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Lecture:

NUCLEAR ENERGY AND NUCLEAR POLIFERATION: LINKAGES AND DISSONANCES

PR Chari

Let me express my gratitude to Mrs. Madhuri Sondhi and the Trustees of the M.L. Sondhi Memorial Fund for having conferred its Annual Prize upon the Institute of Peace and Conflict Studies. I am honored to deliver the acceptance address.

I had the privilege of knowing Professor M.L. Sondhi over the years. We met in the seminar circuit and in the India International Center, and talked about the headline issues of the day. Professor Sondhi always had something useful to say and always had a definite point of view. I don't think he had much use for the half-truths and verisimilitudes that marks New Delhi's public culture, lest radical views mar incipient ambitions. Dr. Sondhi had strong likes and dislikes. Our meetings, therefore, were cordial.

Let me say a few words here about the Institute of Peace and Conflict Studies which General Banerjee and I established in 1996. Creating a new think tank is difficult with no funds, no staff, no premises, and nothing more than ideas on how the new think tank should be structured. We felt that the hard issues of military security had relegated to the background the emerging non-military and non-traditional, but more relevant, challenges to national security. We hoped to emphasize this perception. We started with an initial grant from the Ford Foundation to bring out a book of essays on the Newer Perspectives of Security in South Asia. But, we were overtaken by events—the nuclear tests in May 1998 could not be ignored if we were to remain relevant. A holistic approach to national security was addressed, which has required to be constantly adjusted. We had our share of difficulties and problems, but have weathered them so far. Of one thing I am clear. If the IPCS has secured some recognition it is due to the commitment, hard work and dedication of its younger staff. The IPCS is truly the sum of its research staff and interns, past and present, scattered now across the world.

I must also recognize the major role of those who gave of their time and experience to help us in our initial years. Sadly, many of them are no longer with us. I must recognize the late Giri Deshingkar and Mira Sinha Bhattacharjee, who encouraged our plans to establish a new Institute that would depart from the beaten path. They offered us the hospitality of the Institute of Chinese Studies, then located in Bhagwandas Road—one large room really, which also housed the library, meeting room, four cubicles and three computers, one of which they shared with us. Ashish Nandy was then the Director of the CSDS, and kindly agreed to take our fledgling institution under his wings. Indeed, the name we took—Institute of Peace and Conflict Studies—was designed by him for appealing to both the Eastern and Western blocs. Later, after we registered ourselves as an independent Society, we were greatly encouraged by our first

President, Air Chief Marshall, S.K. (Polly) Mehra, and G.K. (Gopi) Arora. Sadly both are no longer with us. I should also recognize T.A. Ananthachari, former Director-General, Border Security Force, and, of course, Eric Gonsalves, our second President; both were invaluable in charting the growth and development of the IPCS. There are many, many others who need to be thanked, and it is only the paucity of time that prevents me from noticing them.

EARLY HISTORY OF THE NUCLEAR AGE

Coming to the questions that concern us this evening—nuclear energy and nuclear proliferation—let me illumine the problematique, but also explain why nuclear disarmament has been omitted from this trilogy. Nuclear energy and nuclear proliferation are clearly interwoven issues; indeed, they intensify each other's problematique. So, how are nuclear energy and nuclear proliferation conjoined? The oldest cliché in this business is that technology is Janus faced. It can be used for good and bad purposes, and to achieve either the tasks of peace or the purposes of war. Nuclear energy can generate power, isolate isotopes for medical and industrial purposes, and agricultural research. But, nuclear energy has also been used to make nuclear weapons. The descendants of Hiroshima and Nagasaki, attacked in August 1945, are still suffering from the after-effects of nuclear radiation. Consequently, the horizontal and vertical spread of nuclear energy heightens the danger of nuclear weapons becoming available to state and non-state actors, which constitutes the present danger to the international system. These issues are linked to nuclear disarmament but nuclear disarmament is closely linked to conventional disarmament, general and complete disarmament, and requires independent treatment.

Proceeding further, the radical change in the international system brought about by nuclear weapons was apparent viz. that they could best serve to deter the use of nuclear weapons, but little else. Indeed, Bernard Brodie's wise dictum voiced in November 1945 remains true. "Thus far the chief purpose of our military establishment has been to win wars. From now on its chief purpose must be to avert them. It can have almost no other purpose." In October1945, a month earlier to Brodie's prophetic statement, President Truman had tried to link the peaceful uses of nuclear energy with the need for its control. He noted that, "The scientific and industrial knowledge on which this discovery [atomic energy] rests…may someday prove to be more revolutionary in the development of human society than the invention of the wheel, the use of metals, or the steam or internal combustion engine…," but added the caveat that, "The release of atomic energy constitutes a new force too revolutionary to be considered in the framework of old ideas. We can no longer rely on the slow progress of time to develop a program of control among nations." Further, "The hope of civilization lies in international arrangements looking, if possible, to the renunciation of the use and development of the atomic bomb, and directing and encouraging the use of atomic energy and all future scientific information toward peaceful and humanitarian ends." The hope that nuclear disarmament and the peaceful uses of

atomic energy could proceed was premised, however, on the number of nuclear actors not increasing. In other words, in nuclear proliferation not occurring.

Truman's salubrious hopes were expressed when the United States had a monopoly over the possession of nuclear weapons. It could have eliminated its fledgling nuclear arsenal, but this did not happen. Overtures to the Soviet Union to explore this possibility yielded a joint resolve to create a UN Commission on Atomic Energy. Preparatory work led to formulation of the Acheson-Lilienthal Report, published on March 16, 1946; it warned that use of atomic energy for peaceful purposes and bombs were "inter-changeable and interdependent." Reliance that no such inter-change was occurring could only be based on the pledged word of nations. Reassurance was therefore sought by emplacing a system of inspections of nuclear facilities and installations by an external agency to detect and prevent the manufacture of nuclear weapons. Significantly, the Acheson-Lilienthal Report had added that: "We are convinced that if the production of fissionable materials by national governments (or by private organizations under their control) is permitted, systems of inspection cannot by themselves be made effective safeguards…to protect complying states against the hazard of violations and evasions." These words were echoed after more than half a century by the Nuclear Security Summit in April 2010, that welcomed "President Obama's call to secure all vulnerable nuclear material in four years as we work together to enhance nuclear security." This recital informs us that the links between nuclear energy and nuclear proliferation have not materially altered since the birth of the nuclear age.

American nuclear policy evolved further. The Acheson–Lilienthal suggestions were incorporated within an American proposal placed before the United Nations. The Bharuch plan that was presented in June 1946 proposed international ownership over the production of nuclear materials, with two conditions to ensure effective compliance. First, that the Security Council veto would not apply if these arrangements were violated. Second, a graduated approach was favored towards the imposition of safeguards and the American stockpile being brought under international control. Ceasing nuclear weapons production was to be addressed later. In response, the Soviets proposed a convention to outlaw nuclear weapons production and destruction of all existing weapons within three months of the convention being ratified. They also proposed that the nuclear issue be discussed alongside general disarmament negotiations. Soviet archives reveal that Stalin was, in fact, determined to achieve nuclear capability, and no controls were acceptable to him.

These early failures to address the revolution in national security ushered by nuclear weapons could not mitigate the tensions and instabilities in the international system. The late 1940s and early fifties witnessed a series of East–West crises. Soviet troops remained in Iran. Civil war broke out in Greece. In 1948, tensions escalated when, following a coup in Czechoslovakia, the Soviet Union prohibited access to Berlin by the allied powers. In 1949 the North Atlantic Treaty Organization (NATO) was established, the People's Republic of China came into existence, and the Soviets tested their first atomic weapon. The Korean War broke out in 1950. The United States achieved thermonuclear capability in 1952, and the United Kingdom exploded its first nuclear device in

that year. These developments provide the backdrop for a major development that consolidated the linkages between nuclear energy and nuclear proliferation, which was President Eisenhower's announcement of his transformative Atoms for Peace plan in 1953.

NUCLEAR ENERGY AND NUCLEAR PROLIFERATION GET LINKED

Eisenhower was concerned that information on generating nuclear energy must be shared with the NATO allies. He also wished to draw corporate America into exploiting nuclear energy commercially, which he believed was a major growth area. At the same time he was conscious of the dangers of nuclear energy spurring the development of nuclear weapons. In September 1953 itself Eisenhower began outlining his Atoms for Peace vision with an initial proposal to establish a uranium fuel bank administered by an international agency, alongside the Soviet Union. Eisenhower thought fuel banks could, theoretically, reduce the size of nuclear stockpiles, but no details were provided about how this program would be implemented.

Addressing the General Assembly on December 8, 1953 Eisenhower stressed that: "… our earlier start has permitted us to accumulate what is today a great qualitative advantage [fissionable materials] but the atomic realities of today comprehend two facts of even greater significance. First, the knowledge now possessed by several nations will eventually be shared by others, possibly all others. Second, even a vast superiority in numbers of weapons, and a consequent capability of devastating retaliation, is no preventive, of itself, against the fearful material damage and toll of human lives that would be inflicted by surprise aggression.… To stop there would be to accept helplessly the probability of civilization destroyed, the annihilation of the irreplaceable heritage of mankind handed down to us generation from generation, and the condemnation of mankind to begin all over again the age-old struggle upward from savagery towards decency, and right, and justice.…The United States, heeding the suggestion of the General Assembly of the United Nations, is instantly prepared to meet privately with such other countries as may be principally involved, to seek an acceptable solution to the atomic armaments race which overshadows not only the peace, but the very life of the world." The parallel between Eisenhower's impassioned statement in 1953 and President Obama's inspired rhetoric of the present day is striking.

Eisenhower went on thereafter to outline his proposal: transfer by the United States and the Soviet Union from their stockpiles of fissionable materials to an international atomic energy agency; devising under United Nations' aegis modalities for making these materials available under safeguards for peaceful pursuits; and to provide nuclear power to serve the underdeveloped regions of the world. The Soviets raised the issue of urgent progress on nuclear arms control. It took another three years of hard negotiations to found the International Atomic Energy Agency (IAEA) in 1957. Meanwhile the most exaggerated claims were

made about the promise of nuclear electricity—this was the "too-cheap-to-be-metered" era. A Nelson's eye was turned towards the downside of nuclear energy. Like the possibility of major nuclear accidents due to runaway chain reactions, core meltdown and so on. Three Mile Island, Chernobyl, and Tokai-mura were still concealed in the mists of the future. The problems of nuclear waste were also not an issue, which continues to elude credible management. Similarly, the need to 'shroud' nuclear reactors and encrypt them in vaults after their useful lifetime is over was also evaded; indeed, these debates have yet to commence in any seriousness. But, the issue of moment that attracted anxious attention and provided the *leitmotif* for devising the Atoms for Peace Program was that the acquisition of nuclear energy by more countries spelt the concomitant danger of more countries coming to possess nuclear weapons. The Program could not prevent the evolution of the five *nuclear* weapons powers in the first phase. The United States (1945), Soviet Union now Russia (1949), and United Kingdom (1952) had become nuclear weapon states before the Atoms for Peace Program was devised in 1953; later France (1960) and China (1964) exploded nuclear devices, and joined this Nuclear Club. The Atoms for Peace Program had not anticipated these later developments.

The Non-Proliferation Treaty (NPT), negotiated in the late sixties, came into force in 1970. It was expressly designed to address the dilemma that the dissemination of nuclear technology for peaceful purposes forebodes more states acquiring nuclear weapons. The NPT made a valiant attempt to restrict the number of nuclear weapon states to the existing five by defining a nuclear weapon state as one that had detonated a nuclear device before December 1967. In essence, the NPT conceded that the Atoms for Peace bargain was not working. It could not prevent states from acquiring nuclear technology for peaceful purposes and using it to manufacture nuclear weapons. Not could it dissuade countries with nuclear weapons from assisting other states to acquire them. The linkage between the United States and the United Kingdom, between France and Israel, and between the Soviet Union and China in disseminating nuclear technology relevant for military purposes had come to light. A stronger commitment was therefore required to ensure that transferred nuclear technology would only be used for peaceful purposes. Therefore, under Article IV of the NPT the recipient country was obliged to accept IAEA monitoring (Article III), and renounce its choice to acquire nuclear weapons (Article II). The treaty was palpably unequal and discriminatory; it recognized only the existing five nuclear weapon states as having the right to possess these weapons, but denied this possibility to others. To make this discriminatory and unequal arrangement palatable the five "legal" NWS agreed to negotiate in good faith to end the nuclear arms race and proceed with other nations to general and complete disarmament (Article VI). This vague formulation is obviously inadequate.

A short digression is necessary here to highlight that several events occurred immediately after the establishment of the NPT that weakened that Treaty. The nuclear programs of South Korea and Taiwan began tilting in a military direction until they were reversed under American pressure in the mid-seventies. Links between West Germany and South Africa's uranium enrichment program came to light in 1975. Similarly, links between West Germany and Brazil's nuclear program, and efforts by Brazil and Argentina to derive their nuclear options also

came to light. An atmospheric test was detected in the southern Indian Ocean in 1977, and attributed to Israel. The decade of the seventies was very stressful for maintaining the status quo envisaged by the NPT. India's role in interrogating this status quo must be highlighted. It refused to join the NPT, and conducted its "peaceful nuclear explosion" in 1974, despite the foreknowledge that it would be subjected to sanctions that could cripple its nascent atomic energy program.

In further recognition, however, of the fact that materials and technologies acquired for peaceful nuclear programs could be diverted to manufacture nuclear weapons, several nuclear supplier nations joined to form the Zangger Committee in 1971. It was intended to ensure that recipient countries accepted IAEA safeguards upon their nuclear programs before importing sensitive items, collectively called the "Trigger List," that could be used to manufacture nuclear weapons. India's nuclear test in 1974 confirmed that nuclear materials and technology acquired for peaceful purposes, supplemented by indigenously developed technology, could be used for explosive purposes. In response to India's nuclear test several Zangger Committee members formed the London Club, later renamed the Nuclear Suppliers Group (NSG). The NSG added more technologies for prohibition to the Zangger Committee's "Trigger List," which were incorporated within the NSG Guidelines. The NSG Guidelines, in essence, require recipient states to ensure their imports of nuclear technology will not be used to make nuclear weapons. Recipients are obliged to ensure the physical security, prevent theft and unauthorized use of these imports, and refrain from re-transferring the imported technology to third parties without an authorization by the original exporter. The NSG now has 45 members, including all the nuclear weapon states and the major nuclear supplier nations.

Parenthetically, Russia transferred nuclear fuel to India in 2001 despite the NSG's prohibitions. India has now been made an exception to all these prohibitions under the Indo-US nuclear deal. It can access nuclear technology without entering the NPT or accepting comprehensive safeguards on its entire nuclear program. China has offered a similar nuclear deal to Pakistan, and could proceed without the concurrence of the NSG members, exploiting flimsy legal arguments. All these developments have weakened the NSG and the NPT. Proceeding further, arguing that India is a status quo power is an indulgent surmise. India has not hesitated to challenge the status quo whenever its vital national interests so dictated. It had tested a nuclear device in 1974, but could not become a *de jure* NWS in terms of the NPT, since the test occurred after December 1967. India remained a *de facto nuclear* weapon state for twenty four years before it challenged the status quo again with its nuclear test series in 1998.

Other events have challenged the basic premises of the NPT. Iraq was found to be reneging on its NPT obligations. North Korea, suspected of violating its NPT commitments, refused to permit monitoring of its nuclear program, withdrew from the NPT, and has conducted two nuclear tests. Iran has developed clandestine nuclear facilities. On the horizon is acquisition of nuclear weapons by more aspirant states, but, more worrisome, by non-state actors espousing extreme and millenarian ideologies. Nuclear terrorism no longer lies in the realm of science fiction. A new urgency therefore attends reconciling the greater use of nuclear energy with preventing the proliferation of nuclear weapons. The

dilemma of discovering an appropriate balance between these two requirements has, in fact, become more acute.

Incidentally, an argument that was popular some decades back was that the vertical proliferation of nuclear weapons i.e. the growth of nuclear arsenals in the nuclear weapon states was as much in need of attention as horizontal proliferation viz. the spread of nuclear weapons to more countries. Murphy's Law was cited, viz. that if something could go wrong, it would definitely over time go wrong. A retrospective view of the global non-proliferation scenario reveals that the total number of nuclear weapons in existing arsenals is reducing, but more nuclear actors are emerging. The likelihood of nuclear conflict has receded after the Cold War ended. But, the probability of nuclear disaster has become greater with the number of nuclear actors increasing—each an independent decision-making center, each with its specific national security agenda, and each with its different sets of adversaries. The law of probability is inexorable.

These developments have greatly weakened the NPT, and could usher its slow demise, unless global efforts to shore up the NPT succeed. An international system without the NPT would be infinitely more unstable than one with an imperfect NPT. The question of moment then arises: what did the recently concluded NPT Review Conference accomplish? Its greatest achievement was in finalizing a consensus Document, which was not possible after the previous Conference in 2005.

The NPT RevCon laid out a plan of action thereafter, which desired a rapid reduction in global nuclear stockpiles, a diminution in their role within national security doctrines by limiting their operational role. No-use policies were approved. The Conference mandated that progress in these directions be reported to the NPT Preparatory Conference in 2014, a year before the next RevCon in 2015. It also recommended that the CTBT be made operational, the FMCT be negotiated, the Committee on Disarmament in Geneva be resurrected, and security assurances be made effective. The RevCon also decided to convene an interim meeting in 2012, with the Middle East countries attending, to discuss the obdurate Middle East nuclear weapon free zone proposal. North Korea was called upon to return to the NPT and adhere by international norms. The Final Document also urged India and Pakistan to join the NPT--which has greatly exasperated New Delhi--place their nuclear facilities under comprehensive IAEA safeguards, and strengthen their export control measures,.

THE FUTURE OF NUCLEAR ENERGY?

Despite the well-intentioned promise of the Atoms for Peace program why did the growth of nuclear energy not proceed more rapidly? It might have been expected that states would pursue their nuclear energy option aggressively, especially since supplies of fossil fuels were depleting, supplies were uncertain due to political considerations and their costs were increasingly becoming unpredictable due to supply and demand factors. The global recession has

currently eased demand and moderated oil prices; however, a crisis in the Middle East could again lead to pressure on oil prices. New oil fields being discovered could bring prices under greater control, but a major accident could lead to increased prices. The promise of shale oil is growing. In brief, the range of positive and negative factors are too wide to permit any credible predictions regarding future oil supplies and prices; the only safe prediction possible is that fossil fuels, being a non-renewable, depleting and non-exhaustible resource, have a finite life, which strengthens the case for developing all available sources of energy including nuclear energy. A great deal of hype has currently been generated by expectations of a nuclear renaissance, based on fears of fossil fuels depleting and their prices rising uncontrollably. At the same time, 9/11 and recurring incidents of fissile materials being seized highlight the dangers of nuclear terrorism. Peering into the future, I expect that political and financial support for nuclear technology will remain modest. Efforts are proceeding to develop new reactor concepts, but the high costs of developing and installing these new power reactors and the technical and commercial problems in utilizing these new technologies could prove daunting.

The question persists: why has the growth of nuclear energy not proceeded more rapidly? Many reasons could be operative like restrictions on the access to nuclear technology; the high costs involved in establishing atomic reactors, securing uranium fuel, ensuring waste disposal; but prominently the difficulty of financing these programs from national or international sources due to the long gestation periods involved. However, the resistance to enlarging atomic energy programs seems to arise from a pathological fear of radiation which has been strengthened by the occurrence of past accidents like Chernobyl and Tokai-mura that involved the release of radioactivity. The Three Mile Island accident did not release radioactivity, but heightened safety concerns regarding nuclear energy programs. Undoubtedly, the future of non-energy related uses of nuclear technology in medicine, agriculture, biological research, space exploration, and industry is secure, and could advance more rapidly, since these ventures enjoy public support. The challenge here is different and concerns safety and security issues. The recent cases in New Delhi where Cobalt-60 was found in scrap yards and led to radiation deaths is a case in point. In brief, energy and non-energy applications of nuclear technology have expanded over the years, but at a much slower pace than expected.

Two major challenges arise pertaining to the generic issue of nuclear energy that needs mention.

First, the promise of fast breeder technology. The most important fissile materials for civil and military purposes are uranium 235 (U-235) and plutonium 239 (Pu-239). Uranium-235 constitutes 0.7 percent of natural uranium, which occurs in nature. Pu-239 is artificially created when uranium-238, which constitutes 99.3 percent of natural uranium, absorbs a neutron. The Bhabha three-phase program accorded a pivotal role for fast breeder reactors in India's nuclear energy strategy. The main features of the Bhabha plan can be recalled here. PHWRs (Pressurized Heavy Water Reactors) would be established in the first phase. They would use natural uranium and produce plutonium-239 alongside atomic power and other products in the spent fuel. In the second phase the Pu-239 would be separated by

reprocessing and used to fuel FBRs (Fast Breeder Reactors) that would produce more plutonium than they consume, which could then be used to fuel more reactors. Finally, in the third phase, breeder reactors would use Uranium-233 (U-233) in their cores and thorium in their blankets to produce more U-233 in a self-sustaining operation. The present Indian FBR program comprises its 15 MW Experimental Fast Breeder Reactor (EFBR) that went critical in 1986, and the 500 MW Prototype Fast Breeder Reactor (PFBR) expected to come on stream shortly.

The Bhabha plan, incidentally, was based on the paucity of natural uranium in India, but the abundance of thorium (some 70 % of the world's supplies), which provided the rationale for turning to fast breeder technology, despite its technological and proliferation challenges. Uranium supplies for the growing numbers of PHWRs in the Indian program had become acute, since more uranium mines were not opened. in fact, supplies of power from the existing PHWRs in the country had reduced to between 40-50 per cent of their rated capacity while the Indo-US nuclear deal was being negotiated over 2005-08. The official case for fast breeder reactors urges that they are not a proliferation risk, since the proliferation danger only arises if the plutonium in these reactors is reprocessed and separated. Not until then.

However, the downside of fast breeder reactors cannot be ignored. Their capital costs are some 25% higher than PHWRs that are the mainstay of the Indian program. Independent studies suggest that the electricity generated from the PFBR would be more expensive than from PHWRs, which are themselves more expensive than from other sources of electricity generation. Safety issues are of major concern here, because sodium is used as the coolant in the interests of the efficiency of these reactors, instead of light or heavy water. But, sodium is extremely volatile in the presence of either air or water; hence, even a minor leak could trigger a major fire hazard in the reactor.

On the historical note, several countries tried to pursue breeder technology in the past. Germany, the U.K., and the United States have abandoned their breeder programs. France's operating fast-neutron reactor, *Phénix*, was disconnected from the grid in March 2009. Its *Superphénix,* billed as the world's first commercial-sized breeder reactor, was abandoned in 1998, and is being decommissioned. Japan's *Monju* reactor operated for only a year before it was shut down in 1995 after an accident and has not resumed operation. After six decades and spending tens of billions of dollars, the promise of breeder reactors remains chimerical, and efforts to commercialize them have failed. In a recent Report the International Forum on Fissile Materials has opined that:

"The breeder reactor dream is not dead but it has receded far into the future. In the 1970s, breeder advocates were predicting that the world would have thousands of breeder reactors operating by now. Today, they are predicting commercialization by approximately 2050. In the meantime, the world has to deal with the legacy of the dream; approximately 250 tons of separated weapon-usable plutonium and ongoing — although, in some cases struggling — reprocessing programs in France, India, Japan, Russia and the United Kingdom."

This discussion has great relevance for India where the Bhabha three-stage plan enjoys a certain hagiography. But, it was conceived by Bhabha more than a half century ago, and its governing context has changed. The underlying assumption of the Bhabha plan was to proceed towards fast breeder reactors on the assumption that India's natural uranium reserves were limited; hence they had to be optimized by pursuing the breeder route to nuclear energy. The finalization of the Indo-US nuclear deal has changed this governing context. It allows India to import of natural uranium from different external sources. Hence, a strategy based on meeting the scarcity of natural uranium and taking advantage of the abundance of indigenous thorium by establishing breeder reactors has become questionable. Besides, the technical problems associated with breeder reactors have proven to be far more formidable than originally visualized. Only Russia and India are currently building demonstration breeder reactors. Disconcertingly, data on their reliability, safety and costs are scarce. It would, therefore, be appropriate to place the Bhabha three-stage plan before a peer group for review. India need not discontinue experimental work on breeder and thorium technology, but greater reflection is required on proceeding further to commercialize these technologies appreciating their considerable uncertainties.

Second, the promise of small modular reactors (SMRs) that have recently caught the fancy of the United States, needs evaluation. President Obama has requested $39 million for a new program to get SMR designs licensed for commercial use. What are these SMRs? Small Modular Reactor is a generic name for some fifteen different designs that generate around 100MWs of power. Siberia has four SMRs each producing 11MW of electricity since 1976. The US- based General Atomics group is developing a gas turbine helium reactor. South Africa had worked on a 200MW Pebble Bed Modular Reactor (PBMR), but it could not be established commercially on technical and economic considerations. The PBMR is believed to require less expertise than breeders. China has shown interest in the PBMR technology to progress its modular reactor project, based on establishing 200 MW SMRs.

Small modular reactors have the advantage of compact designs and are comparable in size to the reactors that power nuclear submarines. They can be fabricated in factories and transported by truck or rail to their locations; hence, their capital costs and construction times can be scaled down. In fact, SMRs are publicized as being ready to 'plug and play'. An element of flexibility is also available, since SMRs can be added or withdrawn on demand, while relieving pressure on the national grid. Therefore, they are most suitable for small electrical grids and for being located in isolated places. The downside of SMRs is that they require the same level of expertise for operating them as needed to run large commercial reactors. Besides, the problems of nuclear safety and security will only multiply due to their scattered locations. There are personnel issues also involved, especially in India, because qualified personnel are scarce, and it will prove difficult to recruit, train and post them to remote places, but also to retain them.

THE OBAMA INTERLUDE

A new vigor has been imparted into the nuclear non-proliferation and nuclear energy debate after President Obama came to power; he has ushered a refreshing change from the Bush interregnum that had buried nuclear arms control and disarmament under its obsession with American unipolarity. President Barack Obama has identified the primary threat to the international system as arising from nuclear weapons and materials. In his 5 April 2009 Prague speech, he noted that terrorists were "determined to buy, build, or steal" nuclear weapons. An international effort was therefore required to "secure all vulnerable nuclear materials around the world within four years." President Obama proclaimed, however, that a world without nuclear weapons would not, realistically, be realized in his lifetime. Nuclear weapons will continue to play their role in strategic thinking over the coming decades, which underline the dangers from nuclear proliferation and its linkages with nuclear energy.

US officials believe that there are some 2,000 tonnes of weapons-grade uranium and plutonium worldwide, which relates to declared stocks. How much is undeclared is anybody's guess. But, there is optimism that 'states of concern' or terrorist organizations will not be able to assemble, much less conceal, the facilities needed to enrich uranium or reprocess plutonium to weapons grade for assembling nuclear weapons. This optimism, of course, needs to be tempered since newer technologies are becoming available, like uranium enrichment using lasers that can be achieved in small research facilities. The other option of stealing a nuclear weapon from heavily guarded nuclear stockpiles is very difficult. Moreover, nuclear warheads can be kept in a disassembled state and, even if assembled, can only be detonated on receiving a coded signal, called Permissive Action Links. There is some optimism therefore, that states of concern and terrorist organizations cannot gain access to nuclear weapons. But, no such optimism obtains regarding these aberrant actors manufacturing a radiological dispersal device (RDD) after acquiring fissile materials, since the technical expertise required is not great. Widespread panic, high cost of cleaning up and an economic slowdown are some of the deleterious effects of a RDD attack. Apropos, Shyam Saran had informed the 'Global Zero' meeting in Paris earlier this year that, " India is deeply worried about the potential nexus between clandestine proliferation and terrorism and the ever-present danger of such weapons or vulnerable nuclear materials falling into the hands of jihadi and non-State actors."

The year 2010 has also been significant for illumining the Obama's Administration's policies and plans to address nuclear nonproliferation issues. The landmark events were unveiling of the much-delayed Nuclear Posture Review (NPR); signing of a new START agreement between the United States and Russia to further reduce long-range missiles in their nuclear stockpiles; holding the Global Nuclear Security Summit that was attended by some 47 nations and, finally, ensuring that the five-yearly Review Conference of the Non-Proliferation Treaty was fruitfully concluded. The Nuclear Posture Review perceptively noted that "the risk of a nuclear confrontation between nations has gone down, but the risk of nuclear attack has gone up." The Nuclear Security

Summit recognized the safety and security of nuclear materials as being the main threat to nuclear non-proliferation, thereby highlighting the danger from non-state actors.

However, several recent events have signaled that the days when the non-nuclear weapon states unthinkingly supported the non-proliferation policies of the United States are over. Brazil and Turkey had their own foreign-policy and economic compulsions to enter into a deal with Iran to enrich its uranium, despite the United states having mustered the Nuclear Five to impose sanctions on Iran. Quite evidently, Washington's clout to set the non-proliferation agenda has diminished after its economic situation deteriorated, simultaneously with the growth of China's GDP and foreign exchange reserves, which allows its pursuit of an aggressive foreign policy. The arbitrary and contradictory policies of the United States are also coming into high relief. For instance, the United States has threatened Iran on several occasions, but Washington has gone to extraordinary lengths to downplay the proliferation misdeeds of Pakistan, China and North Korea. North Korea's cavalier conduct in sinking a South Korean naval vessel without provocation only elicited a feeble response from the United States. Instead of disciplining Pyongyang, Washington has abdicated its responsibilities to Beijing.

Another example. The exception made in favor of India through their bilateral nuclear deal might have served the American political and economic interests. But, this nuclear deal undercuts the IAEA's safeguards and inspections regime, which undergirds the international non-proliferation regime. China had defiantly announced in April that Chinese firms had agreed to construct two new nuclear reactors in Pakistan, using implausible justifications to avoid placing this matter before the NSG for decision. It was expected that the United States would raise serious objections to this China – Pakistan nuclear deal. However, the United States has soft peddled this issue conveying the impression that it is willing to adjust its non-proliferation policies for reasons of strategic and economic expediency vis-à-vis Pakistan and China, despite their appalling proliferation record. Real politik has always dictated the American non-proliferation ideals, which has repeatedly been subordinated to the requirements of its overall foreign policy.

The cynicism underlying this policy is plainly evident. Its consequences are also evident and predicate a further erosion of the non-proliferation goal. It also reinforces the conclusion that the United States will not be able to sustain its selective nuclear non-proliferation policy. What Brazil, Turkey and Iran attempted to accomplish before being thwarted could be replicated by others. What the world might, therefore, be looking at is a slow but steady decay of the non-proliferation regime, making the world a more dangerous place for its stake holders, including India.

DRAWING THE THREADS TOGETHER

Let me say now what might have been said at the beginning. The stability and continuity in the supply of vital inputs for the population has been a matter of anxious concern for the State since the dawn of history. It was food at all times, gold to buy essential goods, trade to support local industries and so on. Water is becoming an anxious concern, especially for heavily populated states. The current concern with energy began with the industrial age; its significance for the world economy needs no emphasis. Even the Greens are not arguing for a return to a bucolic, pastoral, pre-industrial age, while raising their environmental concerns. Without the assurance of adequate and affordable energy, the economies of the world would grind to a halt.

The anomaly in India is that, despite an early awareness of the significance of atomic energy, availability of political support--the Atomic Energy portfolio has always been held by the Prime Minister--no dearth of resources, and a clear vision obtaining, nuclear energy has only proceeded at a glacial pace. Why? My own belief is that the Atomic Energy Commission was fixated by its military side, which added to its hubris by gaining high level political attention at all times. Had the Commission lowered its profile and re-ordered its priorities the growth of atomic energy in India might have pursued a very different trajectory. I have argued that a peer group should review the Bhabha three-stage plan, against the backdrop of the Indo-US nuclear deal. India can now import nuclear materials, equipment and technology from members of the Nuclear Suppliers Group. The major gain is that India is now enabled to import natural uranium to sustain its Pressurized Heavy Water Reactor Program. I am dubious whether India will gain access to either enrichment or reprocessing technology, or to information that would be useful for its fast breeder program. Indeed, the fast breeder program needs review by the peer group in the light of the problems that have been highlighted in this address.

Still, the naive belief persists that the atomic energy program in India is poised for exponential growth. India's current installed capacity for nuclear power is less than 4000 MW, which is less than 3 % of its total energy generation, with another 3000 MW under construction. This has taken India a half century to achieve. But, our Ambassador to the United States has recently predicted that India was poised "to increase our installed capacity more than seven-fold to 35,000 MWs by the year 2022, and to achieve a target of 60,000 MWs by 2032." Her predecessor had predicted that "nuclear energy could meet as much as 20 % of the energy demand in India by 2050." This would amount to some 260,000 MWs on the basis of India's Department of Energy's predictions that India would generate 1,300,000 MWs by 2050. However, Anil Kakodker informed the press after the Indo-US nuclear deal was signed in end-2008 that nuclear energy would provide 35 % of India's total installed capacity by 2050, which amounts to 455,000 MWs. There are other such estimates of how much atomic power will be generated in future; all have one thing in common—everything lies in the eyes of the predictor. These estimates have something else in common; they do not appreciate the previous record of India's Atomic Energy Commission or the problems in achieving exponential growth on a small base or the long gestation period needed to

establish atomic power plants, or the difficulty in locating suitable sites for constructing them due to the resistance of the local population, or the difficulty in financing their establishment from either private or public funds. FDI is easily suggestible, and it can be further suggested that intending suppliers should be able to make their offers on attractive long-term, low-interest credit terms. The global recession would a dampener in this regard.

Currently atomic energy is only produced in the public sector, and there are doubts about permitting this activity in the private sector on security and strategic considerations. There is much euphoria, however, on optimistic projections of India's economic growth rate, calculated to rise above 9 % of its GDP, which obscures the reality that current account deficits have also risen above 10 % of the GDP, and inflation remains in the double digits. Meanwhile the "civil liability" issue has reached center stage, with both the United States and Russia involved. The question of adequately compensating the victims of the Bhopal gas tragedy has also raised its profile. What these developments portend is that the growth of nuclear energy generation will be much slower than what is expected by the AEC and the Government.

What is being argued here is that nuclear energy obviously has to be factored into any energy mix designed to address India's energy security. But no more and no less than for other sources of energy like hydropower, non-conventional sources of energy, and, most importantly, fossil fuels—India's dependence on them is around 80 %, which just cannot be wished away, despite its implications for climate change. Any vision of India's energy future should include reducing its dependence on fossil fuels which are environmentally sensitive and has increasingly to be imported. Investments are also required in technologies for making the use of fossil fuels safer and more productive. Energy security has to be sought in a holistic manner across the board. Wisdom dictates that all available energy resources be investigated, while taking into account their environmental impact and their life cycle costs.

The focus can be shifted now to the general discourse on nuclear energy. Three questions are raised here.

The first is whether a less energy-dependent pattern of development can address the demand side of the problem. A new and different development pattern would be required that needs acceptance of a different life-style. The 'small is beautiful' ideal promoted by environmentalist lobbies, and the 'back to the villages' slogan raised by the Gandhians may beguile. But, are they feasible as the world hurtles along into the 21st century? The pattern of development unfolding globally is promoting just the opposite viz. the economies of scale and a shift from the villages to the cities. The more basic question is: are we willing to make the life-style changes required to pursue these radical solutions for reducing the overall demand for energy?

The second question leads to a contrary answer. All projections of energy demand are based on currently available technologies. The discovery of more energy efficient fuels and processes—fusion power still remains a gleam in the eye--could result in meeting the growing demands with greater success. This

suggests the need for making greater investments for research into alternate sources of energy, especially renewables, and bio-fuels derived from jatropha and ethanol manufactured from high cellulose materials.

The third question relates to an issue that impinges on both energy demand and supply. Any approach to energy security must cater for conserving energy. There is, for instance, the vexed matter of transmission and distribution losses of electricity, which has technical parameters like large distances involved in conveying electrical power, but also includes the ubiquitous problem of electricity being stolen en route. It is also common knowledge that electrical equipment manufactured for domestic or industrial utilization has not been sensitive to the need for energy efficiency. It should be insisted upon and enforced by a judicious mix of incentives and penalties. Related to this issue of energy conservation is the politically-sensitive matter of realistically pricing fuel and power to reduce the demand for energy. In other words, reduce the freebies and subsidies that are routinely provided to garner votes, but distort demand and encourage the wasteful use of energy. Pricing policy can play a critical role in promoting the judicious use of energy, and lead to more accurate estimations of demand.

Focusing now on the equally perplexing issue of nuclear proliferation, it is clearly linked to the extension of nuclear energy. The inexorable logic of Murphy's Law suggests that nuclear safety and nuclear security could be compromised with growing availability of nuclear energy in more nuclear facilities and installations in more countries of the world. One can make certain suggestions here for reconciling these incompatibilities.

First, the need for establishing multilateral fuel cycle is imperative. This requires that proliferation-sensitive activities like uranium enrichment and plutonium reprocessing proceed in a small number of multilateral facilities under international safeguards. The fissile material requirements for the nuclear energy programs of NPT signatories could be met from these facilities without promoting nuclear weapons programs. But, this would be a hard sell.

Second, the efforts by nuclear weapon aspirants like North Korea and Iran, earlier Iraq and Libya, to pursue clandestine nuclear programs draws attention to the need for imposing an Additional Protocol on existing safeguards agreements for ensuring better compliance with the provisions of the NPT. Accepting the Additional Protocol will be voluntary; hence, securing universal compliance will also be a hard sell.

Third, the imperative need for the nuclear weapon states to address the reduction, prior to elimination, of their nuclear arsenals cannot be indefinitely evaded. This requires the United States and Russia, but also the United Kingdom, France and China to accelerate their efforts to dismantle their nuclear arsenals. Efforts to add to these arsenals, or sophisticate them or to make them more usable flies in the face of their solemn assurance under Article VI of the NPT. Parenthetically, China has been most evasive in this regard, free riding on hortatory demands upon others to reduce their nuclear arsenals, while amassing and modernizing its own nuclear stockpile.

The question now gains salience: what India can do in appreciation of its growing stature in the international system and to recapture the élan it possessed during the Nehru era of being in the forefront of the global disarmament movement? More pragmatically, nuclear proliferation is not in India's national security interests, which might explain its differentiated policy towards Iran—engaging Iran to establish the Iran-Pakistan-India pipeline, but voting against it in the IAEA. India's non-proliferation record is definitely shining. It has not transferred nuclear technology to other countries, despite the political and commercial sacrifices this strict conduct entailed. Can it do more to strengthen the NPT without joining that Treaty?

Many suggestions can be made here that need to enter the national debate.

- Firstly, India has placed a moratorium on nuclear testing, but has not joined the Comprehensive Test Ban Treaty (CTBT). Arguably, it feels no need to join the CTBT until the United States ratifies the Treaty, which is unlikely because the Obama administration does not have the votes to secure its ratification by the U.S. Senate. Could India make a clear statement to this effect?

- Second, India has signaled its willingness to enter into negotiations to finalize a verifiable and non-discriminatory Fissile Materials Cutoff Treaty in the Committee on Disarmament (CD). These negotiations have not commenced, and are hamstrung by Pakistan's insistence that past stocks be taken into account in this Treaty, which is not acceptable to other CD members. Until this impasse is broken, nations are free to produce fissile materials for weapons. However, the question is germane whether India can cease this production since it has accepted the principle?

- Third, these two issues--committing to stop nuclear testing and manufacturing fissile materials for weapons purposes draw very negative reactions from India's security establishment on the grounds that nuclear testing and additional production of fissile materials for weapons are needed to insure against an uncertain future. All such arguments derive from the belief that nuclear weapons are like conventional weapons. More and large is better than less and small. In truth, nuclear and conventional weapons are very different. Nuclear weapons can inflict horrendous destruction in seconds but their after-effects can last generations and lead to apocalyptical climate change. Any serious reflection on these issues would inform that nuclear deterrence is achievable at the lowest ends of the spectrum. The latest edition of the *Bulletin of the Atomic Scientists*, incidentally, estimates that India has assembled 60-80 warheads and produced enough fissile material for 60-105 more warheads. How many warheads does India require for its nuclear deterrents?

- Fourth, these issues are encapsulated within the concept of "credible minimum deterrence" that finds prominent mention in India's nuclear doctrine. There is some reluctance to define its contours in quantitative and qualitative terms, except in vague generalizations. A similar undefined mention is made in India's nuclear doctrine of concepts like "massive

retaliation", while professing India's ambition to establish a "triad" of nuclear weaponry in its nuclear arsenal. The commitment to no first use of nuclear weapons in a conflict has been subsequently qualified and made conditional. It is reiterated that all these concepts will look different if the intrinsic nature of nuclear weapons is reflected upon; it is also reiterated that adequacy and sufficiency can be achieved with less rather than more nuclear weapons. India's nuclear doctrine is ageing; it is now a decade old in an international milieu that has witnessed violent flux beginning with 9/11. It is becoming difficult to explain or justify its various adjuncts like "credible minimum deterrence", "massive retaliation" and "triad," which are eroding with the efflux of time. The nuclear doctrine, therefore, is in urgent need to be revisited.

- Fifth, India should seriously reconsider its objections to entering the Proliferation Security Initiative (PSI), since it has taken several actions in the past to strengthen its goals. Like searching a North Korean vessel bound for Pakistan in the Kandla port in 1999. Its undisclosed cargo was found to contain missile parts and blueprints for a Scud-type missile. Again, permission was denied to a North Korean aircraft to overfly India in November 2008 on suspicion that it was carrying missiles to Iran. Membership of the PSI would acknowledge India's role in appreciating the role of counter-proliferation to achieve the non-proliferation goal, and consolidate its anointment as a responsible state with advanced nuclear technology. Indian membership of the PSI would also recognize its major nautical presence in the Indian Ocean.

- Finally, India can strengthen the non-proliferation ideal by entering the technology restraints and control regimes like the Nuclear Suppliers Group, Missile Technology Control Regime, Australia Group and the Wassenar Arrangement. This dispensation will draw India into these regimes to strengthen them? True, India is not a member of the NPT, which is the passport for entry into these regimes. Therefore, some resistance from the other members of these regimes could be expected. But the NSG rules and regulations were relaxed for India to execute the Indo-US nuclear deal. Can this logic be extended further to India's entry into these regimes?

A SUMMATION

What can one conclude from this mass of data about the interwoven nature of nuclear energy and nuclear proliferation that would be of relevance to India? What are their implications for nuclear disarmament? Academic erudition lies in making simple conclusions complex. Not being an academic, but a bureaucrat who strayed into academics, let me try and make complex issues sound simple.

First, the significance of nuclear energy within the total matrix of energy security needs serious re-evaluation by India. It has taken a half century for nuclear energy

to provide less than 10,000 MWs-- the goal set by the Sarabhai plan four decades back. Nuclear energy amounts to less than 3 % of India's total energy requirements It would require a huge leap of imagination to accept wild claims that nuclear energy provides the answer to meet India's future energy needs. Furthermore, a willing suspension of disbelief is also required to believe that breeder technology is the silver bullet that will ease India's energy security problems. There are serious issues about the viability of breeder technology and its promise, if any, lies buried in the future. But, the problems of nuclear waste, nuclear safety and nuclear security are more imminent, despite their being eschewed in the national debate. A holistic view needs to be taken with energy security being sought by exploiting all available sources of energy, ranging from fossil fuels to non-conventional sources of energy. Unfortunately, the protagonists of one or other source of energy and those involved in the related industry are highly partisan in their advocacy of how energy security should be pursued. The need, however, is for exploiting all available sources of energy at affordable costs. The advantages, disadvantages and problems associated with ensuring energy security would be incomplete without noticing the measures needed to conserve existing energy supplies and avoiding its wasteful use. For instance, subsidising electric power for agricultural use has resulted in electric arc furnace steel plants being set up in rural areas, where they are being billed at agricultural rates. The politics of populism has converted many energy supplying companies in the public sector, especially the State Electricity Boards, into mortally sick organizations. Wasteful subsidies need to be eliminated. The bottom line remains--reliance on fossil fuels cannot be wished away.

Second, the issue of nuclear proliferation is related to the growth of nuclear energy—more reactors, more reprocessing plants, more enrichment facilities, more nuclear wastes, more transportation of nuclear materials and so on, which cannot be blithely dismissed as presenting no problems. Reference was made to cobalt-60 found in the junk yards of New Delhi to highlight the problems of nuclear safety and security. Clearly, nuclear proliferation has both national and global aspects; so the issue also arises as to what India can do to promote the non-proliferation goal, apart from making declarations of principle and issuing hortatory statements as to what others should be doing. Several suggestions have been made on what India can do in this regard, and they need pursuit in the interests of achieving the non-proliferation ideal, but also to re-capture the élan India once possessed in the sphere of disarmament, and to raise its profile in the management of universal problems.

Let me stop here. Let me reiterate my gratitude to Madhuri Sondhi and the Trustees of the M.L.Sondhi Memorial Trust for having conferred its Annual Prize on the Institute of Peace and Conflict Studies. Let me also thank all of you for your patience and your attention.

Thank you.

P.R.Chari
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