The India-US Nuclear Deal and its Implications for Indian Nuclear Capability

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Background

- On July 18, 2005, Prime Minister Manmohan Singh and President George Bush announced an agreement.
- Among other things it calls for India to identify and separate its nuclear facilities into civilian and military categories and place the former under international safeguards.
- In return the US would resume full civil nuclear energy cooperation with India, work with the US Congress to adjust US laws to enable such cooperation and persuade allies in the Nuclear Suppliers' Group to lift their sanctions.
- The separation plan was negotiated and announced in March in New Delhi.
- It then remained to get the US Congress to pass the required legislation exempting India from nuclear sanctions and for the Nuclear Supplier Group countries to agree to do the same.
- Since then the desired legislation has been passed by the House of Reps. The relevant committee of the Senate has also approved of the Deal, which awaits a vote from the full senate at the time of writing

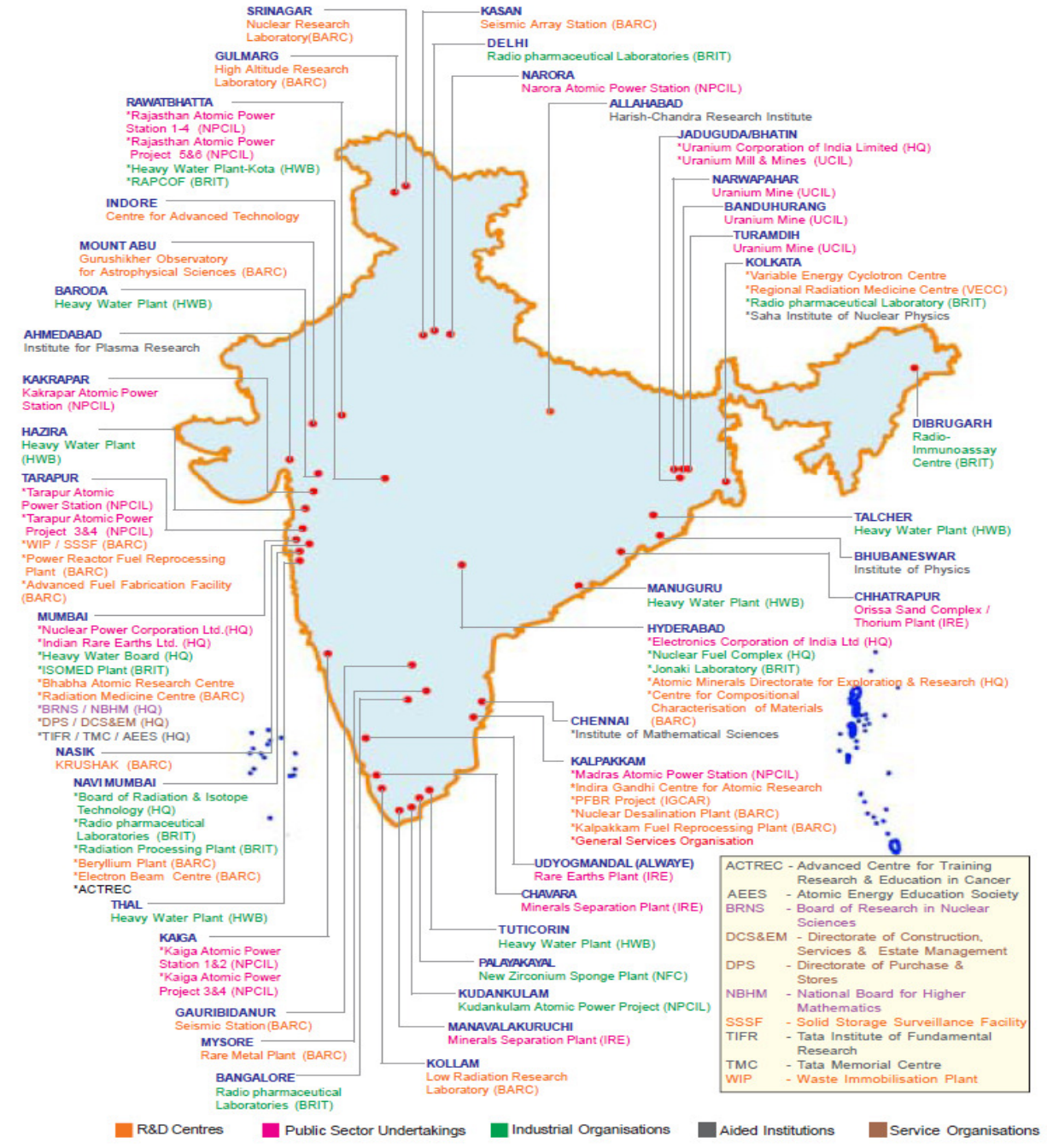
Concerns about the Agreement : In India

- **Even though the Agreement seems well on its way to being formally accepted (update this !!)by both sides, serious concerns have been expressed about the implications of the agreement.**
- **In India, the concern in some quarters was that the agreement tied down India's hands in areas of nuclear energy, national security and foreign policy (eg. The Iran issue, nuclear testing..)**
- **Among the Indian Left, there was also generic concern about entering into deals with the US.**
- **There are more technical concerns such as the fate of the spent fuel, building up a fuel reserve..**

In the US and elsewhere

- 1. By giving special exemption to India, the deal may undermine the NPT regime and nonproliferation efforts
- 2. It leaves India with considerable un- safeguarded capability for producing weapons grade fissile material, should it choose to do so.
- 3. India may be able to spend all its indigenous Uranium ore for military purposes since the Agreement allows it to import fuel for its civilian reactors.
- 4. The Deal may accelerate the arms race in S. Asia
- Today I will discuss issues 2 & 3 in a quantitative manner by estimating the additional uranium availability under the Agreement and the amount of fissile material India *could* produce. Then I will speculate on item 4.
- (The technical results here are from collaborative work with by Z. Mian, A.H. Nayyar, and M.V. Ramana. To appear in *Science and Global Security*, volume 14, nos. 2-3, 2006)

Atomic Energy Establishments in India



The facilities involved in the Separation Plan

- India's DAE has over 50 facilities. Some are minor, or obviously either civil or military. The main items under contention were:
- 15 operating power reactors of which 4 are already under safeguards leaving 11 to be decided on.
- 7 more under construction (2 safeguarded)
- The Fast Breeder reactors– the baby test reactor (40 MW) and the Prototype reactor (under construction)
- The Plutonium re-processing plants and the spent fuel accumulated so far.
- The Rattehally U enrichment facility.

Indian Power Reactors in operation

5 military & 10 safeguarded (4 already)

Power reactor	Type	Power (MWe)	Date of commencement	Safeguards (as of February 2006)	Future Safeguard status
Kaiga-1	PHWR	220	16-Nov-00	Unsafeguarded	Military
Kaiga-2	PHWR	220	16-Mar-00	Unsafeguarded	Military
Kakrapar-1	PHWR	220	6-May-93	Unsafeguarded	2012
Kakrapar-2	PHWR	220	1-Sep-95	Unsafeguarded	2012
Madras-1	PHWR	170	27-Jan-84	Unsafeguarded	Military
Madras-2	PHWR	220	21-Mar-86	Unsafeguarded	Military
Narora-1	PHWR	220	1-Jan-91	Unsafeguarded	2014
Narora-2	PHWR	220	1-Jul-92	Unsafeguarded	2014
Rajasthan-1	PHWR	100	16-Dec-73	Safeguarded	Safeguarded
Rajasthan-2	PHWR	200	1-Apr-81	Safeguarded	Safeguarded
Rajasthan-3	PHWR	220	1-Jun-00	Unsafeguarded	2010
Rajasthan-4	PHWR	220	23-Dec-00	Unsafeguarded	2010
Tarapur-1	BWR	160	28-Oct-69	Safeguarded	Safeguarded
Tarapur-2	BWR	160	28-Oct-69	Safeguarded	Safeguarded
Tarapur-4	PHWR	540	12-Sep-05	Unsafeguarded	Military

Reactors under construction

Kaiga-3	**PHWR**	**220**	**2007 (planned)**	**Unsafeguarded**	**Military**
Kaiga-4	**PHWR**	**220**	**2007 (planned)**	**Unsafeguarded**	**Military**
Kudankulam-1	**VVER**	**1000**	**2007 (planned)**	**Safeguarded**	**Safeguarded**
Kudankulam-2	**VVER**	**1000**	**2008 (planned)**	**Safeguarded**	**Safeguarded**
Rajasthan-5	**PHWR**	**220**	**2007 (planned)**	**Unsafeguarded**	**2007**
Rajasthan-6	**PHWR**	**220**	**2008 (planned)**	**Unsafeguarded**	**2008**
Tarapur-3	**PHWR**	**540**	**2007 (planned)**	**Unsafeguarded**	**Military**

Altogether 14 safeguarded (4380 MWE) and 8 military (2350 MWe)

Other facilities outside safeguards

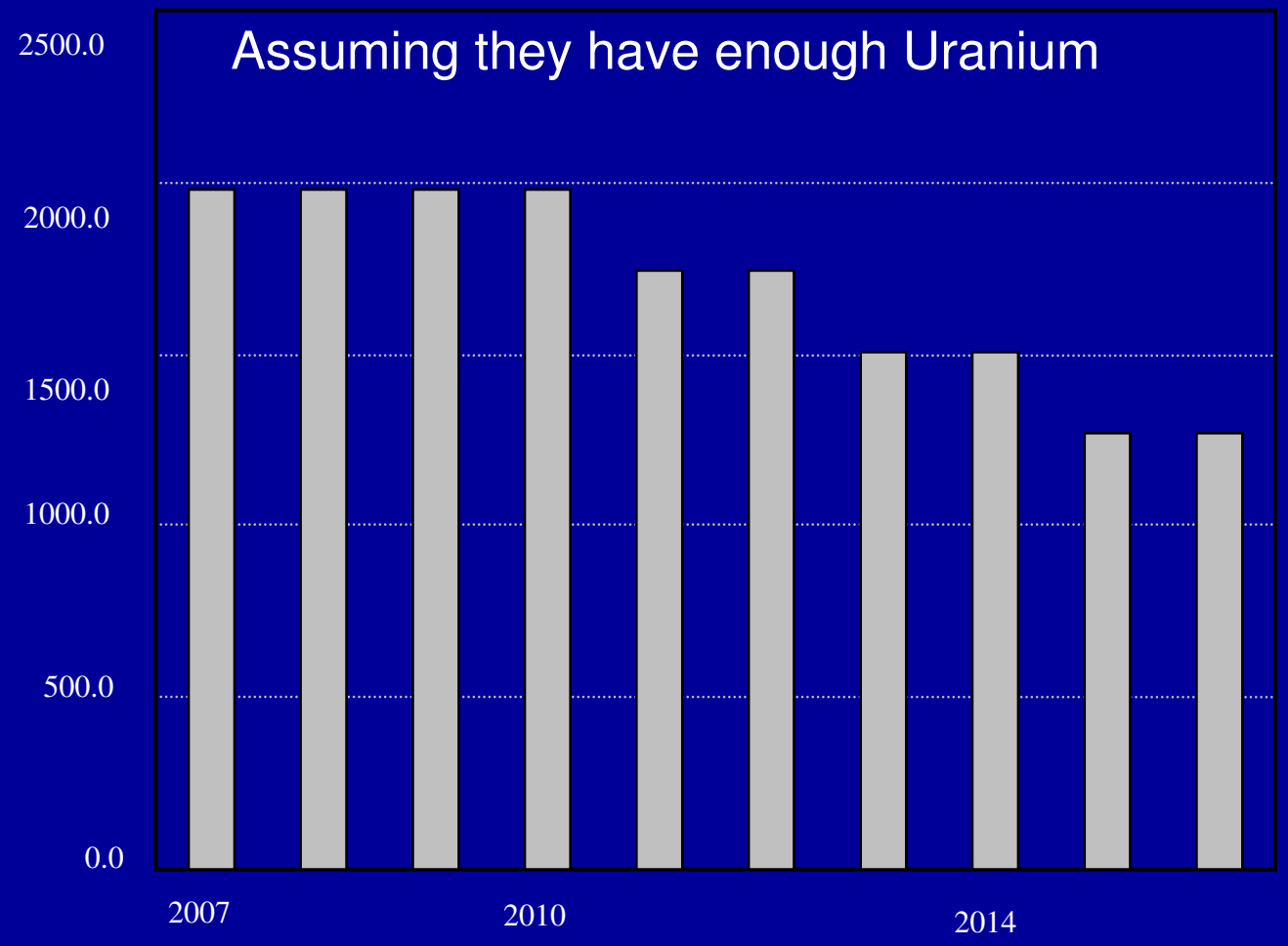
- The Dhruva (100 MWth) and Cirus (40MWth) Pu production reactors
- The Fast Breeder Test Reactor (13 MWe)
- The Prototype Fast Breeder Reactor (PFBR; 500 MWe)
- Pu Reprocessing plants
- Trombay 50 HMt/yr
- Kalpakkam 100 HMt/yr
- Tarapur 100 HMt/yr
- Uranium Enrichment plant (~5000 SWU)
- All the spent fuel stocks until safeguards take over

Projected reactor grade plutonium production from 2007 till reactors are safeguarded

Existing stocks as of May 2006 is 11.5 tons

Reactor	Proposed date of safeguarding	Plutonium production (kg) before reactor is safeguarded
Rajasthan-3	2010	475
Rajasthan-4	2010	475
Kakrapar-1	2012	712
Kakrapar-2	2012	712
Narora-1	2014	950
Narora-2	2014	950
Total		4274

Annual Pu production (in kg) from Unsafeguarded PHWR



India's natural U requirements per year

- U For existing PHWRs : 430 tons
- To be constructed by 2008: 205 "
- Sundries (Dhruva ..) 45 "
- TOTAL 675 tons

- As against this, current production of U is only about 300 tons/yr (600,000 tons of ore of 0.05% U content)
- Efforts are on to open new mines. Estimates on the additional U they can yield vary from 150-200 tons.
- That would still leave a shortage. This was the primary motive behind Agreement. The lifting of nuclear sanctions would, in the first instance, enable India to fulfill its plans for increased nuclear energy.

Uranium Surplus

- But there is concern that the Deal would also provide additional U for military purposes.
- India has offered to place under safeguards 8 more PHWRs worth 1760 MWe.
- If the Deal comes into being, they can obtain fuel for all these from abroad. From this it is argued that India could divert its domestic Uranium for producing W-Gr Plutonium in the un-safeguarded reactors.
- But this depends on how much surplus U is actually produced from their mines.

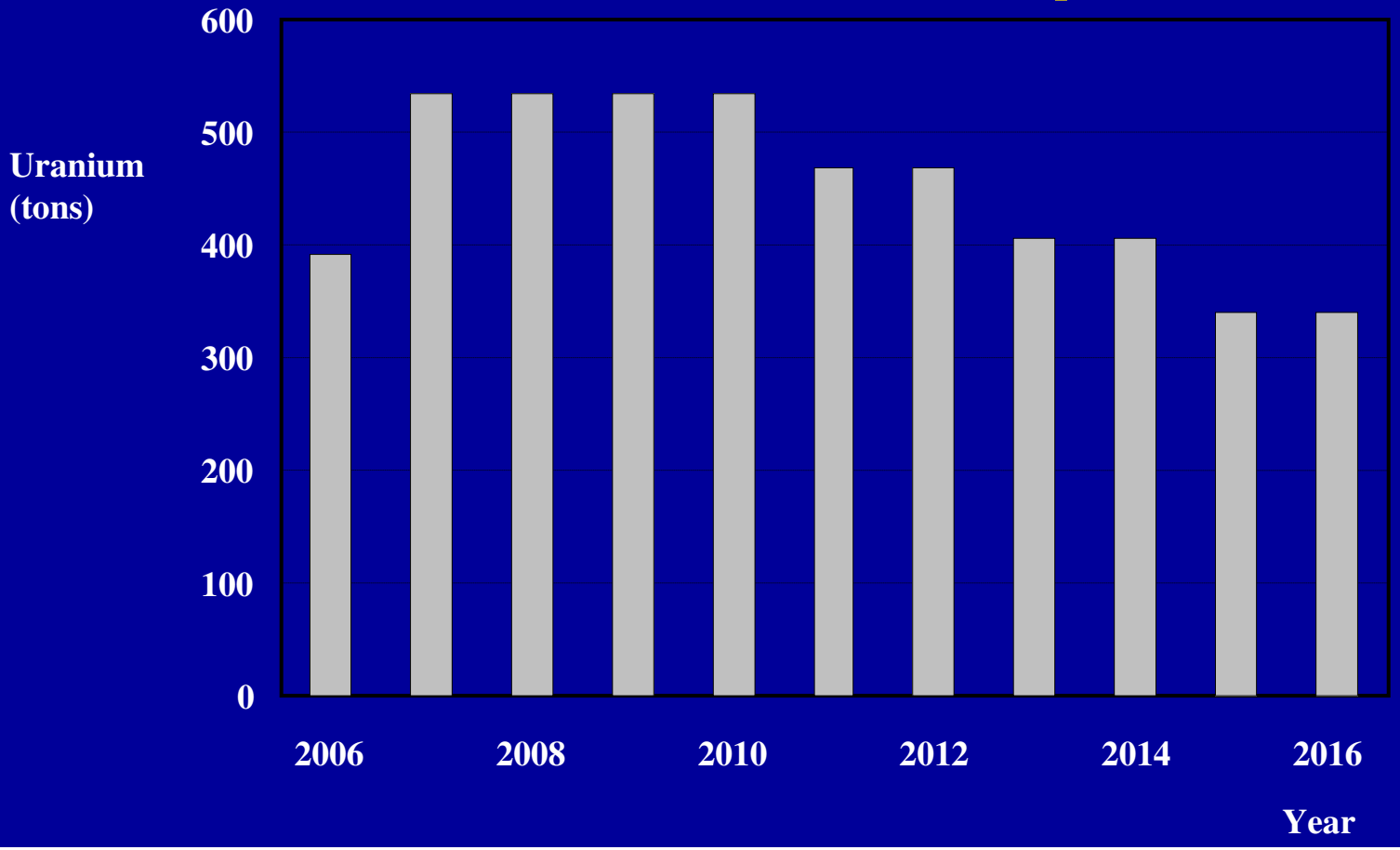
Domestic Uranium for un-safeguarded reactors

Uranium production hoped for in near future ~ 450-500 t/yr

(Add 45 tons for Dhruva, Cirus etc).

Clearly there is shortage for next few years despite deal. But after 2014,when all safeguards are in, a surplus of 75-120 tons of U

Can this be used to increase WGr Pu production ?



Estimated weapons grade plutonium production (kg)

Reactor	CIRUS (Until 2010)	Dhruva	Breeder (after 2010)	Spent already	TOTAL stocks	Weapon Eqwt
Cumulative production (kg) so far	234	414		- 130	~ 520	104
Annual future production (kg)	9	20-25	135		~ 160	32

Note: This stock would have been produced anyway, **deal or no deal**. There is plenty of depleted U stock for fueling that one breeder The extra capability to make WGr Pu arises only if the surplus of domestic uranium released by the deal is used in one of the 8 PHWR outside safeguards at low burn

Using surplus U to make additional W-Gr Pu

- Run one of the 8 unsafeguarded 220 MWe PHWR at burn-up of 1000 MWd/t . It will consume 222 tons of U/yr, i.e. about 190 tons more than the normal 7000 MWd/t burn-up.
- A surplus of 75-120 tons can allow you to only run a part of the PHWR at low burn-up.
- But you can recycle the slightly depleted U (0.6% U_{235}) from this production reactor to partially replace natural U in the remaining 7 PWHR, saving about 20% i.e. about 60 tons.
- In principle ,purely from the U availability point of view, This, along with the a surplus of 120 tons can run almost a full PHWR in production mode producing about 200 kg of WGr Pu/yr, on top of the 160 kg/yr from Dhruva & Breeder
- In practice this will be limited by how fast they can reload the fuel for low burn up, how fast they can re-process the depleted U and how much U they are actually able to mine.

Uranium Requirements and Pu production for India's Unsafeguarded Reactors after deal is implemented

Reactors	Burn up (MWd/tU)	Uranium demand (tons/year)	Reactor-grade plutonium (kg/y)	Weapon-grade plutonium (kg/y)
Dhruva	1000	29		26
Breeder				135
All eight reactors in power mode	7000	338	1265	--
One 220 MWe reactor producing weapons plutonium	1000	222		200
Seven reactors in power mode and one 220 MWe reactor in production mode		528	1147	200
Seven reactors in power mode with partially depleted uranium cores and one 220 MWe reactor in production mode		467	1147	200

Assuming 80% capacity factors. Add 35 tons for Dhruva and enrichment

Is India likely to make so many weapons?

- I personally do not believe so.
- India's repeatedly stated policy is one of minimum deterrence. Of course our govt did not spell out the number and types of weapons needed to establish a minimum deterrence. Such numbers are generally not advertised publicly. But I suspect that no concrete calculation was done even within the strategic defense circles, until the Deal came around.
- Nevertheless, the requirements of minimum deterrence can be examined objectively and without cold war preconceptions.
- Minimal Deterrence does not require a boundless open-ended arsenal, nor that your weapons match in number and strength those of your adversaries. It only demands that you have enough capability, in a second strike, to inflict "unacceptable damage" to the other side.

Unacceptable Damage

- **As we have repeatedly argued in detail elsewhere, half a dozen modest 20 kt weapons if dropped on major Asian cities can kill about a million people. That is more than enough to be unacceptable to even a remotely rational government anywhere, including Pakistan and China.**
- **All you need are a couple of dozen weapons in store to provide due redundancy, taking into account survivability etc, to ensure a such a modest second strike. Accuracy is not so important for counter-value strikes.**
- **If the adversary is controlled by such irrational and suicidal leadership that they find a million immediate civilian deaths acceptable as a price for military adventure (as can conceivably happen) then one cannot logically guarantee that a much larger arsenal will deter them anyway.**

- I am not claiming that my estimate of just a dozen surviving deliverable weapons as sufficient for deterrence is shared by the Indian establishment.
- But we already have a weapons grade Pu stock of half a ton (worth about 100 warheads) , plus nearly 12 tons of reactor grade Pu (worth over a 1000 warheads, although of indeterminate quality)
- That should suffice for even for a much more conservative strategy. Therefore I do not believe that India went into the nuclear Deal to build much larger nuclear arsenal.
- But India has been responsible for giving the impression of going for large arsenals by invoking national security as a reason for keeping the Breeder and 8 other PHWRs outside safeguards.
- Our government should make very effort, consistent with sovereignty and national security, to erase this impression and reassure its neighbors and the world that it has no plans to enlarge its arsenal by exploiting the Deal.

THE END

Estimated cumulative reactor grade plutonium production (May 2006)

Plutonium content in spent fuel (kg)		
	Un-safeguarded	Safeguarded
India	11,500	6800
Pakistan	---	1200

Reprocessing plant capacities in India and Pakistan (tons of heavy metal in spent fuel per year)

	India	Pakistan
Trombay	50	
PREFRE (Tarapur)	100	
KARP (Kalpakkam)	100	
New Labs (Rawalpindi)		10-20

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Impact on nuclear armament in S. Asia

- The DAE lobby successfully invoked the national security argument to protect the Breeder from Inspections.
- Gives the impression of keeping the options open for a larger nuclear arsenal than minimal deterrence
- Can raise alarm in Pakistan, motivate them to go for larger arms build up and trigger an arms race
- Raise concerns in China and even in the US on whether India is planning to go beyond minimal deterrence.
- The Indian Govt would be wise to dispel such fears

Minimum nuclear deterrence.

- **In a laudable act of transparency, India publicly announced its nuclear doctrine in 1999. It was based on the principle of minimal deterrence**
- **Hence projecting the required size of its nuclear force calls for translating minimal deterrence into a concrete estimate of the number and types of nuclear weapons it calls for.**
- **The logic of minimal deterrence has been questioned by many people. But I will not go into that in this talk. Let us take minimal deterrence as given , and explore its quantitative requirements**