Nuclear Stability, Deterrence and Separation of India's Civil and Weapon Facilities

Raja Menon [1]

Abstract

The 18 July Bush-Manmohan Agreement is currently being implemented, in bits and pieces. At the time of the signing of the agreement it was stated by different officials that both governments would proceed to unilaterally implement the provisions that pertained to them and there would be no expectations of reciprocity. Following US Under Secretary of State Nicholas Burns' visit to India in October 2005 there is a clearer understanding of Washington's expectations of New Delhi, before President Bush approaches Congress to amend certain portions of the Nuclear Non-Proliferation Act 1978 (NNA) that strengthened the US Atomic Energy Act 1954. Clearly India needs to achieve a substantial or meaningful fissile material to reserve ratio to ensure that it can go through with a workable plan on separating its civilian and weapons facilities while safeguarding the independence of its deterrent.

The July 18 Bush-Manmohan Agreement (See Appendix A) is currently being implemented, in bits and pieces. At the time of the signing of the agreement it was stated by different officials that both governments would proceed to unilaterally implement the provisions that pertained to them and there would be no expectations of reciprocity. This wish has turned out to be false. The US Under Secretary of State Nicholas Burns' visit to India in October 2005 has led to a clearer understanding of Washington's expectations of New Delhi, before President Bush approaches Congress to amend certain portions of the Nuclear Non-Proliferation Act 1978 (NNA) that strengthened the US Atomic Energy Act 1954.[2] These provisions stand as major obstacles to the implementation of the July Agreement, or so the US administration officials state. The White House seeks from Congress clear exemption with regard to India, so that the NNA remains as strong as ever but India becomes exempt from its more draconian provisions. President Bush is to visit India in the spring of 2006 and the Americans

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have made it clear that by then India needs to have 'a plan' ready for separating its civilian and weapon facilities. Stated clearly, the 'plan' must be reasonable and not outrageous, but beyond that the details of the plan have been left to the Indians.

For most outsiders, formulating such a plan would amount to nothing more than placing the largest number of civilian reactors under safeguards. However, for Indians, there is much, much more to taking this step. The Indian strategic community needs to have a much clearer vision today on why the country went nuclear, what the objectives of weaponisation are and how far those objectives can be met within the confines of the Bush-Manmohan Agreement – if indeed there are any confines. The background work involved for the Government of India in getting to know its own mind, before putting concessions down on paper is going to require a fast forwarding of the processes begun seven years ago. This process which has been aptly called the ideational process, involves the setting up of strategic and targeting mechanisms, ordnance inspection and alerting mechanisms – none of which has not taken place largely because of bureaucratic inertia. In the absence of these processes, or mechanisms, deciding on the finality of the weapon and civilian facilities is going to severely strain the governmental decision making set up. However, what is difficult for the bureaucratic processes is not necessarily bad for the country. These processes begun with a bang in 1998, were put in abeyance, partly as a result of lackadaisical decision-making at high levels, and partly because of the change in culture brought in by the newly elected UPA government. How to overcome the pressures created by the need to adhere to the agreement in a time – bound manner, and avoid constraining its future strategic options is the subject of this article.

The Indian Power Reactors and the Indian Fuel Cycle

An entire list of Indian nuclear power stations is at Appendix B. As may be seen from it, there are four power reactors under safeguards, two of them light water and two heavy water. Ten heavy water natural uranium fuelled reactors are in operation, all of them under the Nuclear Power Corporation of India Limited, a public sector company. Starting with the 90 MWe reactors in Kota, the newest reactors which are in Kota generate 202 MWe. International criticism exists that Indian nuclear power stations ran generally at 49-52 per cent efficiency in the first five years of their lives compared to the 70 per cent average for nuclear power plants worldwide.[3] At first glance it is clear that light water reactors imported from outside have performed outstandingly better. It is true that the world's experience with nuclear power generation has finally settled upon the light water reactors as the safest and easiest to run, especially for large outputs such as 1000 MWe. The trouble of course is that these reactors are the 'once through' variety where enriched U_{235} is used once and thereafter sent to the waste disposal storage facility.[4]

Indian scientists have pointed out that what they have designed and built will eventually catch up with the world averages if they are given time and money, in the same way that was invested in nuclear power abroad.[5] In fact, the Indian scientists have a noble vision, and it is necessary to understand what exactly they are trying to achieve. Thorium is more abundant in the world than uranium. Thorium can be used as a nuclear fuel if it can be bred into $U_{233,}$ which is an isotope of uranium. If thorium is used in a full fuel cycle, far fewer transuranic toxic waste products are produced. Of the one million odd tonnes of thorium reserves in the world, almost 300,000 tonnes are in India which has the second highest reserves, after Australia. On account of these factors, Indian scientists early on had decided to develop a fuel cycle which would make the country independent of imported uranium – a view in which they have been proved correct by the restrictions being imposed today on the supply side. The Indian fuel cycle envisages a three phase concept, namely:

- Pressurised Heavy water Reactor (PHWR) otherwise known as Candus, fuelled by natural uranium generates electricity and the spent fuel is rich in Plutonium.
- In the second phase, this plutonium is used as fuel in Fast Breeder Reactors to breed U_{233} from thorium.
- In the third phase, the Advanced Heavy Water Reactors burn U_{233} with thorium, extracting about 75 per cent of the power from the thorium, instead of the less than 1 per cent of the power extracted from U_{235} in Light Water Reactors.

According to the Indian Atomic Energy Commission's chairman's presentation on the web[6], the first stage of PHWRs would be limited to 10 gigawatts of energy after which the plutonium-fuelled second stage would generate 530 gigawatts over 100 years, followed by the third stage of U_{233} fuelled breeders which would generate 150,000 gigawatts. This closed fuel system would generate large amounts of commercially useful metals such as caesium and strontium and reduce the wastes that will have to be stored permanently. In 2005, the world had created roughly 300,000 tonnes of nuclear waste, of which 100,000 had been processed and 200,000 tonnes stored. The problem of nuclear waste disposal arising out of the waste of a large nuclear-fuelled country like the United States can be seen at the Yucca Mountain waste management project where nuclear waste from 126 different sites in the USA are planned to be moved, because it has a water table only at 2,000 feet. Nuclear waste will be stored 1,000 feet above the table because geologically the site has been declared safe for 10,000 years, a figure that is being sought to be extended to million. These problems according to Indian scientists would be considerably reduced by the closed loop system that produces relatively little waste products.

The current debate on separation largely circumvents the events of the 1970s when the non-proliferation mechanisms of the world were put into high gear owing to India's first nuclear test. The current oversight mechanisms like the Zangger Committee, the Nuclear Supplier's Group (NSG) and the strengthening of the US laws on non-proliferation were all triggered off by the Indian test. So the nuclear community has a long memory about the use if Plutonium from the Indian fuel cycle for Pokhran-1. From these fears have been extrapolated an unreasonable apprehension of the Indian fuel cycle itself. Many anti-India functionaries in the US constantly point out the 'possibility' of diversion of plutonium, when so much is already available. Indian observers and analysts need to be aware of these fears, unreasonable though they may be. It is true that with the overt weaponisation in 1998, and the creation of specific weapon facilities in India, the need to clandestinely do anything has disappeared. What the US government is demanding is a permanent separation of the civilian facilities from the weapons facilities be 'declared' so that the country is at ease with its weapon programme. Separation will create the confidence in the international community that the large plutonium-rich civilian nuclear industry of India has been taken out of the global weapon making complex.

Fast Breeder Technology and India's Second Phase

In September 2003 the union cabinet approved the setting up of India's first fast breeder power reactor at Kalpakkam. With only 60,000 tonnes of natural uranium deposits in India and only 0.72 of energy converted in the 'once through' light water reactor, this would amount to only 12,000

MW, a process clearly unviable for India. The second stage of India's power programme involves the Fast Breeder Reactor which converts 70-80 per cent of non-fissile uranium to fissile plutonium. So, theoretically, Kakodkar has a sound basis for stating that the third phase can go onto produce 500,000 MWe in India. The first FBR at Kalpakkam will have a low breeding ratio of 1.1 initially, but it is expected that by 2010 power could be produced at Rs. 3.25 per unit.[7] Of course, critics say that this unit cost does not incorporate the cost of capital, since the government provided Rs. 3600 crores for the first FBR, a sum, which would not have been available to any commercial reactor except at market rates. In the meanwhile the world seems to have lost interest in FBRs, a difficult technology. The Indian reactor using sodium coolant has had a mixed record at Marju in Japan when the coolant leaked. France's Superphenix FBR was run successfully for only a few years after which it was shut down. To these criticisms, Kakodkar has replied that FBRs are very much in the consideration of other countries for the future of nuclear energy, as evidenced by the recent commissioning of an 800 MWe reactor in Russia. India plans to have four FBRs by 2020. With this as the technology background it is possible to understand that the DAE has apprehensions about putting the Kalpakkam FBR under full scope safeguards. This, they allege would grossly violate the commercial technology developed by India, particularly with the intrusive provisions of INFCIRC 540.[8]

India's Nuclear Facilities

If one looks at India's nuclear facilities with the view that all facilities may have proliferation implications, one could end up with an absurd list of what are permanently innocent complexes. For instance after the 1998 tests some entities that found themselves on the sanctions list included the Centre for Advanced Technology in Indore and the Indian Institute for Science in Bangalore. That kind of approach is obviously unacceptable. For the purposes of understanding separation, India's nuclear facilities have been depicted in the figure on the succeeding page. Those facilities which really have no proliferation implications such as heavy water factories have deliberately not been included as they would only distract attention from those facilities which would be the subject of the discussion.

Without going into the details of every facility, what becomes clear from looking at a broad diagram of India's nuclear facilities is that there are some facilities like the power reactors which almost select themselves for a handing over in the first phase of accepting safeguards. At the other end of the scale there is BARL which would be a major No-Go area for the IAEA. In between are the facilities which would be either clearly weapon oriented or clearly civilian. These relate to the downstream facilities such as plutonium reprocessing and nuclear fuels complexes, most of them being located at Kalpakkam and Hyderabad. It is possible that some of them may have a current dual use function, in which case, investment is going to be required to create duplicate facilities, one for the weapons and one for civilian use.

India's Nuclear Facilities

Civil Facilities
minus 1/2reactors

Power Reactors
10 Operating not under Safeguards
4 Operating under safeguards
6 under construction
2 Under safeguards
4 Not under safeguards
4 Reactors planned
(None under safeguards)
1 Breeder Reactor
(Not under safeguards)

Kalpakkam
Prefre-due to replace BARC prefre
Kamini Research Reactor
ATV Reactor Design
Fast Reactor Fuel Plant (FRFRP)
Tritum Extraction Plant

Weapon Facilities

BARC Trombay
Reactors
Apsara
Cirus
Zerlina (X)
Purnima 122 (x)
Purnima 3 (v)
Dhruva
Plants
Zircorium & Titanium
Uranium Hexafluride
Prefre
Plutonium Metallurgy Lab
Weapon design labs

Tarapur
Advanced Fuel Fabrication Facility
Prefre
Waste Vitrification

Indore
CAT
No prolif implication

Mysore
Uranium Enrichment 20%
(See text)

(Source: Centre for Non-Proliferation Studies at http://cns.miis.edu/research/india/nuclear.htm)

It may be seen that with the placing of the power reactors under the NPCIL, the first stage of separation had already been taken. In the United States the separation in the early years occurred in a natural way when power reactors and most of the up stream and down stream facilities were placed in the private sector. In India no private sector company has the resources to have entered nuclear power generation all these years. So the government has done the next best thing, which is to group the power reactors under a public sector company. Since the public sector company reports differently and publishes its performance figures, this amounts to a virtual first step in separation.

The Problem

When India was building its nuclear facilities a number of common use facilities must obviously have been planned as would be expected in a developing country with limited resources. If all facilities primarily meant for civilian use are handed over for safeguards, how does the country ensure its strategic weapons independence for years to come? How does the government ensure that firstly it calculates the amount of fissile material needed in stock to ensure independence, and secondly build up that much stock? At a rough estimate, it seems that some power reactor or reactors would still be needed (for how long?) to build up adequate stocks of fissile material. What is a rough estimate of the amount required? How much more must be built up in say a year or two years? The omnibus question for India is, how much is enough? How big is the fissile material 'hedge' to be? There are ethical and moral dimensions to this question. The purpose of arriving at a 'satisfied' level is that there is no incentive for a country to cheat. The present IAEA standards on intrusive inspections are based on the belief that nations will cheat, in clever, devious ways by circumventing the IAEA accounting system of a country's fissile material stocks. But why would a country cheat when it has no need to, that is to say, when it has all the fissile material it is reasonably expected to hoard? So the question for India is, how much is that amount? It would be useful to look at the estimates of fissile material stocks that other countries have.

China

It has been assumed by most analysts that Chinese nuclear weapons are essentially plutonium-based. Therefore, it is only necessary to look at the history and output of China's plutonium production reactors. After the Soviets withdrew from nuclear cooperation with China in March 1960, the Chinese continued on their own and commissioned the Jiuquan reactor in 1966, and according to Chinese sources, this reactor went through three phases: 1967 to 1975 when the reactor reached its full designed output: 1975 to 1980 when the reactor's capacity was upgraded, and 1980 to the mid-1980s when the reactor was diverted to power production. The number of days that the reactor operated has been reported primarily by Lewis and Xue.[9]

From the early years, the Jiuquan reactor has been under intense satellite observation, and in the later years its massive cooling towers came under IR satellite surveillance. This kind of coverage has enabled analysts to make estimates of the number of days the reactor has been in operation and broadly speaking, whether at high or low intensity.[10]

The amount of plutonium produced from this plant has been assessed by David Wright and Lisbeth Gronlund.[11] The irradiated fuel had to be processed at a pilot plant, since the main plant was ready only by 1970. At the pilot plant, Wright and Gronlund have estimated that 100 tonnes of spent fuel would have been processed in a year, and thereby yielding 50-100 kgs of plutonium annually. In the case of the main plant, the burn-up of the reactor has been kept at a moving scale, starting with about 250 MW in the early years and building upto 600-700 MW d/t. Using all these variables, the most specific figures arrived at by Wright and Gronlund in 0.5-1.5 tonnes from Jiuquan.

Public information about Guangyuan, the other Chinese plutonium production centre is scanty. This reactor has been assumed to have been started with 400 MWe in the early years and built upto 800 MWe in the later stages. According to these figures the production at Guangyuan comes to an average of 2.9 tonnes. If the reactor figures are tweaked either way the fissile material falls within the range of 1.5 to 3.5 tonnes for the duration of the working life of the reactor. Hence, these estimates place Chinese fissile material stocks at 2 to 5 tonnes. It is acknowledged that the Chinese arsenal is on the move and it could grow from the 20 missiles that threaten the American continent to 100 missiles in the coming years. This increase would only consume 400 kgs of the reserve stock. So it is possible to say that with less than 5 tonnes of plutonium, China has been able to satisfy the needs of deterrence plus maintain an adequate hedge.[12]

Pakistan

This country followed the uranium route for a longer period than any other. Enrichment started in the 1980s and the number of centrifuges that were added and those that broke down over a period of about 15 years have been assessed by several authors. There was a declared moratorium in 1991 but analysts have stated that Pakistan only meant that this moratorium applied to HEU. During the moratorium period LEU continued to be manufactured. Since the time taken to convert LEU to HEU is disproportionately less, HEU production caught up again when the moratorium was dispensed with a few years later in 1998. By 1999, a year after the country's weapons complex went into maximizing production, the rate of manufacture of HEU and plutonium, is estimated at 35-50 Kgs of HEU and 10 kgs of plutonium a year. The latter figure is obtained by assuming the rate been burn up of the Khushab reactor and the capability for reprocessing. Estimating average annual HEU production is more difficult because between 1991 and 1998, the rate of production would have been much higher owing to the accumulated LEU being processed at a much faster than average speed. However, taking all factors into account, the rate of increase of HEU in Pakistan after 1998 is estimated at 48 kgs per year of HEU. Assuming that Albright's figures for stocks in 1998 are 690 kgs of HEU and 10 kgs of plutonium, the stocks in 2005 and 2010 in Pakistan could be as follows:[13]

Estimation of Pakistani Fissile Material

	2005	2010	Nuclear weapon equivalent in 2010
Pu	80 kgs	130	26
HEU	1026	1266	70

Source: Centre for Non-Proliferation Studies at http://cns.miis.edu/research/india/nuclear.htm

Other Countries' Fissile Material

Of all the P5 countries the UK has been the most transparent about its nuclear posture. It has admitted to having reduced its warhead holdings to 200 and reduced the alert state to 48 weapons, which are in any case at 'several days notice to fire'[14]. It has also published its fissile material holdings as of 2000 and consigned the remaining fissile material to facilities under 'international safeguards'. The UK has also placed the reprocessing facility for defence fissile material under international safeguards and provided a historical accounting of fissile material. Therefore, although India, after complying with the Agreement of July 18, may still not be 'equal' to the P5, it is clear that most of the provisions of what India has to comply with are no more stringent than what the UK has conceded to under 'voluntary offers'. The UK's figure of plutonium declared surplus to military requirements was 4.1 tonnes at Sellafield and another 0.37 tonnes at other sites[15] The material is separate from the 9000 tonnes of depleted LEU brought under safeguards separately. All this material is outside the almost 100 tonnes of reactor grade plutonium from the civilian programme that is stored in Britain. The UK also has around 1650 kgs of HEU (20 per cent) obviously used as naval reactor fuel in the UK as of 2000. Including the plutonium in weapons, the holdings of plutonium (military) of the UK is said to be 7.6 tonnes, while France has 5 tonnes. However, the UK also has 15 tonnes of HEU while France has 24 tonnes of the material.

The Solution

The Strategic Overarch and Arms Control

Nuclear stability is normally achieved through an established chain that includes Confidence Building Measures, and establishing crisis stability before going on to arms control stability. This process is one of the lessons of the Cold War, and the depressing fact is that arms control stability has normally taken anything from 4 years to 15 years in earlier cases. This knowledge is today not part of the wisdom of the foreign offices of either India or Pakistan. India's foreign office has no resident expert on nuclear matters, while Pakistan's policy is a perennial hostage to Kashmir. In China's case the situation is even more abstruse because Chinese literature does not indicate the existence of concepts such as arms control stability and crisis stability. Hence there exists no political or diplomatic initiative in Southern Asia to either establish the urgency of this process or to work towards establishing it. So what the Bush-Manmohan Agreement attempts to do is establish some kind of arms control stability by fixing ceilings on fissile material production, although no FMCT exists. To know whether this concept is workable, it is necessary to look at the experience of other countries in arriving at a self-imposed moratorium on fissile material production.

National Fissile Material Stocks in Weapons, and Material Stocked as a Hedge

There are countries such as the USA and Russia where this kind of calculation is not possible owing to the huge amount of weapon. Plutonium taken out of decommissioned weapons. This material is actually still available for remanufacture as weapon cores or for use off the shelf, although they are outside the limits imposed by START. But looking at medium nuclear powers it appears that the ratio of plutonium in weapons to plutonium available as a hedge is not that widely variant as the following Table shows.

Ratio of Plutonium in Weapons to Reserve

	In weapons	As Hedge	Ratio
UK	1.0	6	1:6
France	1.4	4.2	1:3
China	1.0	4.0	1:4

Source: isic-online.org/publications/first/premier/table of contents.html.

Much of the above calculations to estimate fissile material stocks may need further refinement, which only governments with national intelligence resources can do. But the ratio is not likely to be substantially different from the table shown above. The purpose of constructing this Table is to show how other countries dealt with the task of arriving at some kind of a ceiling on what would otherwise have been an indiscriminate and meaningless production run. Even the ratios shown above are clearly exorbitant, particularly in the case of the UK which surely lives in a far more benign neighbourhood than, say China. India could start with these ratios as a source of separation to establish its ceiling for Indian Fissile Material.

Some of the criticism in India against the agreement emerges from an unarticulated fear that the 'flexibility' of our future nuclear posture and the strength of our deterrent would be compromised because of premature separation. This fear is reinforced by the stipulation on what appears to be 'separation in perpetuity', combined with the provisions of an intrusive verification regime. These measures raise the fear of restricting the independence of India's deterrent. It is necessary to allay these fears by ensuring that India also strives to achieve a substantial or meaningful fissile material to reserve ratio.

There is no need for India to imitate those who were driven by the Cold War logic, or those powers whose ideas of nuclear stability were founded upon large arsenals required by first strike stability. The Indian doctrine is based on a second strike capability which prevents ambitions of counter force strikes, which must necessarily be first strike. Assuming that a tonne of fissile material gives rise to about 200 weapons, the figure of one tonne could be the amount that India could aim for its weapon stock. Even a 1:1 ratio would leave another one tonne as the reserve stock or 200 weapons worth. This will adequately cover the needs of flexibility in the next two decades. The current stock may be assumed to be around 1000 kgs, a figure extrapolated from open source literature estimating the country's stocks at about 700 kgs in 1998-99. This takes care of the immediate needs of weapon plutonium. The remaining one tonne of fissile material could be accumulated over a period considered acceptable under the negotiating process. The facilities in BARC plus a power reactor or two could accumulate fissile material at the rate of about 100-150 kgs per year. It would therefore, take 6-7 years to accumulate the reserve stocks considered necessary for flexibility. Negotiations on either side of these basic figures could be possible.

References/End Notes

1 The author worked at the CMC Sandia on a paper that explain how the Bush-Manmohan Agreement could be executed. For the executive summary of the paper, see Sandia papers at www.cmc.sandia.gov.

2 See statement prepared by Nicholas R Burns, Under Secretary for Political Affairs for the senate foreign Relation committee, November 5, 2005, available on www.stage.gov/p/us/rm/2005/55969.htm.

3 http//cns.miis.edu/research/India/in nuclear/htm.

4 For an economic comparison of thermal and nuclear power in India, see Sudhiner Thakur, *Economic and Political Weekly*, December 3, 2005

5 For a comprehensive explanation of the Nuclear Energy scene in India, see Srinivasan, Grover and Bharadwaj, "Nuclear Power in India: Wind of Change", *Economic and Political Weekly*, December 3, 2005.

6 www.pub.iaea.org/MTCD/meetings/pdfplus

7 *The Hindu* Editorial, September 22, 2003, at www.igcav.ernet.in

8 Interview by Anil Kakodkar to *The Hindu* on November 24, 2004, as reported in www.igcav.ernet.in

9 John Lewis and Xue Litai, *China Builds the Bomb,* Stanford University Press, Stanford CA, 1988 p. 9.

10 Declassified US corona satellite Image, Corona Mission 1117, May 30, 1972.

[11] See Wright and Gronlund, *Estimating China's Production of Plutonium for Weapons, Science and Global Security,* Taylor & Francis.

[12] There are enough sources that quote China diplomats who say that China is not producing fissile material any more, but they will not give any assurances on account of their stand at the CD, where they are in opposition to the FMCT in retaliation to the US' moves to 'weaponise' space.

[13] Most sources available in the public domain go eventually back to Albright *et. al.* Hence the only source being mentioned is ISIS website at www.isis-online.org

[14] Foreign & Commonwealth Office Memorandum available at www.feo.gov.uk/servlet/Front

[15] Official Report (Hansard) March 14, 2000, cols. 105-106, Parliamentary questions available at www.wise-paris.org.

Appendix A

US/India Joint Statement of July 18, 2005

http://www.indianembassy.org/press_release/2005/July/21.htm

Joint Statement Between President George W. Bush and Prime Minister Manmohan Singh

Prime Minister Manmohan Singh and President Bush today declare their resolve to transform the relationship between their countries and establish a global partnership. As leaders of nations committed to the values of human freedom, democracy and rule of law, the new relationship between India and the United States will promote stability, democracy, prosperity and peace throughout the world. It will enhance our ability to work together to provide global leadership in areas of mutual concern and interest.

Building on their common values and interests, the two leaders resolve:

- To create an international environment conducive to promotion of democratic values, and to strengthen democratic practices in societies which wish to become more open and pluralistic.
- To combat terrorism relentlessly. They applaud the active and vigorous counterterrorism cooperation between the two countries and support more international efforts in this direction. Terrorism is a global scourge and the one we will fight everywhere. The two leaders strongly affirm their commitment to the conclusion by September of a UN comprehensive convention against international terrorism.

The Prime Minister's visit coincides with the completion of the Next Steps in Strategic Partnership (NSSP) initiative, launched in January 2004. The two leaders agree that this provides the basis for expanding bilateral activities and commerce in space, civil nuclear energy and dual-use technology.

Drawing on their mutual vision for the U.S.-India relationship, and our joint objectives as strong long-standing democracies, the two leaders agree on the following:

FOR THE ECONOMY

- Revitalize the U.S.-India Economic Dialogue and launch a CEO Forum to harness private sector energy and ideas to deepen the bilateral economic relationship.
- Support and accelerate economic growth in both countries through greater trade, investment, and technology collaboration.
- Promote modernization of India's infrastructure as a prerequisite for the continued growth of the Indian economy. As India enhances its investment climate, opportunities for investment will increase.
- Launch a U.S.-India Knowledge Initiative on Agriculture focused on promoting teaching, research, service and commercial linkages.

FOR ENERGY AND THE ENVIRONMENT

- Strengthen energy security and promote the development of stable and efficient energy markets in India with a view to ensuring adequate, affordable energy supplies and conscious of the need for sustainable development. These issues will be addressed through the U.S.-India Energy Dialogue.
- Agree on the need to promote the imperatives of development and safeguarding the environment, commit to developing and deploying cleaner, more efficient, affordable, and diversified energy technologies.

FOR DEMOCRACY AND DEVELOPMENT

- Develop and support, through the new U.S.-India Global Democracy Initiative in countries that seek such assistance, institutions and resources that strengthen the foundations that make democracies credible and effective. India and the U.S. will work together to strengthen democratic practices and capacities and contribute to the new U.N. Democracy Fund.
- Commit to strengthen cooperation and combat HIV/AIDS at a global level through an initiative that mobilizes private sector and government resources, knowledge, and expertise.

FOR NON-PROLIFERATION AND SECURITY

- Express satisfaction at the New Framework for the U.S.-India Defense Relationship as a basis for future cooperation, including in the field of defense technology.

- Commit to play a leading role in international efforts to prevent the proliferation of Weapons of Mass Destruction. The U.S. welcomed the adoption by India of legislation on WMD (Prevention of Unlawful Activities Bill).
- Launch a new U.S.-India Disaster Relief Initiative that builds on the experience of the Tsunami Core Group, to strengthen cooperation to prepare for and conduct disaster relief operations.

FOR HIGH-TECHNOLOGY AND SPACE

- Sign a Science and Technology Framework Agreement, building on the U.S.-India High-Technology Cooperation Group (HTCG), to provide for joint research and training, and the establishment of public-private partnerships.
- Build closer ties in space exploration, satellite navigation and launch, and in the commercial space arena through mechanisms such as the U.S.-India Working Group on Civil Space Cooperation.
- Building on the strengthened nonproliferation commitments undertaken in the NSSP, to remove certain Indian organizations from the Department of Commerce's Entity List.

Recognizing the significance of civilian nuclear energy for meeting growing global energy demands in a cleaner and more efficient manner, the two leaders discussed India's plans to develop its civilian nuclear energy program.

President Bush conveyed his appreciation to the Prime Minister over India's strong commitment to preventing WMD proliferation and stated that as a responsible state with advanced nuclear technology, India should acquire the same benefits and advantages as other such states. The President told the Prime Minister that he will work to achieve full civil nuclear energy cooperation with India as it realizes its goals of promoting nuclear power and achieving energy security. The President would also seek agreement from Congress to adjust U.S. laws and policies, and the United States will work with friends and allies to adjust international regimes to enable full civil nuclear energy cooperation and trade with India, including but not limited to expeditious consideration of fuel supplies for safeguarded nuclear reactors at Tarapur. In the meantime, the United States will encourage its partners to also consider this request expeditiously. India has expressed its interest in ITER and a willingness to contribute. The United States will consult with its partners considering India's participation. The United States will consult with the other participants in the Generation IV International Forum with a view toward India's inclusion.

The Prime Minister conveyed that for his part, India would reciprocally agree that it would be ready to assume the same responsibilities and practices and acquire the same benefits and advantages as other leading countries with advanced nuclear technology, such as the United States. These responsibilities and practices consist of identifying and separating civilian and military nuclear facilities and programs in a phased manner and filing a declaration regarding its civilians facilities with the International Atomic Energy Agency (IAEA); taking a decision to place voluntarily its civilian nuclear facilities under IAEA safeguards; signing and adhering to an Additional Protocol with respect to civilian nuclear facilities; continuing India's unilateral moratorium on nuclear testing; working with the United States for the conclusion of a multilateral Fissile Material Cut Off Treaty; refraining from transfer of enrichment and reprocessing technologies to states that do not have them and supporting international efforts to limit their spread; and ensuring that the necessary steps have been taken to secure nuclear materials and technology through comprehensive export control legislation and through harmonization and adherence to Missile Technology Control Regime (MTCR) and Nuclear Suppliers Group (NSG) guidelines.

The President welcomed the Prime Minister's assurance. The two leaders agreed to establish a working group to undertake on a phased basis in the months ahead the necessary actions mentioned above to fulfill these commitments. The President and Prime Minister also agreed that they would review this progress when the President visits India in 2006.

The two leaders also reiterated their commitment that their countries would play a leading role in international efforts to prevent the proliferation of weapons of mass destruction, including nuclear, chemical, biological and radiological weapons.

In light of this closer relationship, and the recognition of India's growing role in enhancing regional and global security, the Prime Minister and the President agree that international institutions must fully reflect changes in the global scenario that have taken place since 1945. The President reiterated his view that international institutions are going to have to adapt to reflect India's central and growing role. The two leaders state their expectations that India and the United States will strengthen their cooperation in global forums.

Prime Minister Manmohan Singh thanks President Bush for the warmth of his reception and the generosity of his hospitality. He extends an invitation to President Bush to visit India at his convenience and the President accepts that invitation.

Power Reactors: Operating				
Name/Location of Facility	**Type and Capacity**	**Date or Target Date of Completion**	**IAEA Safeguards**	**Country of Origin/ Primary Contractor**
Tarapur 1	Light-water, LEU, and/or MOX, 150 MWe	1969	Yes	United States/General Electric Co.
Tarapur 2	Light-water, LEU, and/or MOX, 150 MWe	1969	Yes	United States/General Electric Co.
Rajasthan, RAPS-1 Kota	Heavy-water, nat. U, 90 MWe	1973	Yes	Canada/Atomic Energy of Canada Ltd.
Rajasthan, RAPS-2 Kota	Heavy-water, nat. U, 187 MWe	1981	Yes	Canada/Atomic Energy of Canada Ltd.
Madras, MAPS-1 Kalpakkam	Heavy-water, nat. U, 155 MWe	1984	No	India/Larson & Toubro
Madras, MAPS-2 Kalpakkam (Tamil Nadu)	Heavy-water, nat. U, 202 MWe	1986	No	India/Larson & Toubro
Narora 1	Heavy-water, nat. U, 202 MWe	1991	No	India/NPCIL
Narora 2	Heavy-water, nat. U, 202 MWe	1992	No	India/NPCIL
Kakrapar 1	Heavy-water, nat. U, 202 MWe	1993	No	India/NPCIL
Kakrapar 2	Heavy-water, nat. U, 202 MWe	1995	No	India/NPCIL
Kaiga 1	Heavy-water, nat. U, 202 MWe	2000	No	India/NPCIL

Kaiga 2	Heavy-water, nat. U, 202 MWe	2000	No	India/NPCIL
Rajasthan, RAPP-3 Kota	Heavy-water, nat. U, 202 MWe	2000	No	India/NPCIL
Rajasthan, RAPP-4	Heavy-water, nat. U, 202 MWe	2000	No	India/NPCIL

Power Reactors: Under Construction

Name/Location of Facility	Type and Capacity	Date or Target Date of Completion	IAEA Safeguards	Country of Origin/ Primary Contractor
Tarapur 3	Heavy-water, nat. U, 490 MWe	2007	No	India/NPCIL
Tarapur 4	Heavy-water, nat. U, 490 MWe	2006	No	India/NPCIL
Kaiga 3	Heavy-water, nat. U, 202 MWe	2007	No	India/NPCIL
Kaiga 4	Heavy-water, nat. U, 202 MWe	2007	No	India/NPCIL
Koodankulam 1	Russian VVER-1000/392 Light-water, LEU 917 MWe	2007	Yes	Russia/Russian Federation and NPCIL
Koodankulam 2	Russian VVER-1000/392 Light-water, LEU 917 MWe	2008	Yes	Russia/Russian Federation and NPCIL
Rajasthan, RAPP-5 Kota	Heavy-water, nat. U, 202 MWe	2007	No	India/NPCIL.
Rajasthan, RAPP-6 Kota	Heavy-water, nat. U, 202 MWe	2008	No	India/NPCIL.

Power Reactors: Planned and Proposed				
Name/Location of Facility	Type and Capacity	Date or Target Date of Completion	IAEA Safeguards	Country of Origin/ Primary Contractor
Kaiga 5	Heavy-water, nat. U, 700 MWe	-	No	India
Kaiga 6	Heavy-water, nat. U, 700 MWe	-	No	India
Rajasthan, RAPP-7 Kota	Heavy-water, nat. U, 700 MWe	-	No	India
Rajasthan, RAPP-8 Kota	Heavy-water, nat. U, 700 MWe	-	No	India
Breeder Reactors				
Name/Location of Facility	**Type and Capacity**	**Date or Target Date of Completion**	**IAEA Safeguards**	**Country of Origin/ Primary Contractor**
Fast-Breeder Test Reactor (FBTR), IGCAR Kalpakkam	Plutonium and nat. U, 40 MWt	1985	No	India/Indira Gandhi Center for Atomic Research
Prototype Fast-Breeder Reactor (PFBR), IGCAR Kalpakkam	Mixed-oxide (MOX) fuel, 470 MWe, excavation work began in 2003	2009	No	India/Indira Gandhi Center for Atomic Research

Raja Menon retired as Rear Admiral from the Indian Navy and was the Assistant Chief of Naval Staff (Operations) in 1994. He is the author of the book, *Weapons of Mass Destruction: Options for India* (Sage, New Delhi, 2004).