INDIA ENERGY FORUM

10th Nuclear Energy Conclave

25th October 2018, Hotel Le Meridien, New Delhi

Theme:

Nuclear Power: Towards a Clean & Base Load Energy

KEY TAKE-AWAYS & RECOMMENDATIONS

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Organiser

India Energy Forum: The Forum is a unique, independent, not-for-profit, research organization and represents energy sector as a whole. It is manned by highly qualified and experienced energy professionals committed to evolving a national energy policy.

The Forum's mission is the development of a sustainable and competitive energy sector, promoting a favourable regulatory framework, establishing standards for reliable and safety, ensuring an equitable deal for consumers, producers and the utilities, encouraging efficient and eco-friendly development and use of energy and developing new and better technologies to meet the growing energy needs of the society. Its membership includes all the key players of the sector including BHEL, NTPC, NHPC, Power Grid Corporation, Power Finance Corporation, Reliance Energy, Alstom and over 100 highly respected energy experts. It works closely with various chambers and trade associates including Bombay Chamber, Bengal Chamber, Madras Chamber, PHD Chamber, Observer Research Foundation, IRADE, INWEA,Indian Coal Forum, and FIPI.

10TH NUCLEAR ENERGY CONCLAVE

THEME: NUCLEAR POWER: TOWARDS A CLEAN & BASE LOAD ENERGY

PROCEEDINGS

The Flagship event of India Energy Forum (IEF)- THE NUCLEAR CONCLAVE: The 10th in the series was successfully concluded on 25th October 2018. The theme of the Conclave was "NUCLEAR POWER: TOWARDS A CLEAN & BASELOAD ENERGY". It was a well-received Conclave deliberated by policy makers at the highest level in the Govt. of India; domain experts; Captains of Nuclear Utilities and Industry from India and abroad. The conclave was inaugurated by the Hon'ble MoS (I/C) DONER; MoS in PMO; Dept. of Atomic Energy; Space; Personnel And Training- Dr. Jitendra Singh.

This Year besides the theme, other applications of Nuclear Energy in the fields of Medical(Diagnostics, Radiotherapy, Isotopes) and agriculture were also deliberated as part of its public outreach efforts.

The conclave was organised under the stewardship of Dr. Srikumar Banerjee, Chairman Nuclear Group IEF and Chancellor Homi Bhabha National Institute (Former Chairman, Atomic Energy Commission & Secretary, Dept. of Atomic Energy) & was addressed by Secretary, Dept. of Atomic Energy & Chairman AEC and also by Chairman, Atomic Energy Regulatory Board besides other distinguished Speakers/ Panellists from Rosatom, Russia, L & T, BHEL, Walchandnagar Industries, Godrej & Boyce Mfg. Co, Tata Memorial Centre, Mahajan Imaging, BARC, Nuvia U.K. etc.

This paper aims to capture the Key takeaways and recommendations coming out of the inaugural session and deliberations from the roundtable and other sessions.

KEY TAKEAWAYS

FROM INAUGURAL SESSION

Convenor, Nuclear Group, Former ED, BHEL

In his opening remarks, Mr. V P Singh Convenor/ IEF explained the context of the Nuclear Conclave- a flagship event of IEF- The 10th in the series – where issues and challenges in the growth of Nuclear Power and its application in the other fields are deliberated by all the stakeholders. IEF provides a discussion platform and recommendations are sent to all concerned thereafter.

The quest for energy continues from ancient times- from fire to wood to coal and then to oil and gas. Today's quest is however qualitatively different. It has to be clean, environment friendly and preferably, renewable lest we over exploit the mother earth. Nuclear power- being the only non-fossil clean energy source capable of meeting base load requirements together with renewables can provide a long term energy security for the country mitigating climate change concerns.

President, IEF & Former Secretary, Power

Mr. Anil Razdan welcomed the Chief Guest- The Hon'ble Minister for his support and inspiration in organising this Annual Nuclear Conclave. He also welcomed Secretary/ DAE, Chairman/ AERB and other distinguished panellists/ speakers on the dais and off the dais for taking out time to deliberate on the theme of the conclave. He made the following points:

1)The rise in earth temperature has to be controlled to within 1.5°C from the pre- industrial times as per the recent recommendations of IPCC to contain the adverse impact of climate change. This is possible by decarbonising the energy resources.

2)The per capita energy consumption of India has to be raised from mere 28 gigajoules to about 200 gigajoules but with clean energy resources like Nuclear Energy and Renewables.

3)In fact Nuclear Energy as a clean, base load energy source is an ideal option for India especially when the use of coal is expected to reach a peak in around 2040 .

4)Apart from providing electrical energy, Nuclear Energy will push the production of radio isotopes in India for medical/ other applications, namely, treatment of municipal sewage, cleaning of rivers, irradiation of food items etc.

Chairman, Nuclear Energy Group, IEF, Chancellor, Homi Bhabha National Institute & Former Chairman, AEC & Secretary, DAE

Dr. S Banerjee Chairman Nuclear Group IEF, Chairman Steering Committee and Chancellor, Homi Bhabha National Institute in his theme address highlighted the topics and framework of the 10th Nuclear Conclave. He made the following Key Points:

1)There is a perception that there is a kind of competition between Nuclear & Solar energy. Many think that when Renewables are growing what is the role of Nuclear power. Dr. Banerjee explained that not rivalry but there is complementarity between the two. This complementarity comes from wind & solar being distributed & intermittent whereas Nuclear is concentrated and continuous source of energy. There are some technological similarities between the solar thermal and high temperature reactor concepts where molten salts are used for extracting the heat produced at high temperatures in the temperature range of 700- 800 degree Celsius.

2)In not so distant a future, when oil/ diesel would not be available, electricity and hydrogen would be the primary energy carrier, the latter being extensively used for transportation. The production of hydrogen by splitting water molecules require high temperatures which can be generated either by Nuclear or by Solar Thermal- again a point of complementarity.

3)Looking at the challenges in the growth of Nuclear power, Nuclear is currently contributing only 3% of the total electricity in the country vis-à-vis the world average of 11%. So in the near term, India has to fast pace its PHWR programme with a fleet mode implementation, cutting down the gestation period and cost as well as installing large capacity LWR sinitially from import. Nuclear Power will gain some relevance in India when its share in electricity basket goes at least upto the world average, in the near future.
Talking of the energy independence of the country in the long term,Dr. Banerjee pointed to the two great gifts of Nature to India-the plentiful of sun-shine and the enormous reserve of thorium particularly in the beach sands, both in the western and the eastern coasts. It will be a blunder if these rich resources are not utilised for gaining the economic prosperity of the country. The importance of fast reactors and thorium utilisation must be viewed in this context.

4)The use of Nuclear energy in areas other than Nuclear Power was also highlighted. Applications of radiation have already made huge impact in nuclear agriculture, food preservation, mutation of seeds, treatment of sewage and medical applications. However there are still plenty of opportunities for their growth. The appreciation for Nuclear Energy and its wide ranging benefits of radiation to the society must be disseminated for dispelling some of the misgivings public at large has on Nuclear Power and radiation.

Professor & Head, Energy & Environment Programme, National Institute of Advance Studies

Prof. R. Srikanth, Professor & Head Energy and environment programme, National Institute of Advanced studies dwelt on the need to have a combination of conventional and renewable sources of energy for ensuring integrity, security and reliability of grid as well as demand- supply match. He made following Key Points:

1)Renewable Energy (RE) sources hardly contribute during peak demand hours at 7AM & 7PM when Sun is not shining/ Wind is not blowing.

2)Significant flexibility in conventional generation fleet is required to accommodate and absorb higher proportion of intermittent RE (e.g. Southern region will have high RE penetration relative to load in 2022 (38% VS 14% & 23% in Northern & western regions respectively).

3)Conventional green power for grid balancing like Hydro, Gas and even coal have different ramp rates:
- Ramp rate of Hydro power plants: ≈50%per minute
- Ramp rate coal power plant≈1.5 to 3% per minute
- Ramp rate Gas based power plant ≈10% per minute.

However share of hydro power generation- best suited for grid balancing- has declined to 13.5% in FY 2018 from 25% in FY 2008
4)Though Nuclear Power Plants have high capex, its low fuel costs results in its energy charge to be only 5-10% of power plants based on imported coal.

5)Policy recommendations include reducing the capex of Nuclear Power plants by a combination of strategies (fleet mode, EPC, bringing in companies like NTPC) to make tariffs more competitive and also determination of system costs of RE (by CERC & SERC) like creating smart grids, two way grids, costs associated with backing down of operational coal power plants.

Chairman, AEC & Secretary, Dept. of Atomic Energy

Dr.K.N. Vyas Secretary Dept. of Atomic Energy & Chairman Atomic Energy Commission while delivering his key note address said that Dept. of Atomic Energy (DAE) has broad based mandate towards harnessing the Atomic Energy for peaceful purposes. He quoted Dr.Homi J. Bhabha- the visionary founder of DAE- very aptly as-"for the full industrialisation of the developing countries for the continuation of our civilisation and for its further development, Atomic Energy is not only an aid but an absolute necessity. The acquisition by the man of the knowledge of how to use, release and use atomic energy must be recognised as the third epoch of human history."

2. Besides Nuclear Power, DAE is contributing in a big way in the non-power applications as well. Some of these are:

2.1 Agriculture: Mutation breeding has been done to improve the seeds of ground nut, pulses, wheat and rice as part of successful DAE programme. So far 45 varieties with improved yields, disease resistance have been developed, with the active collaboration with ICAR, Agriculture Universities etc.

2.2 Health: Useful radio isotopes have been extracted from radioactive wastes for medical applications. About 5 lakh patients are receiving treatment for cancer etc. where radiation therapy for diagnostic and therapeutic purposes is being successfully used.

2.3 Water: Low cost solution for water testing and purification has also been developed.

2.4 Food: Food preservation by irradiationhas been demonstrated and deployed. Commercial viability has been proved in several industrial plants, though there is a tremendous potential for its growth.

2.5Waste Treatment: Radiation hygenisation of municipal waste, demonstrated in a plant in Vadodara over a decade, can be extensively deployed in other areas.

3. NUCLEAR POWER: The energy policy of the country needs a paradigm shift in addressing the twin objectives of climate change mitigation and meeting the increasing demand of electricity. This necessarily entails substantially increasing the share of clean, low carbon technologies like Nuclear Energy and Renewables in the energy basket. Renewables are promising but these are beset with intermittency, lack of economical storage technology and problems associated with grid integration. Nuclear power delivers a huge advantage in reliability and continuity of electrical supply to meet load requirement- essential to keep the system running smoothly.
India has mastered the PHWR technology and its Kaiga power plant has completed 895 days of continuous operation- a world record. India has 22 operating reactors with 6780 MW, another 6700mw are in various stages of construction, administrative approval and financial sanction of 12 more reactors with a capacity of 9000 MW has been obtained to be completed by 2031. In addition, LWRs with foreign co-operation, Indian pressurised water reactors and advanced heavy water reactors are under planning/ development.

4. Dr. Vyas called on the Indian industry to participate from the very beginning to enable convergence of views essential for speedy implementation of the projects.

5. Public acceptance also plays a major role in timely completion of Nuclear Projects and DAE considers it as their corporate social responsibility for allaying any misgivings and opening up better communication channels.

6. Dr. Vyas appealed to all present to be the ambassadors of Nuclear energy, convey its benefits to generate public support, remove any impediment and help the country to attain greater heights.

Inaugural Address of Chief Guest

**The Hon'ble MoS (I/C) DoNER, MoS IN pmo-
Dept. of Atomic Energy, Space, personnel and training
Dr. Jitendra Singh.**

1.While delivering his inaugural address, the minister lauded the developments in the area of Nuclear energy and Space. Today India stands at the forefront in these two areas with state of the art indigenous technologies and development. Six decades later, India has vindicated the VISION of our founding fathers, of developing Nuclear Energy for peaceful purposes in the areas of Power, Agriculture, Health -care, Food-preservation etc.

2.The current Govt. Under the dynamic leadership of Prime Minister Narendra Modi has given unprecedented thrust to Science, Space Research and Nuclear Energy. It has approved in one go, 10 Nuclear Power plants with indigenously developed 700 MW PHWR technology. This unique and significant decision will fast pace the country's Nuclear programme towards a clean and base load energy as well as give a push to Indian Nuclear Industry.

3.Speaking about the other initiatives, he said that Govt. has amended certain provisions of the atomic energy act 1962 (through the atomic energy amendment Bill 2015) which would enable joint ventures to come up with Indian public sector undertakings. This will open door for additional funds for further expansion of Nuclear power programme. A provision of budgetary support of Rs3000crs/ annum has also been made to give a fillip to Nuclear Power Programme.

4.The future road map entails Nuclear capacity to be of the order of 63000MW by 2032 & 25% India's electricity needs will be met by Nuclear Power by 2050.

5.The minister also emphasised continuous efforts towards applications of Nuclear Energy in areas other than power to the benefit of the society. Significant developments have been made in the fields of Nuclear medicine, diagnostics, radiotherapy, radio isotope technology etc. He stressed the need to raise the capacity for the indigenous production of radio isotopes. The minister also dwelt on the role of radiation in food preservation and development of new seeds with better yield, higher disease resistance and early maturity.

6.He also mentioned about the "Hall of Nuclear Power" constructed at Pragati Maidan to educate the students and public about the peaceful applications of Nuclear Energy.

II
RECOMMENDATIONS OF THE ROUNDTABLE ON "GROWTH OF NUCLEAR POWER"

Distinguished Speakers

Mr. S K Sharma
CMD, NCPIL

Mr. Nikita Mazein
Senior VP, Rosatom Overeras Russia

Mr. Anil Parab
Executive VP, L&T Ltd (Equipments)

Mr. GK Pillai
MD & CEO, Walchandnagar Industries Ltd

Mr. Kaustubh Shukla
COO, Godrej & Boyce Mfg. Co. Ltd

Mr. P P Yadav
Executive Director Nuclear Business Group, BHEL

Dr S Kalirajan
Head Special Initiatives (Nuclear-LWR), L&T Construction

The session was chaired by Mr. S K Sharma and facilitated by Shri S M Mahajan.
CMD/NPCIL outlined the task and the challenges in "the Growth of Nuclear Power" in India. The main points made by him include

1.20 Nuclear power projects (NPP's)= 15,700MW (ongoing projects 8 NoS= 6700 MW &sanctioned projects 12 NoS= 9000MW) have to be completed by 2031. This calls for completion of 1.5 reactors every year which is a challenging task for all the stakeholders- viz DAE, NPCIL, Industry, Agencies doing Seismic Studies, AERB.Completion of such high target requires collaborative efforts by all the organisations.

2.The challenges in the growth of nuclear power.

2.1 Viability of nuclear power: competitive tariff is a pre- requisite, avoiding cost and time over- run is Key.

2.2 Finances: About Rs7,50,000 Crore investment is required if Rs15cr/ MW capex is assumed. Finances should be at competitive rate for long gestation period project.

2.3 Diverse technology: manpower with requisite skills at right time and right numbers is necessary for timely completion of Indian PHWRs and imported LWRs.

2.4 Securing public support: New ways to secure public outreach strategy and ensuring safe operation of the existing NPPs, are the best options to instill a sense of confidence.

2.5 Fleet mode strategy: Bulk and advance orders with staggered delivery to facilitate continuous utilisation of resources; standardisation of designs for primary side; Seismic designs for soil site & rocky sites, as applicable are some of the measures identified.

3.On LWR, Mr. Nikita Mazein outlined the Rosatom strategy as follows:

- Implement serial construction approach globally with commissioning of 13 units in 11 years.
- Successful implementation of Kudankulam NPP 1 &2 has paved the way for localisation of manufacturing in India for Russian design NPPs and general frame work agreement signed for unit 3,4,5&6.
- Prepared to proceed with the execution of six 1200MW VVERs of advanced design on another site with progressive localisation under "Make in India" programme.
- Ready to enlarge co-operation from project implementation to comprehensive strategiccollaboration in South Asia, Middle East &Sub Saharan Africa.
- Develop co-operation in non-power areas like Nuclear medicine.

4.On Indian PHWR, the main points made by captains of Indian industry are as follows:

- Indian industry has established the capability in terms of manufacturing and testing facilities; skilled manpower; qualification in quality standards (Indian and foreign- ASME, RCCM,EEPD) and is geared to execute the projects.

- Welcomed the "fleet mode implementation strategy" as the right step to meet the target of constructing 1.5 reactors per annum and emphasised that the speed of implementation would call for strengthening of skilled manpower at NPCIL too for quick clearance of quality check points, mandatory hold points and other intermediate checks.
- Industry is ready to incur further capex to expand / upgrade the facilities and has welcomed the self-certification strategy.
- Continuity of orders is a must for achieving international levels of productivity alongwith cash neutral payment terms.
- Good price discovery is a good strategy but needs to be completed expeditiously.
- Suggestions were made that for the success of the fleet mode implementation, creation of the centres of excellence for technology intensive equipment development for the primary side followed by establishment of EPC model based system engineering.

III

RECOMMENDATIONS/ TAKEAWAYS FROM SESSION ON "NUCLEAR ENERGY APPLICATIONS IN MEDICAL & AGRICULTURE

Distinguished Speakers

Mr. S A Bhardwaj
Chairman, AERB

Dr. Harsh Mahajan
Founder & Chief Radiologist, Mahajan Imaging

Dr Sarbani Ghosh Laskar
Professor & Radiation Oncologist, TATA Memorial Centre

Dr Sudeep Gupta
Professor & Medical Oncologist, TATA Memorial Centre

Dr V P Venugopalan
Associate Director (A), BSG, BARC

The session was chaired by Shri S A Bharadwaj Chairman, AERB and facilitated by Mr. V P Singh Convenor/ Nuclear, IEF.

- The wide spread applications of radiation technologies for the benefit of society were very much appreciated. Dessimination of knowledge in this regard as a part of public outreach strategy would certainly dispel misgivings of Nuclear Energy and Radiation from the public mind.
- It was recommended that these aspects of Nuclear energy be made part of school curriculum.
- Diagnostic applications of nuclear technology including nuclear medicine; nuclear imaging; cardiac imaging; PET/CT- and to metabolic imaging were explained in detail.
- Medical applications of radiation therapy (use of electro magnetic rays for the treatment of malignant & non- malignant conditions) were explained in detail. Nearly 11,57,294 cancer cases are there in India. Cancer incident (ASR) in India is 89.4 per 100,000 & cancer deaths at 61.4 per 1,00,000.
- Medical applications of radio isotopes- for therapeutic use and diagnostic in- Vivo imaging were highlighted.
- There is need to achieve maturity in indigenous technology in production of certain advanced medical equipment like LINAC,s etc. in the country.
- A detailed presentation on applications of Nuclear techniques in Agriculture was made. Induced mutation and biotechnology would continue to improve the crops and their yield towards food security of the country. Radiation is being used for large scale control of agricultural pests avoiding the use of harmful chemicals. Radiation based technologies can be used to reduce post-harvest losses significantly.
- In short ionising radiation sources are driving changes in a big way towards a progressive and healthier nation.

IV
RECOMMENDATIONS/ TAKEAWAYS FROM THE SESSION ON "LONG TERM PERSPECTIVE OF NUCLEAR POWER"
Distinguished Speakers

Dr S Banerjee
Former Chairman
AEC & Former
Secretary, DAE

Dr A B Mukherjee
Rajaramana Fellow &
Former Director
RPG, BARC

Mr. Keith Collett
CEO, Nuvia UK &
Deputy Mg
Director,
Nuvia Group

The session was chaired by Dr. S Banerjee Chairman of the steering committee, 10th Nuclear conclave & chairman of Nuclear Group, IEF.

1.Speaking on the Indian LWR Christened as Indian pressurised water reactor (IPWR) project, Dr. A B Mukherjee explained that the development of IPWR is based on the expertise available on design, construction and operaton of PHWRs, operating experience gained from the existing BWRs in India, the well establishedfuel fabrication technology in India and the expertise available for the development/ making of critical equipment indigenously.

2.Only the nuclear island is different, involving reactor pressure vessel, control rod drive mechanism, fuel etc: The design of steam generator and beyond will remain the same and can be adopted from the PHWR technology.

3.IPWR- Salient safety features include
- Passive heat removal under prolonged black out.
- Aircooled elevated DG set
- 4 independent trains of engineered safety systems with independent power source.
- Philosophy of severe management accident

- Hydrogen mitigation
- Containment pressure management
- Core catcher

4.IPWR- plant specifications
Reactor thermal output: 2700 MW Thermal
Design temperature/ pressure: 350°C/ 17.7 Mpa
Service life: 60 years.

Mr. Keith Collett CEO Nuvia UK & Dy. Mg. Director Nuviacorp spoke on the UK experience in supply chain management for advanced reactors relevant to India.Nuvia the nuclear part of VINCI has a global revenue of 358 m□, workforce 2700, supports full life cycle of nuclear power plant & Medical equipment using nuclear energy. Nuvia India covers new build, plant life extension, operations, Health physics, waste management. Nuvia UK is associated with the new nuclear build in UK with NPP's being set up at Hinkley points site- EPR, Wylfa site- ABWR, Moon site.
Speaking on the UK supply chainexperience relevant to India's new build programme, he mentioned the following points/ issues to be taken care of

- Develop supply chain responsive to different reactor types- LWR, Fast Reactor & future requirements.

- Integration of overseas rector designs with local regulatory requirements & design requirements-EPR, AP 1000, VVER & understanding RCCM, ASME & GOST.
- Expanding nuclear skilled work force
- Partnership between organisations to leverage their experience, training & value maximising.

Dr. S. Banerjee spoke briefly on the FBR & LWR programme as a part of the long-term perspective plan. He referred to the spirit with which Atom for peace programme was started way back in 1950 when world dreamt of nuclear energy as a sustainable source of energy for centuries. India too announced its 3 stage programme in 1955 as it had limited uranium and availability of abundant thoriumwhich has the potential of bringing about the energy independence of the country in the long term. India adopted the closed fuel cycle for the effective utilisation of the reserve of both fissile and fertile materials. The closed fuel cycle with partitioning of long lived transuranic radioisotopes also ensures a very significant reduction in the radioactive waste burden. The fast reactor programme, essential for the rapid conversion of fertile materialsinto fissile, U-238 to Pu -239 and Th-232 to U-233, will enable India to have adequate inventory of fissile materials to embark upon a large-scale utilisation of thorium.In orderto fast pace the three stage programme, the growth in the first stage needs to be expediated and more of fast breeder reactors need to be installed. In the immediate future PHWRs,LWRs and FBRs will work in tandem not only for generating nuclear power but also producing U-233 for securing energy supply for centuries.With India endowed with solar energy and thorium resources, electricity and hydrogen required in the energy economy of the future can be ensured.

Compiled by
V P Singh, Convenor/ Nuclear
IEF & Convenor
Steering Committee, 10th Nuclear Energy Conclave

Edited By
Dr. S. Banerjee Chairman
Nuclear Group, IEF, Chairman 10th Nuclear Conclave,
Chancellor Homi Bhabha National Institute
(Formerly Secretary DAE & Chairman AEC)

PROGRAMME

9.00 a.m. – 10.00 a.m. Registration and Networking Tea

10.00 a.m. – 11.30 a.m. Inaugural Session

- Introductory Remarks by **Shri V P Singh**, Convenor, Nuclear, IEF &Former ED, BHEL
- Welcome Address by **Shri Anil Razdan**, President, IEF & Former Secretary, MoP,GoI
- Theme address by **Dr. Srikumar Banerjee**, Chairman Nuclear Energy Group, India Energy Forum and Chancellor HomiBhabha National Institute (Former Chairman, Atomic Energy Commission and Secretary, Department of Atomic Energy)
- Special Address by **Prof Raman Srikanth**, Professor and Head, Energy and Environment Programme, National Institute of Advance Studies on "Primary Energy Sources: Nuclear and Solar"
- Keynote Address by **Dr K N Vyas**, Chairman, AEC & Secretary, Department of Atomic Energy
- Inaugural Address by the **Chief Guest ,Dr Jitendra Singh**, MoS (I/C) for DoNER, MoS in Prime Minister's Office, Deptt of Personnel and Training, Deptt of Space and Atomic Energy
- Vote of Thanks by **Shri Amarjit Singh MBE**, Secretary General, India Energy Forum

11.30 – 11.45 a.m. Tea Break

11.45 a.m. – 1.15 p.m. **Roundtable on Growth of Nuclear Power**

Chairman: **Shri S K Sharma**, CMD, NPCIL :Fleet Mode Implementation

Distinguished Panelists

PHWR andLWR

- **Shri Nikita Mazein**, SeniorVicePresident, Rosatom Overseas
- **Shri Anil Parab**, Executive Vice President, Larsen & Toubro Ltd (Equipments)
- **Shri G K Pillai**, MD & CEO, Walchandnagar Industries Ltd.
- **Shri Kaustubh Shukla**, COO, Godrej & Boyce Mfg. Co. Ltd.
- **Shri P P Yadav**, Executive Director - Nuclear Business Group, BHEL
- **Dr S Kalirajan**, Head - Special Initiatives (Nuclear-LWR), L&T Construction

Facilitator: **Shri S M Mahajan**, Former ED, BHEL and Advisor (Power &Mfg)

1.15 pm -2.00 pm Lunch Break

2.00 p.m. - 3.00 p.m. **Session I:Nuclear Energy Applications in Medical and Agriculture**

Chairman: **Shri S A Bhardwaj**, Chairman, AERB

Distinguished Speakers

Medical

- **Dr Harsh Mahajan**, MD, Founder and Chief Radiologist, Mahajan ImagingFormer National President of Indian Radiological and Imaging Association (Diagnostics)
- **Dr Sarbani Ghosh Laskar,** Professor and Radiation Oncologist, TATA Memorial Centre (Medical Application of Radiotherapy)
- **Dr Sudeep Gupta**, Professor and Medical Oncologist, TATA Memorial Centre (Medical Application of Radioisotope Technology)

Agriculture

- Dr V P Venugopalan, Associate Director (A), BSG, BARC

Facilitator: **Shri VP Singh**, Former ED, BHEL

TEA WILL BE SERVED ON THE TABLE

3.00 p.m. – 4.15 p.m. **Session II: Long Term Perspective of Nuclear Power**

Chairman: **Dr S Banerjee**, Former Chairman, AEC and Former Secretary, DAE

Distinguished Speakers

- Dr A B Mukherjee, Rajaramana Fellow &Former Director RPG, BARC (Indian LWR)
- ShriKeith Collett, CEO, Nuvia UK & Deputy Mg Director, Nuvia Group (Challenges in Supply Chain Management for Advanced Reactors – the UK Experience)

Summing Up and Vote of Thanks by **Shri S M Mahajan**, Former ED, BHEL and Advisor (Power &Mfg)

Glimpses


Nuclear Energy Conclave


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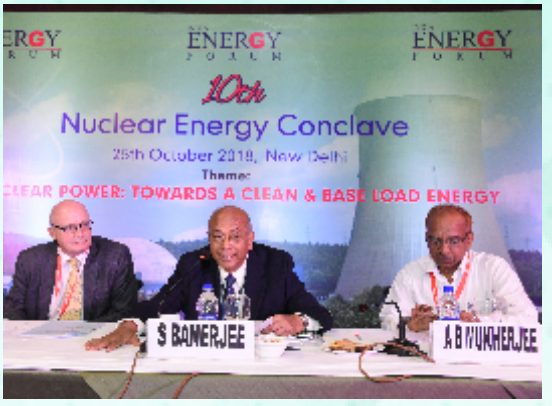
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