuse' whereby reprocessing of the spent fuel and commissioning of fast reactors are being synchronized to preclude any build-up of a plutonium stockpile."[69] However, in the absence of an operational FBR program, and a steadily growing stockpile of unsafeguarded weapons-grade and civil (reactor-grade) plutonium produced in Dhruva-1 and the PHWRs, the expanding reprocessing capability adds to India's latent nuclear potential over and above its existing stockpile of fissile material for nuclear weapons. Currently, India operates four fuel reprocessing plants, of which one is a military facility (Trombay) with a nominal capacity of 50 tons of heavy metal (tHM/year) and three are dual-use facilities, each with a nominal capacity of 100 tHM)/year. These include two at Tarapur (PREFRE I & II), and a third at Kalpakkam, while another 100 tHM/year capacity reprocessing plant is under construction at Kalpakkam.[70] India's reprocessing plants have performed poorly and less than their nominal capacities for much of their operating histories between 1987 and 2014.[71] However, over the past eight years, these plants have been operating at optimal efficiency.[72] In addition to bringing the existing reprocessing plants to maximum efficiency, India is also increasing the size and capacity of the reprocessing program. Dr. Srikumar Banerjee, former Chairman of India's Atomic Energy Commission, disclosed in 2015 that India was increasing the size of its reprocessing capacity from 350 tons of tHM/yr to a target of 1900- 2000 tHM/yr by 2028: "We may yet not be setting up reprocessing plants as big as Rokkasho in Japan or Sellafield in the U.K, but the new reprocessing facilities that are slated to come up in the next decade or so are going to be appreciably bigger than what we have now. Even the one that is nearing completion in Kalpakkam is a fairly large facility."[73] India's reprocessing capacity is therefore on the path of growing by 443 percent by the end of the 2020s. A major expansion in India's reprocessing capacity will be through the completion of the Fast Reactor Fuel Cycle/Reprocessing Facility (FRFCF) at Tarapur with a design capacity of 400-600 tHM/year. The DAE has plans for eventually building a total of three Integrated Nuclear Recycle Plants over the next decade.[74] None of these upcoming back-end fuel cycle plants will be under safeguards. The FRFCF is being built at a cost of 96 billion [Indian] rupees and is expected to be completed by 2023.[75] It is designed to reprocess/separate the weapons and reactor-grade plutonium in the 27 tons of "the spent fuel of the [Prototype] FBR and also other two fast reactors expected to come up at Kalpakkam."[76] If the PFBR also fails to start-up in the near future, India's growing fuel reprocessing capacity will allow it to be directed to separate/reprocess much larger amounts of plutonium from its PHWRs and (military) production reactors. Alternatively, should the 500 MWe PFBR go online, it will exponentially increase India's annual production of weapons-grade plutonium from the current 24 kg to 164 kg—a net increase of 583 percent.

India's separated reactor-grade (civil) plutonium stockpiles that were 800 kg in 1999 have now ballooned to more than 7000 kg,[77] a net increase of 775 percent. India is also nearing completion of the 125 MWth Dhruva-2 production reactor and a 35 MWth research reactor—for weapons-grade plutonium production.[78] These, together with the 100 MWth Dhruva-1 production reactor will overtake the combined thermal capacity of all four 50 MWth Khushab production reactors in Pakistan. It will also more than double the annual weapons-grade plutonium production in India from the current 24 kg, even without the commissioning of the 500 MWe PFBR. India has already accumulated 0.6 ± 0.15 tons of weapons-grade plutonium by 2019 from its CIRUS and Dhruva-1 production reactors. This shows a net increase of at least 142 percent from 310 kg in 1999.[79] Similarly, while India has justified the development of the unsafeguarded centrifuge-based uranium enrichment program by saying that it is only for its nuclear submarines, its existing HEU is enriched to 30-45 % of U-235. While India is reportedly expanding its centrifuge enrichment capacity that will again be in excess of meeting the requirements of its nuclear submarine fleet, the 4.4 ± 1.6 tons of HEU enriched to 35 % (as of 2019) is already more than four-fifths of the time and effort required to produce weapons-grade levels of 90 % enrichment. It takes only 5000 Separative Work Units/year to produce weapons-grade HEU for one nuclear device (25 kg) and since 1999, India's centrifuge enrichment capacity has grown from 3000 SWU/year and is likely to reach 126000 SWU/yr in the current decade, registering an increase of 4100 percent.[80] This excess enrichment capacity is likely to be employed for India's fission and thermonuclear weapons, for which a very large centrifuge enrichment complex has sprung up at Challakere in Karnatka state. This centrifuge enrichment complex was expected to be completed by 2017, and when complete, was believed to be "the subcontinent's largest military-run complex of nuclear centrifuges, atomic-research laboratories."[81]

India is embarked on the road to a third nuclear breakout—the first being and second being its 1974 and 1998 tests—while the third comprises its exponentially growing latent capabilities that will allow it to dip into this potential to meet the needs of its evolving strategic force posture. Although India is a declared nuclear weapon state, it might be on the path to weaponize its latent nuclear capabilities, which in the absence of any verification and safeguards mechanism, will be perceived as a proliferation threat by India's neighbours. Despite the clear trajectory of India's existing and projected fissile material production capabilities, the United States and other countries do not seem to view it with concern. This is primarily due to the India-US strategic partnership anchored in a shared goal of containing China, while Pakistan's much smaller nuclear weapons program is often negatively portrayed and projected as the fastest growing in the world. Pakistan has continued to face discriminatory treatment by the NSG countries during the past two decades, primarily because the illicit proliferation activities involving one of its senior scientists are frequently used against it, despite the country's strong credentials of upholding international commitments and safeguards obligations as a state actor. The fact that India itself has received help from the nuclear black-market in developing its uranium enrichment program during the late 1990s is ignored, as India offers a large nuclear energy market for prospective power reactor producers and fuel suppliers under safeguards.[82]

Conclusion

Pakistan's civilian nuclear energy program could not be developed as planned due to international nonproliferation embargoes by the NSG that originated due to India's misuse of a civilian research reactor for its 1974 nuclear test. Yet the same NSG gave India a waiver in 2008 without the obligations of a NPT signatory state. Since then, India has been able to import uranium and fuel for its power reactors under safeguards, while its domestic reserves are being fully exploited for its civilian and military nuclear programs outside safeguards. Pakistan has not been able to receive any such exceptional waiver from the NSG, and China is its only civilian nuclear energy supplier within IAEA safeguards. The preferential treatment accorded to India is further amplified in terms of undermining of nonproliferation norms becomes more apparent when the NSG's exclusive 2008 waiver in favor of India is compared to other countries that have latent nuclear potential but are NPT signatory states.

Commercial reprocessing programs are increasingly becoming controversial, such as the Rokkasho reprocessing project in Japan, which is believed to drive a cascading effect on the dormant reprocessing programs in East Asia in the future.[83] Japan and South Korea are NPT signatory states and their civil plutonium stockpiles are under IAEA safeguards, while India is a non-NPT nuclear weapon state whose civil plutonium stockpile is unsafeguarded. These developments are fueling strategic anxieties in South Asia.[84] Pakistan has been objecting to the proposed draft of a FMCT that only bans future production and has called for a Fissile Material Treaty (FMT) that also addresses asymmetries in existing stockpiles. To this end, Pakistan has been citing India's unsafeguarded fissile material (civil plutonium and HEU) stockpiles as a potential source of exacerbating an arms race in South Asia.[85] This in turn is driving Pakistan's own fissile material production program. Regional threat perceptions can partly be addressed through implementing a clear separation of India's civilian (safeguarded) and dual-use (unsafeguarded) nuclear energy and fuel cycle infrastructure. Power reactors and fuel cycle facilities must meet the criteria for membership of the NSG for states not a party to the NPT. While this may require revisiting India's 2006 nuclear separation plan and the resultant deficiencies of the IAEA safeguards and civil-military overlap in India's nuclear program, "The NSG is right to be concerned about dual-use facilities; such facilities do not meet contemporary nonproliferation standards and can be seen as a strategic threat."[86]

India stands out as the only country that has the largest unsafeguarded weapon-usable civilian plutonium stockpiles outside the NPT states.[87] In accumulating a strategic stockpile of unsafeguarded fissile materials, India is pursuing a carefully calibrated strategy of nuclear latency through the development of its three-stage nuclear energy program—whereby the weaponization of these stockpiles is only a political decision away—hence the focus on India's latent nuclear potential. This nuclear buildup in India's latent nuclear capabilities and its evolving strategic force posture is driving a shift in India's doctrinal thinking away from No First Use towards while preparing for "Full Spectrum of Conflict"[88], development of a strategic triad of ballistic and cruise missiles, counterforce capabilities, Agni-V and VI intercontinental-range ballistic missiles armed with multiple warheads (MIRVs) and submarine-launched ballistic missiles. These developments are not going unnoticed in the region. The 2020 Annual Report to Congress prepared by the U.S. Department of Defense noted that, "India also plays a factor in China's nuclear threat perceptions," while U.S. scholars disagree.[89] Interestingly, India's weapons equivalent of unsafeguarded fissile material stockpile in 2019 (4.4 tons HEU enriched to 30-45 % U-235 and 7 tons separated civil plutonium, with another 11 tons of reactor-grade plutonium awaiting reprocessing and at least 700 kg of weapons-grade plutonium) matches the weapons-equivalent of China's fissile material stocks (14.3 tons weapons-grade HEU and 2.9 tons weapons-grade plutonium). Pakistan's relatively modest stockpiles in 2019 comprise an estimated 3.7 ± 0.4 tons of weapons-grade HEU and 370 kg of weapons-grade plutonium.[90] Moreover, international warhead estimates continue to estimate the size of India's nuclear weapons arsenal only on its existing stockpile weapons-grade plutonium, that alone is insufficient to meet the needs of its expanding nuclear weapons complex and an assortment of delivery systems. India's increasing stockpiles of unsafeguarded civil and weapons-grade plutonium and HEU and fissile material production capabilities will provide the technical basis for an expanding nuclear arsenal and achieving escalation dominance through counter-force capabilities in a future conflict in South Asia, thereby undermining deterrence and crisis stability.

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