NUCLEAR ENERGY PROGRAMME IN INDIA AND UNDERGROUND WASTE DISPOSAL

Pradeep Chaturvedi
Chairman
Indian Association for the Advancement of Science

Cost of Power

NO Power

Is Costlier than

NO Power

- Dr Homi Bhabha

Wheel of Progress

R.K. Laxman's famous cartoon depicted Pandit Nehru driving the common man on a bullock cart with a nuclear wheel - Appeared on 21st January 1957, the day Pandit Nehru formally inaugurated Atomic Energy Establishment Trombay

Nuclear Energy Development Last Millennium (1957-1998)

- Meager Financial Resources
- Limited Scientific & Technological Manpower
- Facing a Severe Technology Ban regime
- Inadequate Industrial and Manufacturing Base
- Extremely Small resource of Fissile material.

Nuclear Energy Development This Millennium(1998 to Now)

- An Extensive Manpower Training System in place.
- Developed our own Technologies in entirety
- Developed Industrial and Manufacturing Base in India
- Innovated the Uranium-Thorium route – Stage 3
- Harnessed Societal Spin-offs
- Provided Strategic Security

The Approximate Potential Available From Nuclear Energy

Particulars	Amount	Thermal Energy		Electricity	
		TWh	GW-yr.	GWe-Yr.	MWe
Uranium-Metal	61,000-t				
In PHWR		7,992	913	330	10,000
In FBR		1,027,616	117,308	42,000	5,00,000
Thorium-Metal	2,25,000-t				
In Breeders		3,783,886	431,950	1,50,000	Very large

Possible Development of Nuclear Power Installed Capacity in MW

Year	Unit	Scenario	
		Optimistic*	Pessimistic
2010	GWe	11	9
2020	GWe	29	21
2030	GWe	63	48
2040	GWe	131	104
2050	GWe	275	208

Three Stage Indian Nuclear

- <u>Stage-I PHWRs</u>
- 17 – Operating
- 1 – Under construction
- Several others planned
- Scaling to 700 MWe
- Gestation period has been reduced
- POWER POTENTIAL = 1GWe
-   LWrs
- 2 BWRs Operating

Three Stage Indian Nuclear

- <u>Stage-II Fast Breeder Reactors</u>
- 40 MWth FBTR – operating since 1985 Technology Objectives realized
- 500 MWe PFBR –Under Construction
- TOTAL POWER POTENTIAL≡530 GWe (including ≡ 300 GWe with Thorium)

- <u>Stage – III Thorium Based Reactors</u>
- 30 kWth KAMINI –Operating
- 300 MWe AHWR : Pre-licensing safety appraisal by AERB completed, Site selection in progress

Indian Nuclear Power Programme – 2020

Reactor type and Capacities	Capacity (MWe)	Cumulative Capacity (MWe)
18 reactors at 6 sites in operation Tarapur, Rawatbhata, Kalpakkam, Narora, Kakrapar and Kaiga	4,340	4,340
2 PHWRs under construction at Kaiga 4 (220 MWe), RAPP-6(220 MWe)	440	4,780
2 LWRs under construction at Kudankulam (2x1000 MWe)	2000	6,780
PFBR under construction at Kalpakkam (1 x 500 MWe)	500	7,280
Projects planned till 2020 PHWRs (8x700 MWe), FBRs (4x500 MWe)m AHWR (1x300 MWe)	7,900	15,180
Additional LWRs through international cooperation	~20000	35,000

Nuclear Reactor Design and Construction - Capabilities

- Expertise in Reactor Physics; Metallurgy of Nuclear Materials, Chemistry; Mechanical, civil, control and instrumentation, Electrical, Chemical engineering; Radiation Physics; Nuclear safety etc.
- Fabrication Techniques of Reactor Components
- Quality Assurance
- Modern Construction Techniques
- Maintenance, Repair, Renovation Technology
- Safety and Regulatory Practices
- All these are well developed and available at mature commercial level in the country

Indian PHWRs

- Experience of 300 reactor years
- High availability factor and capacity factor
- Indian industries fully capable of manufacturing of large size components
- Complies fully with regulatory requirements
- Most recent technologies incorporated
- High level of

  --Performance

  --Efficiency

  --Operability

  --Economics
- Sound and proven technology
- Integrate the results of decades of research and development at BARC and NPCIL

Third Stage

- Reactors of the Third Stage will be generally same as of the Second Stage
- Thorium fuel cycle technology would however need to be deployed at industrial scale.

Challenges of Radioactive Waste Management

- As yet unsolved dilemma of high-level radioactive waste management;
- Fundamental prerequisites for effective management of high-level radioactive waste;
- Determine what should constitute an acceptable scientific and engineering foundation for proceeding with radioactive waste disposal strategies.
- Forecast of health detriment for such long periods should be examined critically.

Geological Disposal

- Permanent repositories first expected to be commissioned some time after 2017
- A 1983 review of the Swedish radioactive waste disposal programme focused on necessity for waste isolation to be fully justified
- Storing high level nuclear waste above ground for a century or so considered appropriate
- Sea-based options for disposal of radioactive waste
- Proposed land-based seductive waste disposal method prohibited

Material for Geological Disposal

- Glass forms including borosilicate glasses and phosphate glasses
- Ceramic waste forms offer high loadings
- Nano-structured materials seem to be frontier beyond ceramic waste forms

National Management Plans

- Finland, the United States and Sweden are the most advanced in developing a deep repository for high level radio active waste disposal
- Asia
- Europe
- North America

International Repositories

- Pangea International Association
- COVRA is negotiating a European-wide waste disposal system

What Next ?

- **Onkalo’s underground tunnels won’t even begin to address the global situation. But they will do the next best thing. This project, estimated to cost 3 billion ($4.5 billion), will either demonstrate that the technical, social, and political challenges of nuclear waste disposal can be met in a democratic society, or it will scare other such countries away from the repository idea for decades to come.**

Winds of change

I do not want my house to be walled in on all sides and my windows to be stuffed. I want the cultures of all the lands to be blown about my house as freely as possible. But I refuse to be blown off my feet by any.

- Mahatma Gandhi

- This appropriately sums up India’s Approach to Nuclear Power Development