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Assessing the Indo-US Deal on Civil Nuclear Cooperation

Managing Risks and Opportunities

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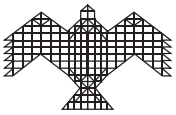

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Assessing the Indo-US Deal on Civil Nuclear Cooperation

There has been a lot of debate in India on the risks associated with entering into civil nuclear cooperation with the US. The deal raises inter-related political, strategic and operational risks. The Henry J. Hyde Act passed by the US Congress lays down the legal framework within which the US must negotiate the bilateral 123 Agreement with India.[1] This critical analysis of the Indo-US deal assesses the risks associated with entering into this deal and suggests strategies to manage these risks. This report also contains two annexures. Annexure I analyses the major provisions of the Hyde Act. Annexure II examines the economic implications of creating and maintaining a strategic fuel reserve over the lifetime of each imported reactor.

Building India's Nuclear Power Industry

Will the successful conclusion of the Indo-US nuclear deal help or hinder India's nuclear power programme?

According to the Department of Atomic Energy (DAE), nuclear power will contribute 20,000 MWe of capacity to the Indian electricity grid by the year 2020. The achievement of this target involves:

- Completion of all ongoing 220 MWe and 540 MWe Pressurised Heavy Water Reactors (PHWR) projects.
- Scaling up the existing 540 MWe PHWR reactors to 700 MWe and creating the infrastructure to build eight additional 700 MWe reactors.
- Successfully commissioning the fast breeder reactor and adding four additional fast breeder reactors of 500 MWe each to the one already under construction.
- Import of six reactors of 1,000 MWe each.[2]

As we can see from the above projection, 6,000 MWe out of the projected 20,000 MWe capacity for 2020 will have to be met through import of 6 reactors of 1,000 MWe each. While India currently has two 1,000 MWe reactors being built with Russian collaboration at Koodankulam, the contracts for these were concluded before the formation of the Nuclear Suppliers Group (NSG).[3] The US waived its objections to the sale of these reactors as a special case. Any sale of new reactors to India will have to be governed by NSG guidelines. India may not be able to import any more reactors from Russia or from any other country unless the NSG guidelines are changed under the Indo-US nuclear deal. This includes the four Russian reactors for Koodankulam agreed to during President Putin's recent visit to India. If for some reason India does not reach agreement with the US, the nuclear power

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1 The name 123 Agreement is derived from Section 123 of the US Atomic Act that deals with cooperation with other nations. India and the US will enter into a bilateral agreement that will lay down the operational specifics of civil nuclear cooperation under this section of the Act.

2 Meeting the Demand Projection. Available at http://www.dae.gov.in/publ/doc10/pg50.htm

3 The Nuclear Suppliers Group is an informal arrangement between the nuclear weapons States and a number of other countries that controls the supply of nuclear fuel, materials , equipment and technologies to prevent the proliferation of nuclear weapons and nuclear weapon technologies to non-weapon States.

projections for the year 2020 will have to be revised downwards by 6,000 MWe to 14,000 MWe. This would represent a direct economic loss to the country.

Currently, India's largest reactor is the 540 MWe reactor that has recently become operational. Current plans of the DAE envisage further increasing the size of these reactors to about 700 MWe and creating the necessary infrastructure to replicate these reactors in larger numbers. It may not be possible to build reactors larger than 700 MWe in the near future because of the current industrial constraints in the country. Typical state-of-art plants from various members of the NSG (including France, Russia and the US) all have sizes that are at least 1,000 MWe. Several countries have plans to build even larger sized reactors going up to about 1,600 MWe.

Nuclear power plants are capital intensive. A large nuclear plant requires higher initial capital investments than the investments required for a comparable size coal or natural gas plant. They, like many other alternative power sources, also offer technical possibilities for achieving significant economies of scale. Scaling up by reducing the investment costs per MW of electricity produced, makes nuclear power more competitive with electricity produced from coal or natural gas. While nuclear power plants have the disadvantage of high upfront investment costs, they do have a significant advantage in terms of low operating costs. Therefore, power from plants of larger capacity will be cheaper than power from plants of smaller capacity.This explains the global trend towards larger reactors.

From the Indian viewpoint, while the scaling up of the indigenous reactors from 500 MWe to 700 MWe may not pose any special problems, this size may still not be sufficient for nuclear power to maintain its competitive position with other electricity alternatives. As long as the international community linked civil nuclear cooperation to India's weapons programme, India did not have any choice. The Bush-Manmohan Singh Agreement and the recently enacted Hyde Act enable India for the first time in more than thirty years to access global state-of-art reactor technologies. Indian companies in the private and public sectors can set up joint ventures with companies from Russia, France and the US. If we negotiate hard we may even be able to access some non-sensitive high technology elements that can improve the Indian industrial infrastructure to build reactors of larger size that are comparable to reactors being built in other advanced countries. The recent Chinese agreement with Westinghouse illustrates the possibilities that would open up to Indian companies if the deal goes through.

The Indian government must amend the Atomic Energy Act and open up the nuclear power industry to the private sector.

For such international collaboration to take off it is essential that the Indian government amend the Atomic Energy Act and open up the nuclear power industry to the private sector. There seems to be a view that given national security considerations, nuclear power should reside solely in the public sector. There is no doubt that the government should exercise complete oversight authority over all nuclear-related activities. It should also have a critical role to play with respect to initiatives related to R & D and new technology development. However, the operation of nuclear power plants should be opened up for participation by the private sector either by themselves or in partnership with the public sector. Market forces that will emerge from the resulting competition will create an efficient, competitive and viable nuclear power industry in the country. International

collaboration between companies in the nuclear field will also increase economic inter-dependence between India and its foreign partners in civil nuclear cooperation. This will act as a stabilizing force in case of any political downturns that might threaten the deal.

Apart from the above mentioned technological possibilities, joint ventures between Indian and foreign companies will also increase electricity production. If the Indian government can quickly bring about the necessary changes in the Indian legal and regulatory framework, new large reactors could add capacity to the Indian power grid. Even with very conservative assumptions we believe that at least ten additional reactors with a capacity of 1,000 MWe each can be made operational by the year 2020. This addition of 10,000 MWe to the nuclear capacity is a tangible benefit to India under the deal. This may not happen if India does not finalise the bilateral arrangements with the US.

The availability of uranium with higher enrichment levels at lower prices will improve the operational efficiencies of the installed nuclear capacity.

There is also little doubt that India faces a serious uranium shortage for expanding its domestic nuclear power base at least in the short term. This fuel constraint may also affect the operational efficiencies of Indian nuclear power plants. The deal will make available uranium fuel with higher enrichment levels at lower prices. This will definitely have a positive impact on the operation of Indian nuclear power plants. While we have not been able to quantify this benefit, it is our belief that a five to ten percent improvement in operational efficiency is feasible. Given the recurrent nature of power shortages in the country this is quite significant. More importantly these benefits can be realized quite quickly.

We can clearly see from these arguments, that the Indo - US nuclear deal nullifies many of the major constraints facing the nuclear power industry in the country. The availability of uranium with higher enrichment levels at lower prices will improve the operational efficiencies of the installed nuclear capacity. The deal will also allow Indian entities to import reactors into the country. Such imports are crucial if India wants to realize the target of 20,000 MWe of nuclear power by 2020. With some planning this capacity can be increased to about 30,000 MWe by 2020. The deal also provides India with an opportunity to bridge the technology gap in reactor size to make the Indian nuclear power industry more competitive both in the domestic and global marketplace. These are clear tangible short and medium-term economic benefits that the deal will bring to the Indian nuclear power industry.

The question that many critics of the deal have raised however does not relate to the short or medium-term economic impact of the deal. Many people think that the widespread use and diffusion of uranium based technologies that would happen as a consequence of the deal would delay or hinder India's logical transition into a thorium fuelled nuclear energy economy. Some have extended this argument to state that the US intentions in backing the deal is to make sure that India's emerging nascent capability in this vital area is eliminated through the forces of market power. How valid are these fears?

The three phase Indian programme involves a logical transition from an initial uranium fuelled start towards a nuclear power industry that is largely fuelled by thorium. Since India has very large reserves of thorium, the development of technologies that facilitate its widespread use in Indian reactors makes both economic and strategic sense. This approach also involves an intermediate fast breeder

technology step that is essential for establishing the viability of the thorium route.

There can be no doubt that the R&D and technology development related to the three phase Indian programme is essential to preserve crucial options necessary for meeting India's energy needs in the post 2020 period. Mastery over technologies that enable India to use its vast reserves of thorium should be a key component of India's strategy for energy security. However, these decisions are purely internal Indian decisions. Any fears that US has a Machiavellian mala fide plan to derail the three phase Indian programme may be singularly misplaced. Thorium based technologies are yet to be proven in the commercial market place. They will emerge as a consequence of R&D and technology developments that are currently underway. It is the job of the Indian political and scientific establishments to preserve, protect and grow these capabilities so that commercial technologies relevant to Indian needs emerge during the transition period. Rather than worrying about US intentions behind the deal, Indian decision-makers should directly address issues related to accelerating India's transition to the thorium cycle. There is no doubt that the sooner we achieve these breakthroughs the better off we will be in terms of energy security. The other question we should be asking is whether we can advantageously use the deal and our status as a responsible power with advanced nuclear capabilities to accelerate our thrust towards the thorium cycle.

A more worrisome issue that critics of the deal have raised relates to India's rights to reprocess spent fuel that is supplied to India under the deal. How should India deal with the issue of reprocessing in the proposed 123 agreement with the US?

The Indian three phase programme involves reprocessing the spent fuel from the uranium fuelled first phase reactors and breed them in the second phase reactors to more effectively use the available fuel base. Hence, India sees reprocessing as a crucial step in the closed fuel cycle chain of activities. Countries like France and Russia also believe that reprocessing the spent fuel and using it in other reactors is important from economic as well as waste management considerations. Opinion in the US is divided, not on the principle of reprocessing, but rather on the economics of reprocessing.

What is more relevant for the Indo-US nuclear deal however are the provisions in the Hyde Act that bar the transfer of reprocessing technology to India. The Hyde Act also clearly stipulates that the spent fuel from Indian reactors cannot be sent back to the US.

The Hyde Act does not bar the reprocessing of the spent fuel under IAEA safeguards.

The Hyde Act only prohibits the transfer of reprocessing technology to India. It does not bar the reprocessing of the spent fuel with Indian technology in an Indian reprocessing plant or with some other technology in other foreign plants as along as the reprocessing facility is under IAEA safeguards. If India prefers to reprocess spent fuel in an Indian facility it has several options. It can choose to place one of its existing facilities under safeguards or it can build a new facility and place it under safeguards. Alternatively, it can negotiate to reprocess the spent fuel in an unsafeguarded reactor that will be under IAEA safeguards only during the period of reprocessing of the spent fuel. The spent fuel could also be sent to some other facility located elsewhere for reprocessing. If private companies set up reactors they may chose to reprocess the spent fuel or store it depending on their perceived economics. In the 123 Agreement, India should try to retain the right

of India to use all these options. If the deal goes through, spent fuel will be available for reprocessing and use in about five years time. India should have in place a concrete plan to use this fuel optimally to advance both its R&D and operational capabilities.

Critics of the deal argue that the Hyde Act which links civil nuclear cooperation to nonproliferation concerns will limit India's strategic autonomy. Will the deal get into trouble in case India carries out a nuclear weapons test? How can India manage the risk of disruption of fuel supply in the case of such an eventuality?

The Hyde Act outlines the conditions under which the US will be legally bound to abrogate the deal. These conditions are (a) nuclear detonation by India (b) violation of MTCR, NSG guidelines, or IAEA safeguards by India under the nuclear civil cooperation agreement. It is also possible that the deal may be abrogated for political reasons if Indo-US relations go into a tailspin.

India should keep open the option for conducting a nuclear test and not commit to anything further than a voluntary moratorium.

A nuclear detonation by India is the most serious and likely scenario under which the deal might be abrogated. India may decide to test due to technical or political reasons. For example, if the US resumes testing for a new generation of nuclear weapons, China, India and Pakistan may all need to follow suit. Another reason for India to resume testing would be if the international situation changes and China or Pakistan test to upgrade their deterrent. India would then need to respond. It can also be argued that a third country connives with India's adversaries to initiate tit-for-tat nuclear tests forcing the abrogation of the deal. Under all of these circumstances, the US would be legally bound to abrogate the deal. It is however, possible that in case India is responding to a nuclear test by either China or Pakistan, the US might not be opposed to an Indian test as a reaction.

India should keep open the option for conducting a nuclear test and not commit to anything further than a voluntary moratorium. To protect its right to test India could include in the 123 Agreement a *rebus sic stantibus* clause.[4]

Assuming that the US would be legally bound to abrogate the deal in response to an Indian nuclear test, what strategies can India adopt in the long, medium and short term to minimize the impact on India?

The Hyde Act is a US domestic law that is binding on US companies doing business with India. One way to minimize the impact of any sanctions in the case of a weapons test is to ensure that all contracts that India enters into are not directly with wholly owned US companies but with those that are in joint venture or alliance with companies in other countries.

The other option is to spread the risk and negotiate agreements with other countries like France and Russia which are not subject to US law. In an increasingly global world, mergers and acquisitions are almost daily occurrences. Who owns what is a dynamic phenomenon. Managing this efficiently may provide some legal leeway to India for managing the situation arising from a weapons test. However,

[4] A tacit condition attached to all treaties to the effect that they will no longer be binding as soon as the state of facts and conditions upon which they were based changes to a substantial degree. A complete exposition of the clause is available at http://law.enotes.com/wests-law-encyclopedia/rebus-sic-stantibus

In India's case this would mean a change in the global or regional strategic environment requiring an Indian test as a response.

one should assume that in spite of these measures sanctions will be imposed at least for some time on India in case of a nuclear test.

Regardless of the timing of an Indian nuclear test, the following risks with regard to nuclear cooperation will have to be managed by India to minimize the impact of any sanctions.

Ongoing investments in the nuclear power industry will have to be protected. One of the ways to protect commercial interests would be:-

- To try and negotiate a guarantee in all commercial contracts that sanctions should not apply to nuclear reactors that are operational or under construction. Such a clause would lay the foundation for a mutually beneficial risk management option for both foreign companies and the Indian power sector.

- India can protect the physical nuclear power infrastructure built under the deal by mandating that ownership of reactors should be Indian. This would bring all nuclear reactors operating in India under the purview of Indian law and preclude any unilateral or precipitate action by the US.

- The Indian government can take insurance on the nuclear power sector to absorb the financial losses that may arise out of the abrogation of the deal. This would be over and above the standard commercial risk management options entered into by Indian and foreign companies.

The above measures will, of course, not provide guarantees against disruption in power supply. However, this risk too can be managed as discussed below.

The aftermath of the Pokharan II tests would seem to indicate that the period of sanctions on commercial Indian entities would not be for more than one or two years. This period is likely to come down as economic interdependence between the Indian nuclear industry and the global industry increases. The Hyde Act stipulates that fuel supply to Indian reactors would take care of "reasonable reactor operating requirements." India should negotiate to maximize this definition while negotiating the 123 agreement.

The Prime Minister in a statement to Parliament has indicated that under the deal India will build a strategic reserve of fuel for each imported reactor over its lifetime. As the Hyde Act currently stand there is no possibility of building this 'strategic reserve' of imported fuel from the US. However, this does not prevent India from building this reserve from alternate sources. India can adopt a contractual template clause that ensures that every imported reactor is required to be accompanied by a minimum reserve of fuel as specified by India. Explicit mention of these possible arrangements need not be reflected in the 123 Agreement. India has the leeway to negotiate with other members of the NSG to secure fuel over and above normal reactor operating requirements. This, however, could be contingent upon the degree of US influence on these potential supplier states. The Hyde Act stipulates that the US should not "seek to facilitate or encourage the continuation of nuclear exports to India by any other party if such exports are terminated under United States law."

While the 123 Agreement should not prevent India from building up a strategic reserve of nuclear fuel, India should try to assess the implications of the costs of such a reserve on the cost of electricity generation.

While the 123 Agreement should not prevent India from building up a strategic reserve of nuclear fuel, India should try to assess the implications of the

costs of such a reserve on the cost of electricity generation. Our analysis of the costs of the reserve indicates that if the reserve has to last the lifetime of a reactor, which is currently about 30-40 years, India would need to invest approximately one billion dollars per 1,000 MWe reactor in procuring and storing fuel. This will add at least $150 million a year to the operating costs of each reactor and make nuclear power economically unviable. India obviously, cannot afford to ignore completely the question of a strategic reserve either. However, the volume of its strategic reserve must be guided by both economic and political considerations.

From an analysis of inventory holdings of some nuclear power plants in the US, it would appear that the standard inventory held by most nuclear power companies would cater to their fuel requirements for about two years. It would appear therefore, that over and above this standard inventory, India may need some additional safety factors in case sanctions extend to more than two years. A two to three year inventory will not add appreciably to the cost of power. However, a thirty or forty year inventory may add significantly to the cost of power. While India should aim for its right to build a strategic reserve, the actual stockpile of fuel for each reactor should be governed by the economics of power generation. Annexure II analyses the economic impact of a strategic fuel reserve over the lifetime of imported reactors to make the point that a lifetime reserve of fuel will make nuclear power generation uncompetitive in India.

To further minimize the risk of fuel supply disruption, India must negotiate in the 123 Agreement a Statement of Principle that guarantees India adequate time to switch suppliers in case the deal is abrogated by the US. A similar Statement of Principle must be included in all commercial contracts with regard to fuel supply as a general proviso for all supplier States and companies to spread the risk of fuel supply disruption.

During the period between signing of the deal and its possible abrogation, all Indian reactors classified as civilian under the Separation Plan, could work with imported fuel. This will release some fuel for building up an additional reserve from indigenous sources. Since this fuel would be required for power generation if India does not sign the deal, it should be possible to divert some of it to a reserve without slowing down India's strategic programme.

In addition, along with the above measures that are designed to mitigate the immediate impact of sanctions, India must adopt a broad based long term strategy with the US and other major powers to expand its economic relations with potential partners for civil nuclear cooperation. To ensure that the US does not take any unilateral measures to abrogate the deal, India must actively encourage investment by US companies in the Indian nuclear and power industry. Over the medium and long term, this will ensure that company to company level collaboration on both sides will facilitate speedy resolution of any political disputes between the two sides.

Civil nuclear cooperation is only one part of a larger relationship that India must build with major powers.

Civil nuclear cooperation is only one part of a larger relationship that India must build with major powers to ensure that it creates mutual trade and investment dependencies that can act as shock absorbers for any potential downturn in relations leading to an abrogation of the deal. US-China relations are a good example in this regard. US's growing threat perception from China is offset by the growing economic relationship between China and the US.

Irrespective of the possibility of detonation by India, India should take the following measures to ensure its energy security in the long run.

- Accelerate India's three stage nuclear power programme to maximize utilization of India's thorium reserves and reduce dependence on imported sources of nuclear fuel.

- Speed up indigenous exploration and exploitation of uranium in India.

Independence of Indian Foreign Policy

Will entering into the Indo-US nuclear deal increase the risk of additional constraints on the independence of India's foreign policy?

The question of independence of India's foreign policy has invited strident criticism from the Left parties and others who oppose the deal. The main thrust of this opposition derives from Section 103(b)(4) of the Hyde Act that states that it shall be the policy of the United States to "secure India's full and active participation in United States efforts to dissuade, isolate, and if necessary sanction Iran for its efforts to acquire weapons of mass destruction including a nuclear weapons capability and the capability to enrich uranium, or reprocess nuclear fuel, and the means to deliver weapons of mass destruction." Under Section 104(c)(G) the President of the US is also required to report to Congress and provide "a description and assessment of the specific measures that India has taken" to fulfill the above objective.

There is nothing in the Hyde Act that binds India to any specific course of action with regard to Iran.

Unless the 123 Agreement stipulates that Indo-US nuclear deal will be conditional on India's support to achievement of US objectives in Iran, there is nothing in the Hyde Act that binds India to any specific course of action with regard to Iran. In case the 123 Agreement does contain a prescription binding India's foreign policy options to US interests in Iran, it would be wholly unacceptable to India.

It has also been argued that the reporting requirement mentioned in the Hyde Act with regard to Iran may be used by the US at a later date to arm-twist India into following a policy congruent with that of the US. However, the reporting requirement does not require the US administration to abrogate the deal with India in case India's foreign policy on Iran runs contrary to US interests. The reporting requirement only empowers the US Congress to get information from the administration about the level of cooperation between India and the US on matters relating to foreign policy. It is an internal US process that has no legal bearing upon the Indian government or the conduct of civil nuclear cooperation. Reporting to Congress is a requirement in the US that the President must fulfill. It is the right of the Congress to be in the know about matters relating to US foreign policy. The Executive, however, is the dominant actor in the formulation and implementation of US foreign policy, a fact clarified by President Bush after he signed the Hyde Act. As argued above, unless the bilateral agreement links the working and continuation of the civil nuclear cooperation to specific Indian actions with regard to Iran, there is little ground for arguing that the deal would legally constrain the independence of Indian foreign policy with regard to Iran.

Currently, the US and India have broadly the same goals with respect to controlling the proliferation of

Weapons of Mass Destruction (WMD). In fact, under its WMD Act India is committed to containing and preventing the proliferation of WMDs regardless of the conclusion of the Indo-US nuclear deal. Even though there is congruence in broad goals of containing the spread of WMDs, it is possible that India and the US may differ on the modalities of achieving this objective. In such a case, does the nuclear deal impose any constraints on India's options? At the legal level, unless the 123 Agreement specifically mentions such a condition, India is under no constraint to follow US diktats.

In spite of these legal niceties the US could still arm-twist India to toe its line. Does entering into the deal make India more or less vulnerable to US pressure?

Currently, relations between India and the US are dominated by the US; although over the last fifteen years, the relationship is steadily moving toward a more equitable one. In the transition period which India is currently going through, it is dependent on the US for many things including trade and investment. This makes India vulnerable to US pressure regardless of whether India signs the deal or not. This is a risk that the political and the foreign policy establishment will have to manage with or without the deal. Since the nuclear deal is being signed during this 'transition' period, it is subject to these associated risks. However, the nuclear deal also provides India with political and economic opportunities for moving Indo-US relations to a higher level of interdependence at a faster pace. As economic relations become the driver of Indo-US relations, US leverage to politically arm-twist India is likely to diminish.

What are the opportunities India will forgo if it chooses not to sign the deal?

The Indo-US nuclear deal has de facto recognised India's nuclear weapons programme. Under the Separation Plan, India is free to develop, stock and deploy nuclear weapons. The recognition of India as a "responsible state with advanced nuclear technology" provides India a unique status facilitating India's participation in global nuclear trade and R & D. If India chooses not to go into the nuclear deal, this unique status will be immediately withdrawn. The nuclear deal is the only political initiative that has taken India closer to being recognized internationally as a nuclear weapon State. This is a window of opportunity that will not be available if India does not conclude the deal.

The Indo-US nuclear deal has de facto recognised India's nuclear weapons programme. Under the Separation Plan, India is free to develop, stock and deploy nuclear weapons.

If India does not sign the deal, it stands to lose out considerably in increasing its power generation capacity in the next 10-15 years. According to official projections, the indigenous India nuclear power programme will have an installed capacity of 20,000 MWe by 2020. Out of this 6,000 MWe is slated to be met by imported reactors. If the deal does not go through this target is not achievable. However, if the deal does go through, India may be able to raise its installed nuclear capacity to about 30,000 MWe by 2020.

The Indo-US nuclear deal opens doors for Indian participation at international research and development project like ITER and the Global Nuclear Energy Partnership (GNEP). India could utilize the opportunities offered by civil nuclear cooperation to enhance research and development in Indian nuclear science. This can be facilitated through joint research and development in nuclear

engineering. India could also identify and buy critical research technologies. For example, Indian participation in the GNEP could facilitate the augmentation of nuclear R & D in India and reduce dependence on the US for technology in the long run. These opportunities would not be available to India without the deal.

India will most probably face economic sanctions if it conducts a nuclear test. These sanctions will be imposed irrespective of whether India has or does not have an agreement with the US on civil nuclear cooperation. The Indo-US agreement on civil nuclear cooperation will increase the interdependence between the Indian and global nuclear industries. The duration of the sanctions is therefore likely to be much less if India and the US agree to cooperate. On the other hand, if India does not sign the deal, the sanctions period is likely to be of longer duration. By going ahead with the deal India will create a strong lobby of nuclear power companies in the US that will advance Indian interests in case of a crisis triggered by an Indian nuclear weapons test.

The foreign policy of any country is inherently constrained by its political, economic or military power. The question India has to answer is whether the nuclear deal is likely to increase or diminish India's political, economic and military clout. On balance, it would appear that the deal will augment rather than decrease India's stature in the global arena. The nuclear deal while having manageable political risks associated with it, offers India the opportunity to become a more important global player.

The nuclear deal provides India with opportunities to increase India's nuclear power generation capability. It also gives de facto recognition to India's nuclear weapons programme and facilitates Indian participation in global nuclear energy trade and research. In case India decides not to enter into the deal, it stands to lose much more than what it may gain.

If India aspires to become a great power, it must engage with the US and learn how to work with it within the framework of its national interest. While this path is not without risks, any alternative route may not enable India to reach this goal.

Recommendations

1. India should amend its Atomic Energy Act to allow for **private participation** in building, owning and operating nuclear reactors in India.

2. Introduce **investment protection** clauses in all contracts with all suppliers after the conclusion of the 123 Agreement.

3. Ensure that the **physical infrastructure** created in the Indian nuclear industry is protected through appropriate legal means against any unilateral actions from outside the country.

4. Examine the possibilities of providing additional **insurance protection** to the Indian nuclear power industry.

5. Negotiate a **Statement of Principle** in the 123 Agreement as well as with other supplier states that provides for sufficient lead times to switch suppliers in case of possible disruptions in fuel supplies.

6. India should actively **promote its research and development of new technologies** to

enable speedy transition towards an eventual thorium based fuel cycle.

7. In the 123 Agreement, **India should protect all its options with regard to reprocessing spent fuel**. At the same time, an environmental and economic assessment of reprocessing of spent fuel is necessary to take the decision in favor of reprocessing or storage.

8. India needs to **spread the risk** of the economic impact of a possible abrogation of the deal by making sure that it is not overwhelmingly dependent on any single supplier country.

9. The above approach must, however, be balanced by ensuring participation by US companies so as to **create a lobby in the US** that would promote the cause of India's nuclear industry.

10. Negotiate a **maximal definition of a "reasonable reactor operating requirements"** in the 123 Agreement. Ideally India should pitch for a definition that is closer to the concept of strategic reserve as defined by the PM.

11. Operationally, however, the quantum of the **strategic reserve must be governed by economic considerations** to keep nuclear power competitive with other sources of power.

* *The authors would like to acknowledge valuable inputs by Dr. K. Santhanam towards writing of this report.*

Annexure - I

Henry J Hyde United States - India Peaceful Atomic Energy Cooperation Act of 2006

Analysis of Major Provisions

Nuclear Detonation: The Hyde Act is clear that exploding a nuclear explosive device by India would terminate Indo-US Nuclear Cooperation. India, however, is not bound by any legal requirement to not detonate or to go beyond its unilateral moratorium. It would be unrealistic to expect a domestic US legislation to explicitly allow an Indian nuclear test. It is for India to decide the benefits and risks of such action. The issue of nuclear detonation is related to the India's energy security and the issue of fuel supply assurance which India must satisfactorily address if it enters into the deal.

Transfer of Technology: The Hyde Act does not allow for transfer of reprocessing, enrichment and production of heavy water technologies to India. India is, however, free to reprocess spent fuel under safeguards. This has led many in India to argue that "full civilian cooperation" has been denied to India.

Section 104(d)4 as explained in the Section by Section Analysis accompanying the Hyde Act, states that *"Section (104)(d)(4) regulates US Cooperation with India on the areas of uranium enrichment, reprocessing and heavy water production. Under the Atomic Energy Act, such cooperation is not restricted but agreements for cooperation must specify if such cooperation is to take place. . . In 1999 when the United States Government opted to expand US-Australian nuclear cooperation to allow for cooperation in the SILEX uranium enrichment process, an amended agreement was submitted to Congress for approval. The conferees intend that should any such cooperation with India be contemplated, either the original agreement for cooperation would specify that such cooperation is authorized or a subsequently amended agreement would be submitted to the Congress."*

This is not to argue that India would have access to currently prohibited technologies but that there is space for India to negotiate for amendment of the current Act to enable access to them. Such a precedent exists in the US. This is however, an interpretation and also assumes that the political approval for transfer of technology would be forthcoming in the US Congress This would most probably also require closer alignment of India's strategic goals with that of the US.

Nuclear Fuel Supply: The Act does not provide for "a strategic reserves of nuclear fuel over the lifetime of India's reactors" as mentioned in the PM's Statement in Rajya Sabha on 17th August 2006. The Act only provides for fuel reserve "commensurate with reasonable reactor operating requirements." The definition of "reasonable reactor operating requirements" is not specified. While it does not assure India lifetime supply of fuel, it also does not prevent India for negotiating for the maximum possible reserve during the contractual negotiations.

Fallback Safeguards: Fallback Safeguards refers to an US end-use monitoring program to be put in place in case the IAEA is unable to implement its safeguards agreement with India because of budget or personnel constraints. This clause has been softened in the final version of the Act. Fallback

safeguards will take effect in the event that the IAEA is unable to implement its safeguards agreement with India. This provision seeks to assure the nonproliferation lobby in the US that in case the current international nuclear regulatory regime implemented by IAEA is threatened, weakened or becomes defunct, the US will have the legal right to monitor India's safeguarded facilities.

Iran: "Statements of Policy" section of the Act says that it shall be the policy of the United States to "secure India's full and active participation in the United States efforts to dissuade, isolate and if necessary sanction and contain Iran for its efforts to acquire WMDs, including a nuclear weapons capability and the capability to enrich uranium or reprocess nuclear fuel, and the means to deliver weapons of mass destruction."

There is also a reporting requirement on the US President to inform Congress about the "specific measures India has taken to fully and actively participate in the United States and international efforts to dissuade and isolate and if necessary sanction Iran"

Neither the "Statements of Policy" nor the reporting requirements are binding on India. India can choose to align with the international efforts to resolve the Iran issue under the aegis of the UN.

Annexure - II

Implications of a Strategic Fuel Reserve over the life time of a1,000 MWe reactor

The amount of enriched uranium (enriched to about 4.5%) required for operating a 1,000 MWe reactor (with a burn up of 50 Gigawatt days per tonne of initial heavy metal, a 90% capacity utilization factor and a thermal to electrical conversion efficiency of 33%) is about 20 tonnes.[5]

Current prices of uranium (long term contract prices) in the international market are approximately $1770 per kg.[6] Spot prices will be much higher.

The cost of uranium fuel per year for a 1,000 MWe plant with the above characterization is approximately $35 million.

If each reactor that is bought under the Indo-US agreement comes along with a life time stock of fuel and if the lifetime of the reactor is thirty years, each reactor would require about 600 tonnes of enriched uranium fuel. The total cost of the inventory would be about $1.05 billion per each 1,000 MWe reactor.

Even if we assume that we do not buy any further fuel since we have a large inventory and we can run down that inventory without any danger of sanctions, additional operating costs are going to arise because of inventory holding costs.

If the commercial lending rate is about 15% then the interest charges will be an added burden on the operating costs associated with nuclear power. In the first year of operation this interest charge can be as much as $159 million though as the inventory depletes the interest cost would come down to $ 5.31 million toward the end of life of the reactor.

The additional cost to nuclear power because of this lifetime holding of a strategic reserve can now be estimated for the first year of operation.

About 7.88 billion KWh of electricity can be produced by a nuclear plant with the above specifications.

The additional cost with a lifetime strategic reserve would be a cost of 1.92 cents per KWh produced. In rupee terms this would translate into an additional cost of approximately 90 paise per KWh at current prices. Given that electricity prices today is about Rs.2.50 per KWh this extra inventory holding cost will increase the price of electricity per unit by about 33% and erode the competitive position of nuclear power.

The table overleaf indicates the impact of a lifetime strategic reserve over a thiry year period on the cost of nuclear electricity. We can see that a thirty year inventory of enriched uranium will add about 90 paise to the cost of each unit of electricity. On the other hand, if we have an inventory of only one or two years the additional cost incurred would only be between 3 and 6 paise per unit of electricity at current prices.

Clearly, if we want to completely negate the impact of possible US sanctions, the inventory holding should be for the lifetime of the reactor. The

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[5] "The future of Nuclear Power - an Interdisciplinary MIT Study" Massachusetts Institute of Technology, 2003, available at http://web.mit.edu/nuclearpower/

[6] "The Economics of Nuclear Power" Briefing Paper 8, at http://www.uic.com.au/nip08.htm

economic implications of mitigating this political risk would, however, make nuclear electricity more expensive and erode its competitive position with respect to other sources of power.

What should be the optimum inventory given that these political risks have to be managed in the Indo-US nuclear deal?

Our assessment, based on some cases of valuation of nuclear power plants in the US, indicate that the typical fuel inventory held by nuclear power companies in the US are for roughly two years. As we can see from the following table a two year inventory may only add about 6 paise to the cost of a unit of electricity.

Experience from the past would suggest that the maximum period of sanctions may be one or two years. To make sure that there is no major impact on power production we may want to keep an inventory for one additional year. This three year inventory will add about 10 paise to the cost of a unit of power. This may not affect the competitive position of nuclear electricity in a big way. Our analysis would suggest that anything above five years of inventory may erode the competitive position of nuclear power.

In case negotiations with the US get sticky with respect to the definition of "reasonable reactor operating requirements" a case can be made out for at least a two to three year inventory as necessary for the operations of nuclear plants in India. While we want to negotiate for the maximum position of a lifetime strategic reserve we can see from this assessment that such an approach does not make much economic sense.

Our assessment has not included the additional costs of storage and security that holding the inventory will entail. This will add further to the costs.

An easier way to deal with this issue is to make sure that the US stake in the nuclear power industry in India becomes significant. In such a situation pressure from the US industry on the US government will help in reducing the period of sanctions. This diplomatic and political management of the risk may be more appropriate than working on a lifetime supply of nuclear fuel.

This assessment is based largely on a study on nuclear power carried out by MIT.

Table 1

Cost of Holding Lifetime Inventory of Nuclear Fuel (1,000 MWe Imported Nuclear Power Plant)

Year	Electricity produced in Billion KWh per 1,000 MWe reactor per year	Enriched uranium inventory in tonnes for full life of reactor	Inventory holding costs at 15% in Million dollars	Additional cost per KWh in paise
1	7.884	600	159.3	90.92
2	7.884	580	153.99	87.89
3	7.884	560	148.68	84.86
4	7.884	540	143.37	81.83
5	7.884	520	138.06	78.80
6	7.884	500	132.75	75.77
7	7.884	480	127.44	72.74
8	7.884	460	122.13	69.71
9	7.884	440	116.82	66.68
10	7.884	420	111.51	63.65
11	7.884	400	106.2	60.62
12	7.884	380	100.89	57.59
13	7.884	360	95.58	54.55
14	7.884	340	90.27	51.52
15	7.884	320	84.96	48.49
16	7.884	300	79.65	45.46
17	7.884	280	74.34	42.43
18	7.884	260	69.03	39.40
19	7.884	240	63.72	36.37
20	7.884	220	58.41	33.34
21	7.884	200	53.1	30.31
22	7.884	180	47.79	27.28
23	7.884	160	42.48	24.25
24	7.884	140	37.17	21.22
25	7.884	120	31.86	18.18
26	7.884	100	26.55	15.15
27	7.884	80	21.24	12.12
28	7.884	60	15.93	9.09
29	7.884	40	10.62	6.06
30	7.884	20	5.31	3.03

Calculations assume - burn up of 50 Gigawatt days per tonne of initial heavy metal, a 90% capacity utilization factor and a thermal to electrical conversion efficiency of 33%.

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