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Status of Nuclear Power Plant and their Site Selection Criteria in India

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ABSTRACT:

India suffers from a severe shortage of electricity generation capacity. According to the World Bank, roughly 40 percent of residences in India are without electricity. Per capita energy consumption in India is less than 500 kgoe, compared to the global average of nearly 1,800 kgoe India has recently established a civil nuclear cooperation deal with the United States. The U.S.-India Civil Nuclear Energy Cooperation deal signed in July 2005, also known as the 123 Agreement, allows for civil nuclear trade between the U.S. and India with the goal of increasing India's installed nuclear power generation capacity. In light of the deal, the Indian government has set its nuclear generation target at 40,000 MW by 2020. After this deal Nuclear Power Corporation of India Limited (NPCIL) looking for new site to develop Nuclear Power Plants (NPP) in the country.

INTRODUCTION:

Site selection is one of the first steps towards the safety of society. If the site selection is for the Nuclear Power Plant then the importance of site selection also increase. The site selection for the NPP is different from the other site like residential, commercial etc. first step in site selection is to check availability of land. "Compared to other non-carbon-based and Carbon-Neutral Energy options, Nuclear Power Plants require far less land area. For a 1000-MW plant, site requirements are estimated as follows: Nuclear, 1-4 km^2; Solar or Photovoltaic Park, 20-50 km^2; a wind field, 50-150 km^2; and biomass, 4,000-

6,000 km^2. The area requirement for NPP is less but the effect of any disaster due to NPP is more than other man made energy resources.

NPCIL have a site selection committee which select the site for NPP. The site selection for NPP is carried out by the Site Selection Committee, notified by the Government of India which selects site for setting up a Nuclear Power Plant, reviewed various parameters as per the requirements laid down in the code of Atomic Energy Regulatory Board and the laid-down criteria. The site selection committee follows the following criteria for mark the site of Jaitapur NPP.

- Availability of land vs. population density
- Available source of cooling water
- Seismicity
- Safe-grade elevation at site (flood analysis etc.)
- Environment aspects and proper access for transportation of heavy/over-dimensional equipment to plant site.

Along with these conditions and based on some other considerations the Government approved Jaitapur site for the establishment of the NPP.

Table 1: Showing existing Nuclear Power Plant

Power station	State	Type	Operator	Units	Total capacity (MW)
Kaiga	Karnataka	PHWR	NPCIL	220 x 3	660
Kalpakkam	Tamil Nadu	PHWR	NPCIL	220 x 2	440
Kakrapar	Gujarat	PHWR	NPCIL	220 x 2	440
Rawatbhata	Rajasthan	PHWR	NPCIL	100 x 1 200 x 1 220 x 4	1180
Tarapur	Maharashtra	BWR (PHWR)	NPCIL	160 x 2 540 x 2	1400
Narora	Uttar Pradesh	PHWR	NPCIL	220 x 2	440
Total				**19**	**4560**

Source: NPCIL

Table 2: Nuclear Power Plant projects which are under construction can be listed below

Power Station	**State**	**Type**	**Operator**	**Units**	**Total capacity (MW)**
Kudankulam	Tamil Nadu	VVER-1000	NPCIL	1000 x 2	2000
Kaiga	Karnataka	PHWR	NPCIL	220 x 1	220
Kalpakkam	Tamil Nadu	PFBR	NPCIL	500 x 1	500
Total				**4**	**2720**

Source: NPCIL

Table 3: Nuclear Power Projects which are planned up for the future are as follows:

Power Station	**Operator**	**State**	**Type**	**Units**	**Total capacity (MW)**
Rawatbhata	NPCIL	Rajasthan	PHWR	640 x 2	1280
Kakrapar	NPCIL	Gujarat	PHWR	640 x 2	1280
Jaitapur	NPCIL	Maharashtra	EPR	1600 x 4	6400
Kudankulam	NPCIL	Tamil Nadu	VVER	1200 x 2	2400
Kaiga	NPCIL	Karnataka	PWR	1000 x 1, 1500 x 1	2500
	NPCIL		AHWR	300 x 1	300
	NPCIL		PHWR	640 x 4	2560
	NTPC		PWR	1000 x 2	2000
Total				**19**	**18720**

Source: NPCIL

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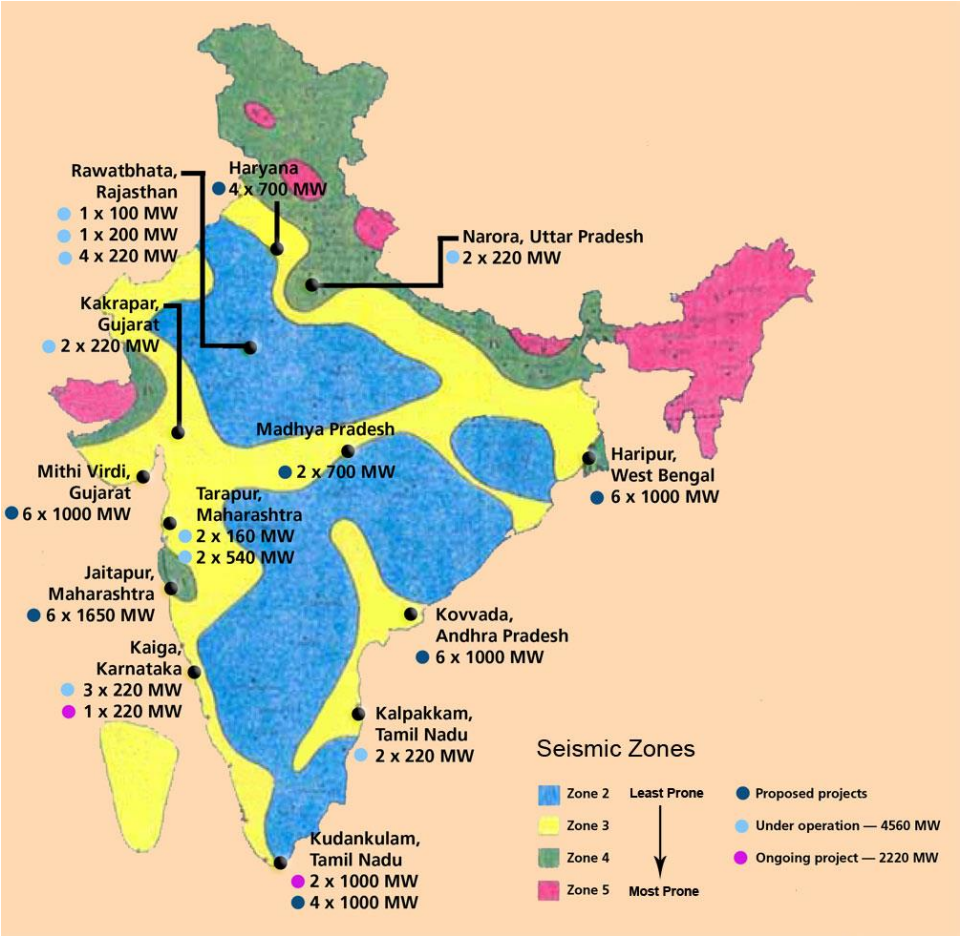

Figure: Map showing location of NPP in India

The ripples of Japan's Tsunami-triggered nuclear crisis are being felt in India. It reminds us of the Tsunami of 2004. Tsunami wave's five-meters high hit the power reactors at Kalpakkam in Tamil Nadu. A minor water leak was reported in the plant. Walls collapsed but were repaired by 2007. We all believed that the system was robust enough to survive such a disaster.

The situation in Japan has made us think more about our nuclear security. The Nuclear establishment in India has assured us that our systems are robust. In India, a nuclear plant cannot be built within a radius of 400 kilometers of a seismic zone. Out of the 20 reactors, only two in Tarapur are based on the boiling water principle as the ones in Japan. Going by the statements of the Department of Atomic Energy, diesel power backups for our

Nuclear Power Plants, particularly in Tsunami prone areas, have been constructed at high altitudes to avoid flooding by Tsunami. However, looking at Japan, we need further reassurance. That too in comprehensive terms.[1]

Consideration for site selection of NPP:

1. **Land availability:** The land requirement for NPP is one of the most important aspect. Land requirement for Jatapur NPP is 893 hectare and people these land acquisition. The land acquire under the "land acquisition act 1894." The area requirement for NPP is less than other power plant. But the surrounding land use is control by the strong zoning regulation and building byelaws.

Table 4: Area requirement for 1000 MW plant

Type	Area
Nuclear Power Plant	1-4 km^2
Solar or Photovoltaic Plant	20-50 km^2
Wind field	50-100 km^2
Biomass	4000-6000 km^2

Source: International Atomic Energy Agency

2. **Exclusion Area:** Area surrounding the rector in which the rector licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area.
3. **Low Population Zone**: Area immediately surrounding the exclusion area which contains residents, total no. and density of which are such that there is no reasonable probability that appropriate protective measure could be taken in their behalf in the event of a serious accident.

[1] *"Author(s): Richard Mahapatra Issue: Mar 14, 2011 down to earthquake"*

4. **Population Center Distance:** The distance from the reactor to the nearest boundaries of a densely populated center is (>_25,000 residents)
5. **Available source of cooling water:** The amount water a power station uses and consumes depends on the cooling technology. The distinction between 'use' and 'consume' is important. Some power stations use large quantities of water, but most of this water is returned to the source and can be used again by other consumers or for environmental purposes. All power stations do consume some of the water they use. This is generally water that is lost as evaporation. Availability of cooling water for all possible operational states of the reactor is also another important consideration. Those NPP which is situated near the sea coast have easily obtained water from sea. But, an inland plant cooling towers become necessary and a nearby water source is used (e.g Kaiga from the Kadra Reservoir, Narora from the Ganga)[1].

Annual water requirement by energy sources assuming that a power station run 24 hours a day and based on the lower end of the estimates in the table 5, 6 & 7, annual usage and consumption per megawatt would be as follow.

Table 5: Once through[2]

	Water withdraw (ML/MW[3])	**Consumption (ML/MW)**
Fossil/Biomass/ waste	633	10

[1] Sudhinder Thakur
[2] Once-through' — the steam is cooled by more water that is pumped from an outside source in pipes through a condenser.
[3] MW= one million watts, ML= one million liters approximately

Nuclear	829	13

Source: Department of Parliamentary Services, Australia

Table 6: Pond cooling

	Water withdraw (ML/MW)	**Consumption (ML/MW)**
Fossil/Biomass/waste	10	10
Nuclear	17	13

Source: Department of Parliamentary Services, Australia

Table 7: Tower cooling

	Water withdraw (ML/MW)	**Consumption (ML/MW)**
Fossil/Biomass/waste	17	16
Nuclear	27	24

Source: Department of Parliamentary Services, Australia

"A recent Australian nuclear science and technology organization (ANSTO) report did a cost benefit analysis of establishing one of these stations in Australia. The plant referred to this report was an advanced pressurized water reactor (approximately 1000). This plant would have an operating output of between 1115 and 1150 Megawatts depending on the cooling technique employed." A report by the U.S. department of energy published estimates of the likely cooling water requirement of this sort of plant. These were stated to be between 450,000 to 75000 US gallons per minute. This equates to an annual average usage rate of between 779 and 1338 magaliteres per megawatts' which is consistent with the above analysis for existing nuclear power plant.

Seismicity: This is also important consideration for site selection for a NPP. According to the Site selection committee for NPP is define following parameter to cheak site free from seismic activity:

- Site falls within seismic zone 1-4
- Absence of capable faults within 5 k.m
- Distance from air fields/airports

The minimum length of fault to be considered various distance from site: capable fault of lesser length than those indicated in table 8 which are capable faults need not to be considered in determining the safe shutdown earthquake such consideration is appropriate.

Table 8: Distance from site and minimum length of fault

Distance from the site (miles)	**Minimum length of fault**
0 to 20	1
Greater than 20 to 50	5
Greater than 50 to 100	10
Greater than 100 to 150	20
Greater than 150 to 200	40

"Seismic or other activity at a site location is less critical to safety than reactor design" for example Japan is an active seismic earthquake prone region, about 54 rector are operational in the country.

Other consideration

- Geology and Soli Mechanism
- Topography
- Hydrology and Hydro Geology
- Metrology
- Natural phenomena such as Earthquake, Fault, Tsunamis and Cyclones

- Failure of human made structure such as Dams and Sea wall
- Potential external human made-include event e.g. plane crashes, fires, explosion
- Availability of water for plant cooling and ultimate heat sink
- Reliability of offsite Electrical Power

Problem related with NPP

1. **Land Acquisition:** On 29 December 2009, 12 January 2010, and 22 January 2010, when the government authorities visited Madban for distribution of cheques in lieu of compulsory land acquisition, the villagers refused to accept the cheques. Government officials were shown black flags, denied any co-operation in carrying out their activities. 72 people were arrested on 22 January 2010 when people protested against the compulsory land acquisition. On December 4, 2010, protests became violent when over 1500 people were detained from among thousands of protesters, who included environmentalists and local villagers. Members and leaders of the *Konkan Bachao Samiti* (KBS) and the *Janahit Seva Samiti* (organizations that are spearheading opposition to the project) were also detained. In Mumbai, members of various trade unions and social organizations came together to protest against the project. The protesters have raised serious doubts about the neutrality of the Environment Impact Assessment Report, prepared by National Environmental Engineering Research Institute (NEERI) which forms the basis of environmental clearance for the project, since parallel studies by

the Bombay Natural History Society have shown that the project will cause substantial environmental damage.

With the new law related land acquisition i.e. *"The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013"*, it is very difficult to acquire the land. Although, the land required for the purpose NPP is acquire on the higher rate which increase the cost of the project, further the surrounding area of NPP are restricted for the further development as mentioned in the Consideration for site selection of NPP. Therefore, not only the land acquired but also the surrounding area affected by this type of project.

2. **Probability of any Disaster:** As already mentioned this type of project energy resources made by human has more probability of manmade disaster. Further, in the today world the security from the terrorists is also major concern as this type of project are always main target of the non-social elements. Natural climaticies has also effects the site selection criteria for NPP project. Even after due consideration of the side selection criteria, natural climaticies effects the working and expose the probability of disaster from these projects. The examples mentioned above are the live examples.
3. **Impact on Environment:** Since this type of project requires huge amount water as cooling element and this used water cannot be use for other purposes due to the radioactive content. Thus the treatment of this water is required before put to use. Not only is this threat of any mishapppning always remains alive with this type of project. If any, disaster convert in to hazards than the impact of these will remain a long time in the environment and this will affect the flora and fauna of the area under its influence.

4. **Change in Land Use:** This is the most important aspect which receive heat before the implementation / working of this type project as the phenomenal changes are occurred due to the establishment of NPP project. Due to this, the physical changes are occurred are also affects the social and economic activity of that area. Strict zoning regulation and building bye laws are the pre-requisite for the surrounding area of NPP. Further, change in the character local as well as regional economy are also affect as negative and positive terms.

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