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INDIAN NUCLEAR SOCIETY

INS News Letter

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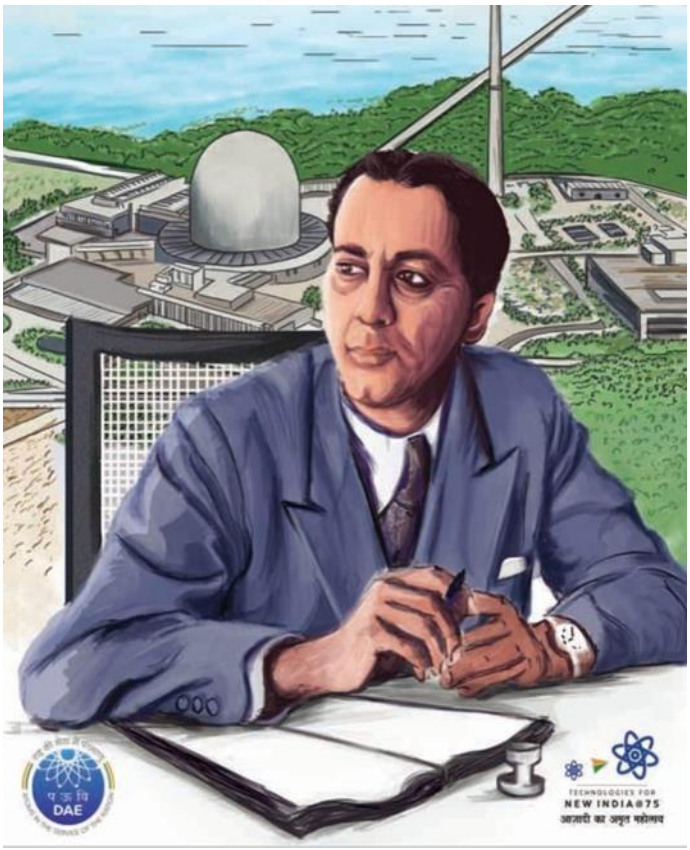

Dr Homi Jehangir Bhabha
(30 Oct.1909 - 24 Jan.1966)
Indian Nuclear Society dedicates this issue of Newsletter to the Founding Father of INDIAN NUCLEAR PROGRAMME
(Picture:Courtesy Public Awareness Division, DAE)

Contents

From Editor's desk:

Global leaders will descend on Glasgow (UK) to participate in a summit entitled " UNITED NATIONS CLIMATE CHANGE OF the PARTIES , 26th iteration (COP-26) during 31st Oct.-12th Nov., 2021 to deliberate on the progress and measures to cut carbon emissions to meet the targets set by IPCC. **It appears there is a slow realisation around the world that it overreacted aftermath of the FUKUSHIMA accident.** It is almost impossible to meet the time line of reducing global emissions to half by 2030 and zero emission (complete carbon neutrality) by 2050 without reliance on nuclear power. Salient features of nuclear power like 24X7 base load reliability and very low carbon foot print

Happy Deepawali

and the fluctuating price of gas and oil has made many opinion makers in the west to raise their concern against myopic decision of curtailing nuclear power without realising its long term implications. Among EU nations, Germany has been the most aggressive in pursuing a renewable energy future by shutting down its nuclear power stations under its Energiewende (energy transition) plan. It has been investing hugely on wind and sunlight. But last month, it woke up to the reality that even after investing half a trillion dollars on the plan, it does not have the capacity to store enough weather-dependent clean power to hold out even for a few fossil-fuel-free hours. Meanwhile, Germany's household-sector electricity price is the highest in the EU: $0.37 per kilowatt-hour (KwH). In France, it's $0.13. In 2019, Germany emitted 350 grams of carbon dioxide for every KwH generated. France emitted 56 grams, six times less. Power in France is much cheaper and cleaner simply due to its reliance principally on Nuclear Power. Last month, the GOI announced that India would triple its nuclear power capacity in the next 10 years. All efforts should be made to achieve this target. There are reports that AERB may play more active role to grant green nod to strategic nuclear power plants which can expedite the projects

This NL issue has an interesting article on Radiation Processing of Food by Dr Arun Sharma .There has been hesitancy to accept irradiated food and it is important for INS fraternity to explain to general public, in the words of author, "Exposing food to radiation, and getting self exposed to radiation, are akin to cooking food on fire, and getting fingers burnt in fire." Statement by Shri K. N. Vyas Chairman, Atomic Energy Commission and Secretary, Department of Atomic Energy of India at 65th General Conference of IAEA Vienna, Austria, September 22, 2021 briefly describes the present status of various programs of DAE. INS would like to thank Shri Steven P. Nesbit, President American Nuclear Society (ANS) who wrote a column for our Newsletter. He mentions how a discussion organized by younger ANS members could stir a public debate on the premature closures of two nuclear power plants in the state of Illinois and save them from closure. INS team comprising Shri R.Mago and Shri S.P.Dharne interviewed CMD, NPCIL on the future of nuclear power in India. A Brief Report on World Nuclear Association (WNA) Symposium 2021 has been prepared by Dr. A. Jayaraman .

It is heartening to learn that India has crossed 1000 million mark for vaccination and is vaccinating about 10 million adults every day. There is sustained decline in the COVID-19 cases and normalcy is returning gradually in different walks of life. I am very happy to share the news that Apsara-U reactor attained the rated power of 2 MW on 8th October, 2021. INS too has been able to initiate new activities during the last few months. As a part of celebrations of **Azadi ka Amrit Mahotsav**, INS announced a Poster / Cartoon Competition for the families of INS / DAE members to involve them actively in spreading the message that Nuclear is safe, environmentally friendly and beneficial to society. We express our gratitude to the participants for their overwhelming response and convey hearty congratulations to the winners of the event (Details are given in INS round up). A new beginning has been made to co-organise INS Webinars with reputed educational institutes to create awareness about the important role of Nuclear Science in young generation. **INS congratulates Dr Rajendra Badwe (who delivered 7th INS Webinar on Oct.9,2021) for being conferred Nelson Mandela Nobel Peace Award.** Cross word is a regular feature of NL and it is encouraging to see the response of members. I once again urge members to give their feedback on various features of NL and send their suggestions to editor at insvkmeditor@gmail.com.

Vijay Manchanda

Statement by Shri K. N. Vyas, Chairman, Atomic Energy Commission and Secretary, Department of Atomic Energy of India

At 65th General Conference of IAEA

Vienna, Austria, September 22, 2021

Mr. President, Excellencies

Ladies and Gentlemen, Good morning to you all.

1. I take this opportunity to convey on behalf of the people of India and Government of India warm greetings to the International Atomic Energy Agency (IAEA) and the Member States on the occasion

of the 65th General Conference. It is indeed an honour for me to be representing India at IAEA.

Mr. President,

2. Please accept congratulations from all of us on your election as President of 65th General Conference. We also welcome Saint Christopher (Saint Kits) and Nevis as new member of IAEA.

3. The COVID-19 pandemic has adversely affected all of us but despite these impediments, substantial progress has been achieved by the Department of Atomic Energy (DAE). DAE continues to strive towards developing technologies which provide immense value and benefits to industry and society.

4. Over the last six and half decades, the growth of IAEA and India's nuclear energy programmes have evolved side by side. India reiterates assigning its primacy to the IAEA for its central role in the promotion of peaceful uses of atomic energy for the development &prosperity of mankind while maintaining its due support to Safeguards even in the pandemic periods.

Mr. President,

5. I am happy to inform that last year, Narora Atomic Power Station has set a fresh record of 852 days of continuous operation. This is the 37th occasion that one of our reactors has operated continuously for more than a year. We have a cumulative record of about 551 reactor-years of safe operation. Even during the pandemic, our Nuclear Power Plants have operated optimally, and we have continued to maintain a fleet capacity factor of around 85% throughout the year.

6. On the projects front, the first of indigenous 700 MWe Pressurized Heavy Water Reactor (PHWR), Kakrapar Atomic Power Plant-3 was successfully synchronized with the grid on 10, January 2021.

7. The construction of Kudankulam Nuclear Power Plants {KKNPP 5 & 6 (2x1000 MWe) reactors}, being set up in cooperation with the Russian Federation, have commenced with the First Pour of Concrete on June 29, 2021.

8. As a part of the nuclear power capacity addition programmed, considerable progress has been made for setting up 10 indigenous 700 MWe PHWRs in fleet mode. Discussions with M/s. EDF of France for setting up NPPs at Jaitapur and M/s. Westinghouse Electric Company of the USA for setting up NPPs at Kovvada are progressing satisfactorily.

Mr. President,

9. I will also mention a few key developments related to non-power applications.

10. Bhabha Atomic Research Centre (BARC) has developed an Indigenous Carrier free Yttrium-90-acetate and Ruthenium-106 plaques for cancer diagnosis and treatment.

11. BARC has also developed two new radiopharmaceuticals 90-Yttrium-hydroxyapatite (90Y-HA) and 177-Lutetium-hydroxyapatite (177Lu-HA) which shall serve as effective and economical treatment for the management of joint related disorders.

12. Board of Radiation and Isotope Technology (BRIT) has developed HYNIC-RGD cold kits (for Technetium-99m) towards early diagnosis of malignant tumours.

13. At the Variable Energy Cyclotron Centre (VECC), a major milestone in the country's first K500 Superconducting Cyclotron has been achieved by accelerating and extracting the first harmonic, 252MeV Nitrogen4+ beam (i.e., 18MeV/nucleon). This is currently the highest beam energy available in the country for experiments in nuclear physics and other researches.

Mr. President,

14. Tata Memorial Centre (TMC) has not only been at the forefront of enhancing the cancer treatment facilities in the country but also played an important role in the nation's fight against the pandemic. TMC has supported over 100 hospitals in India with oxygen concentrators, oxygen generation PSA plants, PPEs, N95 masks, monitors and ventilators. TMC has initiated CAR-T cell therapy for the first time in India. This has brought down the cost of treatment from Rs 40 million to Rs 2.5 million.

Mr. President,

15. Indira Gandhi Centre for Atomic Research (IGCAR)in collaboration with BARC has successfully developed and demonstrated a process for magnetic pulse welding of stainless-steel grade 316L(N) end-plug with ODS alloy thin-walled fuel cladding, to overcome issues related to loss of creep strength of the alloy in fusion welding processes.

16. Despite the prevailing pandemic, Global Centre for Nuclear Energy Partnership (GCNEP)conducted several virtual meetings in areas related to Cyber-security and security of radioactive sources. GCNEP has also signed an MoU with Ghana in July 2021, thus reinforcing India's collaboration in training and capacity building.

17. DAE has continued to make substantial contributions to the mega science projects, viz. CERN (ALICE, CMS, WLCG), ITER, LIGO, SKA, etc. through its aided and R&D institutes.

18. Atomic Energy Regulatory Board (AERB) continued to participate in the activities of IAEA, NEA and other bilateral arrangements through virtual platforms. AERB has participated in review of the draft IAEA reports on Nuclear Safety Review 2021 and Nuclear Technology Review 2021. AERB has also continued to enrich itself with information on the effect of COVID-19 on Nuclear Installations worldwide and the preventive and corrective measure taken by different installations.

Mr. President,

19. We thank the city of Vienna, and the people and the Government of Austria, for hosting the IAEA, with the warmth and commitment of a gracious host. India looks forward to IAEA's continued leadership for fostering safe, secure, and sustainable use of nuclear energy in the future. India will continue to support IAEA in all its endeavour.

We wish the 65th General Conference a grand success.

DAE News Brief

Second indigenous ballistic missile submarine: Powerful case for Aatma Nirbhar Bharat

The second indigenous ballistic missile submarine, the 'S3' (earlier called the Arighat), will be commissioned shortly. It is the largest, most sophisticated platform to be built within the country. The 110-metre-long 'S3', the second unit of the Arihant class of four SSBNs (Ship Submersible Ballistic Nuclear), equals the displacement of four Scorpion class conventional submarines built by the Mazagon Docks Ltd. The 'S3' began harbour trials sometime in 2020 and could head out for sea trials sometime in 2021. The 'S3' will form part of India's Strategic Forces Command, which controls India's nuclear deterrent. It carries an arsenal of 12 K-15 short-range SLBMs (submarine-launched ballistic missiles), which have a range of 1,000 km or four K-4 medium-range SLBMs, which have a range of 3,500 km.

https://www.indiatoday.in/india-today-insight/story/vikrant-nuclear-submarine-commissioning-to-ring-in-75th-independence-anniversary-celebrations-1838057-2021-08-08

BAU Releases High Yielding Seeds

Eleven high-yielding, early-maturing and disease-pest resistant crop varieties developed by scientists of Birsa Agricultural University (BAU) have been released by the Jharkhand Government. These varieties include one each of black gram, pigeon pea, soybean, mustard, baby corn, ragi, two of brinjal and three of linseed. These varieties have a yield advantage of 15 to 20 per cent over the existing traditional varieties.

Birsa Bhabha Mustard-1, developed in association with Bhabha Atomic Research Centre, has bold seed with 40 percent oil content. Average yield potential is 14.9 q per ha and matures in around 112-120 days.

https://www.dailypioneer.com/2021/state-editions/bau-releases-high-yielding-seeds-after-years----long-research.html

Atomic Minerals Directorate Looks for Lithium in Karnataka, Rajasthan

The Atomic Minerals Directorate for Exploration and Research (AMD), is carrying out exploration for lithium in potential geological domains in parts of Karnataka and Rajasthan. Preliminary surveys on surface and limited subsurface exploration have shown presence of lithium resources of 1,600 tonnes (inferred category) in the pegmatites of Marlagalla –Allapatna area, Mandya district, Karnataka.

The global demand for lithium is expected to increase more than double to 117,400 mt by 2024 from an estimated 47,300 mt in 2020, due to an increase in electric vehicle battery production. The Government has approved the manufacture of Advance Chemistry Cell (ACC) batteries in the country with an outlay of ₹18,100 crore over five years. The scheme envisages establishing a competitive ACC battery manufacturing set up in the country (50 Giga Watt hours).

https://www.thehindubusinessline.com/news/atomic-minerals-directorate-looks-for-lithium-in-karnataka-rajasthan/article35890816.ece

Recycling e waste to recover valuables

The compound annual growth rate of e-waste is 30%, with estimated annual generation of 5.2 million tonnes of e-waste . On one hand this is a serious environmental concern due to heavy metal toxicity, on the other hand it is a promising urban mine and can become a resource of valuable metals. In recent years recycling of e-waste is considered for recovery of valuable (medals in 2020 Olympics at Japan were produced by this route) as well as hazardous metals. One of the major e-waste sources is Printed Circuit Boards (PCBs) from spent electronic accessories, which contains about 10-20% copper by mass. Copper oxide nanoparticles are employed in sensors and solar cells, anti-microbial and anti-fouling coatings, electrochemical energy storage, heterogeneous catalysis and rocket propulsion. A process for the production of copper oxide nano particles (purity >99.9%) from printed circuit boards (PCBs), using indigenously developed polymeric resin is developed for the first time by Hydrometallurgical Section, MPD and ChED, BARC. The major steps are leaching, selective metal sorption/ desorption by functionalized polymeric resins, precipitation and filtration of the product for final drying and packaging of CuO nanoparticles along with PbS and Sn-oxide as by-products.

https://technologies.britatom.gov.in/technology/Cu%20selective%20polymeric%20resins

ANUSUCHAK: Dongle for real time detection of elevated levels of gamma radiation

Bhabha Atomic Research Centre has developed a novel radiation detection dongle - ANUSUCHAK, for the real time detection of elevated levels of gamma radiation. It is based on a silicon PIN detector for achieving small size and low power/low voltage operation. It is implemented adopting an approach to provide desired performance at very low-cost enabling mass production for the deployment over a large scale. ANUSUCHAK is simple to use without any special training. It is interfaced with a USB 2.0 interface to a smart phone or PC/ Laptop to enable recording of data in real time for visualization and for transfer to a control room or emergency response center. The recorded data is linked to GPS coordinates of the location with an indication on Google Map.

http://barc.gov.in/technologies/anusuchak/index.html

HDR Brachytherapy system Karknidon-I

HDR Brachytherapy system Karknidon-I is a single source 20 channels afterloading device developed for safe, accurate, and cost-effective intracavitary treatment of cancer. It involves a miniature Ir-192 source of radiation being temporarily positioned into the body very near to malignant tumor. The source is placed directly into or very near to the tissue where treatment is required through the applicator. The use of the system is in Medical Oncology area.

http://www.barc.gov.in/technologies/karknidon/index.html

High Quality Respiratory Face Mask

Reliable face masks, having features like high filtration efficiency with respect to sub micron sized particulate matter, comfortable breathing, low cost etc. are in huge demand due to Covid-19 pandemic, having highly contagious virus spread. BARC has developed a High Quality Respiratory Face mask using indigenously developed glass filter media (HEPA) which serves as an import substitute and is a step towards Atmanirbhar Bharat.

http://barc.gov.in/technologies/r_mask/index.html

Compiled by

A.Rama Rao and Vijay Manchanda

Radiation Processing of Food - Current Status

Abstract

The word radiation is commonly linked with the destructive power of atom. Some myths and misconceptions are genuine, but some are propagated by vested interests. Lay public fails to comprehend the difference between the process of irradiation, and radioactivity as a food contaminant, as in aftermath of accidents like Chernobyl and Fukushima. It is important to understand that exposing food to ra-

diation, and getting self exposed to radiation, are akin to cooking food on fire, and getting fingers burnt in fire. It is also important to inform the public about the inbuilt safety features of radiation processing facilities that prevent any human exposure to radiation

Historical perspective

Dr. Homi Jehangir Bhabha, the founding father of the Indian atomic energy program, had visualized the role atomic energy would play in uplifting society through its peaceful applications. Dr. Bhabha had foreseen the potential of atomic energy as germicidal and preservative properties of X-rays and gamma rays had been discovered near the start of the century. He brought in the state-of-the-art machinery and equipment including the cobalt-60 Food Package Irradiator, and a portable cesium irradiator, making BARC one of the most advanced R&D centers in this field in this part of the world. After the unfortunate demise of Dr. Bhabha in 1966, the successive Chairpersons of AEC, and Directors of BARC carried forward his legacy, and made sustained efforts to bring peaceful uses of atomic energy (including radiation processing of food) in public domain for the larger benefit of the society.

Food irradiation

Food irradiation is a physical process in which food or agricultural commodities, pre-packaged or bulk, are exposed to controlled doses of ionizing radiations to achieve desirable technological objectives. The broad objectives are to strengthen food security, to ensure food safety, and to enable market access. These are accomplished by the benefits of radiation such as inhibition of sprouting in stored tubers and bulbs, delay in ripening and senescence in fruits and vegetables, killing of insect pests in stored commodities, destruction of parasites, spoilage microbes, and pathogens of public health importance, and elimination of quarantine pests and pathogens in exportable commodities. Radiation technology also offers several advantages. It is a physical, non-additive process that causes minimal change in food. It is more effective compared to chemicals and fumigants. Being a cold process, it preserves food in its natural form and does not leave harmful residues. The process is safe to workers and also eco-friendly.

Sources of ionizing radiation

Radioisotopes

Ionizing radiations permitted for food processing include gamma rays produced by radioisotopes cobalt-60 or cesium-137, or high energy electrons or X-rays produced by electron beam (EB) machines. Globally, cobalt-60 is used as the main source of gamma radiation. It emits two photons of energy 1.33 MeV and 1.17 MeV. India and a few other countries have indigenous capacity to produce cobalt-60 and cesium-137. Though cesium-137 is useful in making portable food irradiators because of its long half life and the lower energy (0.66 MeV) of its gamma rays, it is hardly used anywhere in the world for food processing. Besides,Cesium-137 is a byproduct of spent fuel reprocessing, and many countries have a moratorium on fuel reprocessing.

Machine sources

Machine sources permitted are the EB accelerators, both DC and microwave or radio-frequency linear (LINAC) accelerators. In an accelerator, electrons are accelerated close to the speed of light in an evacuated tube. A scanning magnet at the end of the tube directs the mono-energetic electrons on to the product. In a LINAC, pulses of electrons produced at the cathode are accelerated along the tube by radio-frequency waves. As the electrons are directed straight at the product, the efficiency is about 20% higher than that of gamma sources. Energy and current determine the throughput capacity. Electrons of energy 10 MeV or below are permitted for food processing. Because of the lower depth of penetration (~5 mm/ MeV in water), EB cannot be used on thicker packages. This difficulty is overcome by converting electrons into X-rays by striking them on a high Z target such as copper or tungsten in a converter assembly placed at the end of the scanner. The conversion efficiency of electrons to X-rays depends on the material of the converter plate and the energy of the striking electrons. X-rays up to 5 MeV are permitted for food processing, but many countries including India allow X-rays up to 7.5 MeV with the use of a tungsten target. The X-rays are as penetrating as gamma rays.

Engineering features

The heart of an irradiator is an irradiation cell within a biological shield. The thickness of the cell's

walls and roof are designed to prevent any escape of ionizing radiation outside the cell. The cell houses the source of radiation which is either cobalt-60 or EB. In case of cobalt-60, the cell also has a 6-7-meter-deep pool containing water for safe storage of cobalt-60 source. Water acts as a shield for the stored source which can be raised or lowered in and out of the pool using a source hoisting/ lowering mechanism. This allows controlled access to service personnel. Being switch on / off types, the EB/ X-ray sources do not require water pool, A schematic of a typical gamma plant is shown in **Fig. 1.**

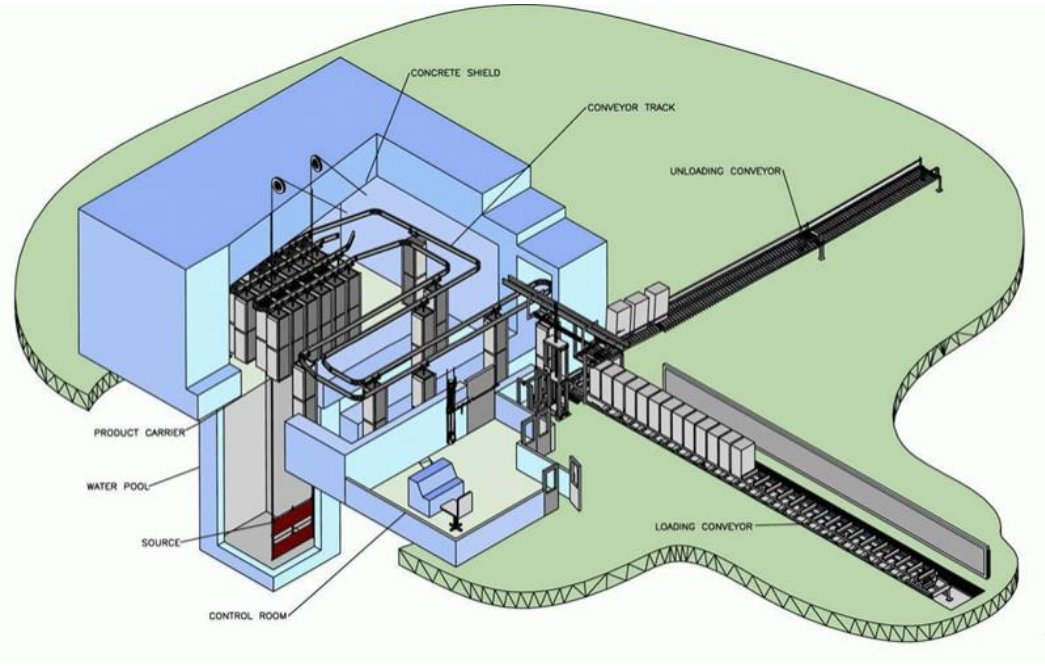

Fig. 1. A cut out of a typical gamma irradiation plant (Source RPP TECDOC,2014)

Both batch and continuous type irradiator designs are available for commercial food processing. The continuous irradiators have a labyrinth or a maze through which the product is conveyed in and out of the irradiation cell using roller or slat or monorail conveyors. A pre-determined time spent by the product inside the irradiation cell, called cycle time, determines the dose it receives. In batch irradiators, the labyrinth is not needed, since irradiation is interrupted while the products are taken in and out of the irradiation cell. A SCADA (Supervisory Control and Data Acquisition) system is used to control the process. The plant is designed as per the safety standards prescribed by the Atomic Energy Regulatory Board.

Move to machine sources

World industry experienced difficulties inherently associated with the use of cobalt-60. Its availability is constrained by the availability of power reactors, and the willingness of the operators to allow adjuster rod positions for irradiating cold cobalt-59, and the resultant impact on power factor. Further, the reactor produced cobalt-60 needs a qualified facility for turning into source pencils of desirable dimensions for use in irradiator. Also, production and handling of radioisotopes need trained manpower, and costs man-rems. After it is installed, cobalt-60 continuously decays, and needs replenishment at regular intervals to keep up with the plant's throughput. The other difficulty is that only shippers registered with the nuclear regulator can transport cobalt-60 as per approved protocols. The decayed pencils returned by the users to the original supplier also need long term safe storage. International terrorism added another dimension to the safety and security of cobalt-60, that is its potential as a 'dirty bomb'. Because of this risk IAEA, the U.S. National Nuclear Security Administration (NNSA), and the U.S. Defense Threat Reduction Agency (DTRA) advise limiting commercial use of radioisotopes.

Above drawbacks of radioisotopes are slowly weaning away the industry towards EB machines that use electricity. They can be easily turned off when not in use, unlike radioisotopes which emit radiation all the times. It has also major implications in terms of operating costs, worker safety, and the carbon footprint. In India early experimental work on EB food processing was carried out at Mangalore University (Microtron). Later a number of studies were carried out using ILU6 (BRIT, Vashi), the LINACs at EB Centre, BARC, at Kharghar, and at RRCAT,Indore. However, till now there is no commercial technology demonstration plant for EB food processing in India.

High dose applications

Radiation processing can be broadly divided into high dose and low dose application. High dose applications that use doses above 10 kGy include commercial sterilization of spices, herbs and Ayurvedic products. Doses 25 kGy or above are used for sterilization, also known as radappertization (named after Nicolas Appert, discoverer of canning) of certain foods, medical and healthcare products. Radiation Processing Plant (RPP), Vashi was the first commercial technology demonstration plant established by DAE. The plant was designed for 1 MCi of cobalt-60, with a capacity to process 32 tons/ day of spices. It showcased commercial viability of gamma Irradiators for food processing and was commissioned on January 1, 2000.

Low dose applications - Advent of split source design

Most agricultural produce require doses below 1 kGy going down to 0.1 kGy for sprout inhibition. The ratio of low and high dose is typically 1:250. Thus it is nearly impossible to deliver low doses in a facility designed to do high dose applications, primarily because of the challenge of matching conveyor speeds. To overcome this difficulty a clever alternative has been developed. The source pencils are placed in two racks in the pool, one small rack, with less number of low activity pencils, and the other large rack, with a higher number of high activity pencils. For high dose irradiation both the small and large racks are lifted in a rack-in-rack configuration, and for low dose applications only the small rack is lifted. So split source irradiators are multitasking and can do both high dose and low dose irradiation. Food Package Irradiator in FIPLY has this source configuration.

A Potato and Onion (POTON) irradiator was proposed by FTD, BARC under the IX plan project for demonstrating low dose applications on agricultural produce. The facility was designed to hold 300 kCi of cobalt-60 with a capacity to process 10 tons/ h of onion. It has a mono-rail conveyor carrying hanging containers each designed to receive product boxes carrying 200 kg of material, in sacks or cartons, to the irradiation cell. POTON was later renamed KRUSHAK an acronym for 'Krushi Utpadan Sanrakshan Kendra'. The facility is located midst the onion bowl of the country, Lasalgaon (Nasik), and was dedicated to nation by the late Prime Minister Shri Atal Bihari Vajpayee in 2002. In 2006 the facility was refurbished for phytosanitary treatment and received approval of the US Department of Agriculture, Animal & Plant Health Inspection Service for export of irradiated Indian mangoes to USA. Currently it is being run by a private operator.

Safety and regulatory approvals

Foods processed by ionizing radiation have been subjected to a thorough assessment for its safety and wholesomeness, nationally and internationally. In 1981 WHO/FAO/IAEA Joint Expert Committee on Food irradiation pronounced that consumption of irradiated food poses no risk to human health. Thereafter, in 1983 FAO/WHO Codex Alimentarius Commission (CAC) adopted a General Standard for Irradiated Foods that was again revised in 2003. Soon after the World Trade Organization (WTO), International Plant Protection Convention (IPPC), and the International Office of Epizootics (OIE) also endorsed irradiation as a phytosanitary tool.

Food Irradiation Processing Laboratory (FIPLY) at Trombay, housing the Food Package Irradiator, and the portable cesium irradiator was commissioned in 1967. The R&D work started in right earnest under the leadership of Dr A. Sreenivasan (the then Head, Biochemistry and Food Technology Division, BARC, and later Director, Cancer Research Institute, Mumbai) . The thrust was to test all Indian foods for their amenability to preservation by gamma radiation. After nearly a decade of hard work the techno-commercial feasibility of the process was also established. DAE started its efforts to get approval from the Ministry of Health, Government of India, in early seventies. However, the actual approval came only in 1994. On the regulatory front the Atomic Energy (Control of Irradiation of Food) Rules were notified in 1991, later amended in 1996. In 2004, the Ministry of Agriculture included irradiation in the amended Plant Quarantine (Regulation of Import into India) Order, 2003, enabling use of irradiation for overcoming quarantine barriers in international trade. The current Atomic Energy (Radiation Processing of Food and Allied Products) Rules, 2012, were notified repealing earlier rules. After establishment of the Food Safety & Standards Authority of India (FSSAI) under the Food Safety & Standards Act, 2006, the new regulations on radiation processing were notified under the Food Safety and Standards (Food Products Standards and Food Additives) Amendment Regulations, 2016.

Table-1. Classes of foods permitted in India for radiation processing

Class	Food	Purpose of Treatment	Technological dose range (kGy)	
			Min	Max
1	Bulbs, stem, root tubers	Inhibit sprouting, Microbial decontamination (under process)	0.02 2.0	0.2 5.0
2	Fresh fruits, vegetables (other than Class 1)	Delay ripening Insect disinfestation Shelf-life extension Quarantine application	0.2 0.2 1.0 0.1	1.0 1.0. 2.5 1.0
3	Cereals, their milled products, pulses, their milled products, nuts,	Insect disinfestation Reduction of microbes	0.25 1,5	1.0 5.0
4	Fish, aquaculture, seafood, their products (fresh or frozen)	Elimination of pathogens Shelf-life extension Control of human parasites	1.0 1.0 0.1	7.0 3.0 2.0
5	Meat, meat products including poultry (fresh, frozen), eggs	Elimination of pathogens Shelf-life extension Control of human parasites	1.0 1.0 0.3	7.0 3.0 2.0
6	Dry vegetables, spices, condiments, dry herbs, tea, coffee, co-	Elimination of pathogens Insect disinfestation	6.0 0.3	14.0 1.0
7	Dried food of animal origin	Insect disinfestation Control of moulds Elimination of pathogens	0.3 1.0 2.0	1.0 3.0 7.0
8	Ethnic foods, miscellaneous foods including RTC/RTE foods	Quarantine application Reduction of microbes Sterilization	0.25 2.0 5.0	1.0 10 25.0

The new regulations have approved radiation processing of food and agro commodities on generic food class basis **(Table-1).**

Further, as per Food Safety Standards (Food Product Packaging and Labeling) Regulations, 2011, the irradiated products need to be labeled with the 'Radura' logo. Licensed radiation processing facilities have to comply with the conditions of approval prescribed under the Atomic Energy (Radiation Processing of Food and Allied Products) Rules, 2012.

Global scene

Food Irradiation is a need based technology. In North America the technology is used as a tool for ensuring food safety, while in South America it is mainly used as a phytosanitary tool by countries including, Mexico, Brazil, Peru, Dominican Republic, Grenada, Ecuador and Colombia. In African region South Africa, Egypt, Ghana and Nigeria have food irradiation facilities. In the Asian region China is the major user of the technology. It also has the maximum number of facilities in the world (130 cobalt-60, and 46 accelerators based). The EB facility at Odessa port in Ukraine, earlier in USSR, that irradiated grain is reportedly relocated to China. Vietnam is the second largest user of the technology in this region. In July this year Food Safety Australia and New Zealand (FSANZ) permitted irradiation as a phytosanitary measure for all fresh fruits and vegetables. Commercial food irradiation facilities and the food commodities processed in the world are summarized in **Table-2.** Following establishment of technology demonstration plants by DAE, a number of units came up in private domain in different parts of India **(Table-3).**

Public perception

Several studies have shown that when industry and consumers are educated and made aware of the benefits of the technology and its safe use, there was a clear change in attitude, and even willingness to pay by the consumer for the value addition by irradiation. Radiation processing of fresh fruits and vegetables, spices, meat and meat products is being increasingly carried out to meet the requirements of

Table-2 - Commercial food irradiation facilities and the food commodities processed in the world

(Source: DIIF IAEA/ Carl Blackburn / T. Kume/ P. Gao, (Personal Communications) * 10 MeV, Multitasking/ R&D)

S. No.	Country	Quantity (Approx,T) /annum	Facilities		Main food commodities treated
			Gamma	EB* / X-ray	
1	USA	120000	19	24	Meat, spices, dry ingredients
2	Canada	1400	1	1	Meat, spices
3	Brazil	25000	4	2	Fruits
4	Mexico	170000	3	3	Fruits
5	South Africa	20000	3	2	Spices, honey
6	Egypt	600	1	0	Spices
7	Europe	5700	31	25	Spices, frozen frog legs, poultry
8	Russia	-	1	5	Spices, meat, vegetables
9	Australia	6000	1	1	Fresh fruits and vegetables
10	Bangladesh	145	1	0	Spices for export, pet foods
11	China	1000000	130	46	Garlic, spices, health foods, grains, chicken feet
12	India	12, 500	23	3	Spices, grains, pulses, mangoes, dry fruit ,pet food
13	Indonesia	650	1	2	Herbs, spices, general foods
14	Japan	3000	1	0	Potatoes
15	Republic of Korea	250	2	2	Dry vegetables, ginseng products, grains, seasonings, yeast
16	Malaysia	1100	4	0	Herbs, spices, processed foods
17	Pakistan	2000	2	1	Herbs, spices, mango, fruits and vegetables, dog food
18	Philippines	470	1	1	Herbs, spices
19	Sri Lanka	1	1	0	Herbs, spices
20	Thailand	1,500	3	0	Herbs, spices, mangosteen, processed foods
21	Vietnam	120,000	8	3	Fresh and frozen seafood, herbs, spices, grain, fresh fruits, pet food

quality and quarantine. In fact, today irradiated foods are available in several countries. No adverse reports have been filed by the consumers from these markets. More efforts are required to demystify food irradiation for public.

Table- 3 Gamma Irradiation Facilities in India

S.No	Name of Facility	Comm. Date
1.	Food Package Irradiator, BARC, Mumbai	1967
2.	ISOMED, BARC, Mumbai	1974
3.	SARC, SII, Delhi	1984
4.	Radiation Processing Plant, BRIT, Vashi	2000
5.	KRUSHAK, Lasalgaon	2002
6.	VIKIRAN, Kolkata	2004
7.	Sterico, Mumbai	2005
8.	Universal Isomed, Vadodara	2006
9.	Microtrol, Bengaluru	2006
10.	Agrosurg, Mumbai	2008
11.	Gamma Agro, Hyderabad	2008
12.	Jhunsons, Bhiwadi	2009
13.	InnovaAgri, Bengaluru	2011
14.	Hindustan Agro, Rahuri	2012
15.	Impartial Agro, Unnao	2014
16.	Gujarat Agro, Ahmedabad	2014
17.	Aligned Ind, Rewari	2015
18.	MSAMB, Vashi	2015
19.	Pinnacle, Ahmedabad	2018
20.	EM Ind, Vadodara	2019
21.	Avanti, Devas	2019
22.	Jamnadas Ind., Indore	2020
23	Solas Ind., Mathura	2020
24	Microtrol, Bawal	2021

Availability of affordable, safe, and wholesome food is basic to all human endeavors. India is among the world's largest producers as well as con-

sumers of food. Though the country is self-reliant in food production, ensuring its safe storage, transport and distribution across the length and breadth of the country still poses numerous challenges. India's technological needs are to ensure security, improve safety, as well as to get international market access for its food. Radiation processing integrated with efficient supply chain infrastructure can provide lasting solutions to above needs. The government has been very keen and supportive of the modern technological interventions including radiation processing in the food sector. This is evident from the continued R&D support, enactment of favorable legislations, policy backing, and even the subsidies the government has provided for radiation technology. Recently, government of India has announced further support for establishing food irradiation facilities in public private partnership mode under its Atmanirbhar Bharat program. This should provide impetus for accelerated growth of the technology in India.

Acknowledgement

This article is a tribute to the untiring efforts of all my past and present colleagues from FTD, and other divisions of BARC, who made immense contributions to the food irradiation program of the department. I thank Mr. Carl Blackburn, Food & Environment Protection Section, IAEA, Vienna, Prof. Tamikazu. Kume, Department of Nuclear Engineering Applications, Dalat University, Vietnam, and Dr. Peng Gao, Sichuan Institute of Atomic Energy, China, for their valuable inputs related to the global status of the technology, without which the article would have remained incomplete. I thank Dr. Vijay Manchanda, Editor, INS Newsletter for making very useful suggestions during review.

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Chairman & Managing Director, NPCIL, in Conversation with INS, News Letter Team

Nuclear power is gaining its foothold back in the arena of green power worldwide. Nuclear Power Corporation of India Ltd. (NPCIL), the lone nuclear power producer in India, entered its 35th year of formation on 17th September 2021. Driven by the urge of presenting this journey as well as the plans of NPCIL for future, the INS NL Team comprising of ***Shri Ravinder Mago and Shri Shashikant Dharne,*** *entered into a long conversation with* ***Shri Satish Kumar Sharma, CMD, NPCIL*** *on 24th September 2021. The excerpts of the conversation are presented here for esteemed readers of INS News Letter.*

At the outset, NL Team highlighted the achievements of NPCIL and Shri Sharma. Shri Sharma, is electronics engineer from 24th batch of BARC training school and has a vast experience in all phases of project implementation as well as station operation in the capacities of Station Director and Site Director at Rajasthan Rawatbhata site. He was inducted into NPCIL Board of Directors as Director (Operations) in 2015 and later elevated to the post of CMD, NPCIL on June 1st, 2016. Recognizing his immense contribution in the Indian Nuclear Power programme, INS awarded him the 'INS Outstanding Service Award' in 2014.

NPCIL, the only utility in India producing electricity by nuclear route, has the world's oldest operating Boiling Water Reactor at Tarapur Maharashtra Site, which has completed its Golden Jubilee in 2019 and still going strong. In 2000-2001, Unit1 of Kakrapar Gujarat site beat all the operating reactors in the

world to clock the best annual average capacity factor, thereby claiming the coveted 'Nuclear Excellence Award' by WANO. In 2018 Unit- 1 of Kaiga Generating station set the then world record of operating continuously for 962 days. NPCIL has also a distinction of bringing on stream, the First of a Kind 700 MWe Pressurized Heavy Water Reactor during the difficult times of COVID pandemic. NPCIL has performed a host of activities in a time and cost-effective manner, like EMCCR, EMFR, to quote a few. A big hand to NPCIL and DAE.

INS Team: Sir, the first and foremost thing which comes to mind is the 2008 Indo-US Nuclear Deal. Almost thirteen years have passed since signing the deal. What way this deal has helped India or the Indian power programme?

Shri Sharma: This is a unique arrangement between the two governments. It has opened the possibility of accessing the nuclear technology and material for India and particularly DAE and NPCIL. There is no need to reinvent the proverbial wheel every time. It boosts the co-operation between the countries and supports faster growth of the segment of our program based upon large size nuclear power plants

INS Team: Sir, can you give some examples where we have received either technology or materials or both from any country?

Shri Sharma: After this deal, discussions have been started with EDF France for acquiring six EPRs with 1650 MWe capacity each and with Westinghouse for AP1000 reactors. These discussions are progressing quite well. You will appreciate that projects of such complex nature take time to reach consensus. We are progressing to acquire these technologies and quickly add to the capacity along with our own, domestic PHWR technology.

INS Team: Did it help us in getting fuel and /or other things like technology?

Shri Sharma: Yes, now we are able to import fuel. It has become a routine commercial deal. However, the owner of fuel is DAE and we get it for use in power plants. We used to get it from NFC and continue to get it whether indigenous or imported.

INS Team: Sir, the Industrial Way Forward Agreement was signed with EDF in March 2018. Now we understand that it has moved one step further and a techno-commercial proposal has been received from EDF. Could you share with us something on that?

Shri Sharma: Yes, we have received the proposal and it is under study and evaluation in NPCIL.

INS Team: Will it be possible to set any time frame as they have taken their own time for submitting the proposal?

Shri Sharma: It is difficult to set the time line. In the process of evaluation, discussions and clarifications on many points are needed. The process of mutual engagement is going in right earnest and good progress is being made. Both parties, EDF and NPCIL are interested to complete the assessment of techno-commercial proposal in a reasonable time. On completion of this, a viable project proposal will be prepared and put up to the government through DAE for approval.

INS Team: We are very glad to hear this and we wish that the proposal moves as fast as possible.

With EDF proposal, there is a speculation making rounds that the cost of plant will be very high, of the order of Rs. 40 Crore to Rs. 50 Crore per MWe of installed capacity, compared to 10 to 15 crore per megawatt even for Kudankulam, and the corresponding cost for PHWR being even lower. The unit cost of electricity is also predicted by media as 30 to 35 Rupees per unit. Can you kindly elaborate on this issue?

Shri Sharma: I think the numbers being quoted are speculative because all the elements of the cost have not yet been finalized or agreed. One major element of unit cost is the capital cost. So it is not possible to predict per megawatt cost or per unit cost. One thing is sure, ultimately the viability of the tariff is going to be the testing parameter.

INS Team: At various public discussions during Jaitapur protests, it was told that the unit cost of power generated from JNPP would be at par with the unit cost of electricity generated from the coal station connected to grid during same period of time. Do we still stick to it?

Shri Sharma: Electricity sector has evolved a lot since then. The benchmarks considered then may not be valid today. We now will have to go by the criteria applicable today. Current demands of the

market need to be taken into consideration. Due to climate considerations, coal as a source of generating electricity itself is falling out of favor. Hence the demands will also be different. Nuclear is of course a base load source of clean electricity. In my opinion significant contribution of Nuclear to Indian grid will be necessary to keep the cost of consumer at optimum level as we process towards our goals for climate mitigation.

INS Team : Similar to EDF, we had an Early Works Contract with Westinghouse for AP1000. It was for Kovada, isn't it?

Shri Sharma: Yes. It was for Kovada. It is the site being prepared for AP1000. There also we are engaged in discussion with them for division of responsibilities. We will try to agree on broad commercial terms and from there on we can go for the techno-commercial offer.

INS Team: Sir, currently there is a lot of stress on 'Aatm Nirbharta'. We know that NPCIL has been practicing the principle of 'Aatm Nirbharta' right from beginning. Could you please elaborate the NPCIL's efforts for localization?

Shri Sharma: We have been following the policy of progressive localization in all our imported plants. Take an example of Kudankulam (KK). There was a very small local content in KK1&2. For KK3&4 we have taken responsibility for many equipment on our shoulders. The extent of localization is substantially high for KK-5&6. Similar policy will be followed for AP1000 and EPR also.

INS Team: Recently there were many news items about NPCIL in media. One was about delivery of KSB pumps and other one was about a contract to BHEL for Rs. 10000 crores. Would you like to comment on that?

Shri Sharma: Yes. KSB has been supplier to NPCIL for primary heat transport pumps and the recent news might be in connection with 700 MWe plant pumps. With respect to BHEL, let me tell you that it has been decided to complete the 10 PHWR reactors sanctioned by government, in the fleet mode. The contract to BHEL is for Turbine Island for six reactors. This will boost the industry as well as ensure continuity of supplies. It will also ensure both, the quality and economy of the scale.

INS Team: Now Sir, let us talk on the PHWR programme of NPCIL. It is very reassuring that government has reposed confidence in NPCIL and its leadership with sanction of 10 PHWR reactors as just mentioned by you. The plan is to build a capacity of about 22480 MWe by 2031. Doing simple arithmetic of projected capacity, existing capacity and time available hence, one can deduce that it will be needed to add about *1200 MWe nuclear capacity every year*. Would you like to elaborate on this aspect?

Shri Sharma: This is not only a proposed plan but that is a mission for NPCIL, backed by the appropriate action plan to execute the same. All the timelines, required for its execution, are defined and the work is proceeding accordingly. Four reactors of 700 MWe, two at Kakrapar- 3 & 4 and RAPP- 7 & 8 are in advanced stages.

INS Team: Sorry for interrupting sir, but as you just said about Kakrapar, a lot of time has elapsed after its criticality and synchronization to grid. When is it expected to go commercial?

Shri Sharma: This is a first of its kind reactor. Many changes have been done in design and many systems are introduced for first time. Hence it is necessary to test these changes and systems thoroughly. Currently it is at 50% power, first we will take it to 80% or 85 %power. The boiling in the channels starts at this power. We will thoroughly observe and then proceed to the full power and then we will declare it commercial.

INS Team: that means that we will reach 100% power by December 2021 and then go for commercial.

Shri Sharma: Yes, I am very sure that by December we will reach 100%. Of course, this is subject to the fact that there are no problems encountered in the newly introduced systems. In such a scenario, there can be a slight delay. We can say that March 2022 is the most pessimistic target for commercialization.

INS Team: OK Sir, let us go further on NPCILs PHWR programme.

Shri Sharma: Yes. Next are Kakrapar- 4 and RAPP- 7. Both are going hand in hand and they will be on in next financial year. Whatever problems we encounter in Kakrapar- 3 will help us in expediting Kakrapar- 4 and RAPP- 7.

INS Team: Sir, when we are talking this, we just want to put to you that last PHWR brought on stream was Kaiga- 4, in 2011 and after that there was a lull of about ten years till the criticality of Kakrapar- 3 in 2021. Would you like to comment on this?

Shri Sharma: Let me first complete your earlier question and then we will come back to this. So, the target of 2031 is not a wishful thinking but it is backed by the action plan. After the four 700 MWe reactors at Kakrapar and Rajasthan, there will be Kudankulam -3 &4. For KK- 3&4 50% construction has been completed. The progress was bit slow due to COVID pandemic but now again it has picked up and progressing well. Hence after that KK- 3 & 4 will get completed in two consecutive years. After that will come reactors in Gorakhpur, Haryana i.e., GHAVP project. We have already cast the pile foundations of GHAVP- 1 & 2. We are also working on Kaiga site. The excavation there will start soon. Mahi Banswara site in Rajasthan will follow Kaiga in Karnataka and then will be Chutka site in Madhya Pradesh. We have acquired Land in Haryana and we have all sanctions from the government for the reactors there.

INS Team: Sir, we have here a statement by Honorable Minister Dr. Jitendra Singh in Parliament on 19th July 2018, that we will add 22480 MWe Nuclear electric capacity by 2031.

Shri Sharma: Yes, and that is backed up by various things like a doable action plan. We needed more time for making initial 700 MWe reactors but now we will be able to speed up due to actions like standardization of design, advance procurement, advance ordering etc. With these actions we will be able to complete the last four reactors very fast. As we want to achieve the target by 2031, we will launch the last reactor in 2026 itself.

INS Team: Sir, now coming back to the question which we left midway earlier, regarding the long time lapse between Kaiga- 4 in 2011 and Kakrapar- 3 in 2021. What are the reasons?

Shri Sharma: There are two reasons for this. One major being the Fukushima accident. As an aftermath there were lots of activities like revisiting our designs, revisiting safety provisions in the light of recommendations post Fukushima accident. Later there was introduction of CLND act, due to which our suppliers were little wary. To resolve it, an Insurance Pool was formed and it was settled. Further, there are new equipment in 700 MWe reactor. Hence there was a learning curve on both sides. We were learning on design aspects and the industry partners were learning on large equipment manufacturing with nuclear quality requirements. Along with this the construction partners were also learning. Due to this learning period, it took longer to for criticality of the first 700 MWe reactor at Kakrapar.

INS Team: That essentially means that work was going on behind the curtain but the results were not visible.

Shri Sharma: Yes, and coming back to your initial remark of the faith reposed by government in NPCIL and its leadership, I will say that government values the track record. Especially, the present government is result oriented. Hence, government has faith in NPCIL due to contribution of generations of professionals working in this organization. Of course, this faith by government also means a lot of responsibility on NPCIL to achieve the targets.

INS Team: Sir, we are sure that NPCIL will certainly achieve the targets and all our best wishes are with you for the success of NPCIL.

INS Team: Sir now we will go to a different topic. There is a big boost to renewable energy like solar and wind. A large capacity addition is being done through these sources. In fact NPCIL diversified into Wind energy at Kudankulam by installing wind turbine to produce about 10 MWe. NPCIL has a lot of land in the form of exclusion zone around the plants. How about utilizing it for say solar and wind energy generation?

Shri Sharma: As far as solar energy generation is concerned, the area available in the form of exclusion zone may not be sufficient to generate sizable amount of electricity through this route. With respect to wind energy, the wind potential is not there at all sites. Thus, we will not be able to generate much of energy by these routes with the available exclusion zone land assets. Further, I don't feel like we should divert part of our strength and resources away from our nuclear generation goal of 22480 MWe of nuclear capacity by 2031. There are many sources for generation of energy in distributed form but the base load clean and green energy

can be provided only by nuclear means. Hence our focus should be on our nuclear.

INS Team: Today small modular reactors are a craze worldwide. There are technology reports of possibility of container shipped SMRs ranging from 30 MWe to 300 MWe. NPCIL started with 220 MWe reactors, which is well within the range of SMRs. What is your take on that?

Shri Sharma: See, today all talk about SMRs is experimental. But one thing is certain that they have a big promise in them and a sure role to play in certain areas, circumstances or applications. But today we need large clean and green baseload plants and the mandate for NPCIL is to build those large base load nuclear plants in a timely manner. That does not mean that we should not look into it. Our R&D organizations might have already been engaged in the research and other aspects of SMR.

INS Team: Sir, now let us come to a topic which is common man's concern - Safety and Nuclear Waste. The common man has a fear in his mind about radiation from nuclear waste, especially so after the accidents like TMI, Chernobyl and recently Fukushima. How do we assure them that our nuclear plants are fully safe and there is no need to harbor any such concern?

Shri Sharma: It is true that these accidents have happened. But whole world has learnt enormously from these accidents. We always give safety as the top priority in all stages of our plants. During design, multiple barriers are established between the radioactive material and environment. Not only these barriers are established but there are mechanisms to reliably and continuously monitor their integrity. During construction, we ensure quality of construction and components. The operation is as per the well-established standards by well-trained operators who always hold safety as the highest priority. When all these measures are taken, I feel that there should be no fear about any accident happening in our plants.

Talking about waste management let me tell you that the policy of India in this regard is different. What most of the world terms as 'waste' is not a waste for us, but a valuable resource. The waste in nuclear world is spent fuel. We reprocess the spent fuel to extract fissile and fertile material out of it, which is about 99.5% of total mass. The natural uranium is used in first stage power plants while the other fissile material is used in the second stage power programme. What is left are some actinides and some fission products. We do isotope partitioning for these also. The useful isotopes are then extracted for use in the medical field and industry. After all these about 0.3 % is only the high-level waste. To handle and manage this waste, we have a very active programme. It can be incinerated in fast reactors or in the accelerator driven systems. Nuclear waste is a major problem to those nations who want to dispose off the spent fuel from reactors in Deep Repositories without reprocessing.

INS Team: Sir, on behalf of INS, and on our behalf, we thank you for sparing the time to talk to us and provide insight into various aspects of nuclear power and NPCIL, to the members of INS. We wish best for NPCIL and yourself.

(Message from President, ANS)

Nuclear in Covid-America:

Advancing nuclear in a digitally "hybrid" but still pandemic world

More than a year into the pandemic, our ongoing work of supporting nuclear professionals and the advancement of nuclear technology continues at the American Nuclear Society, or ANS. Supporting the nuclear professional community has always been "the bread and butter" of ANS but challenges posed by Covid-19 has forced us to overhaul this support – and not take things for granted.

We at ANS, like other nuclear societies across the world, are working hard to accomplish our NGO work in an environment hamstrung by limitations imposed by the Covid-19 pandemic and resulting lockdowns. Video teleconferencing platforms like Zoom and other innovative approaches have enabled us to continue our activities, albeit not always

in the most optimal manner.

The pandemic forced ANS to adapt quickly. Since the start of the initial "two week"-lockdown in March 2020, ANS stopped having in-person meetings, but we have held over 50 virtual webinars and counting; up from a total of three webinars for all of 2019.

Some of our recent webinars include a discussion among five former heads of the U.S. Department of Energy's Office of Nuclear Energy and an ambitious discussion organized by younger ANS members on the scheduled premature closures of two nuclear power plants in the state of Illinois. The Illinois webinar brought attention to the issue; earning media coverage including on TV and the radio, and featured a state lawmaker, a labor union representative, local school district officials and others as pro-nuclear speakers. A subsequent grassroots campaign, led by labor unions and pro-nuclear activists, successfully lobbied Illinois state lawmakers to pass legislation that saved the two nuclear plants by compensating them for generating resilient, carbon-free electricity.

In Washington, D.C. and beyond, ANS is playing a role in the discussions about what the clean energy future looks like, and specifically how nuclear energy will play a vital role in the future. We have stepped up our letter and Opinion-Editorial writing to inform decisionmakers of the benefits of nuclear energy and the negative consequences of not investing in advanced nuclear technologies. We continue to expand our use of social media as well.

Our message is finding a more receptive audience. Among U.S. politicians and environmentalists, there is increasing appreciation of the role that nuclear energy plays in keeping our lights on and meeting climate goals. Even some anti-nuclear environmentalists have begrudgingly endorsed nuclear energy, if only as a "bridge" to renewable solar and wind energy.

In early August, ANS held our first in-person meeting in more than a year and a half and its attendance showed the tremendous appetite our members have for direct, in-person interactions. We are following up on that success with a "hybrid" ANS Winter Meeting in Washington, D.C. from Nov. 30th to Dec. 3rd. Since many of our members still are not able to travel to physical meetings, ANS's leadership decided to allow conference goers the choice of attending in-person or virtually online.

We at ANS understand that Covid has challenged all nations and all nuclear professional societies worldwide, including the Indian Nuclear Society. We wish you the best and we hope we will all soon have the worst of the worldwide pandemic behind us.

Steven P. Nesbit, P.E., is the 2021–2022 president of the American Nuclear Society. He founded LMNT Consulting after a long career with the U.S. utility Duke Energy, where he worked in nuclear fuel, reactor safety, and nuclear policy. He has also served on the International Panel of Experts for the Nuclear Threat Initiatives' 2016, 2018, and 2020.

Brief Report on World Nuclear Association (WNA) Symposium 2021

The World Nuclear Association (WNA) Symposium 2021 was held in London from 8-10 September and focussed attention on the issues confronting the global nuclear community. There are 440 operable commercial nuclear power reactors, with a combined electrical capacity of 390 GW. Additionally, there are 55 reactors under construction and 109 reactors planned, while 329 more reactors are proposed. India and China have ambitious nuclear power programs on the anvil. The nuclear generation capacity is expected to grow 2.6 % annually reaching 615 GWe by 2040.The lower figure projected is 450GWe and the higher figure is 840 GWe. This is the future landscape of the nuclear world 20 years from now.

The symposium was flagged off by the opening remarks of Philippe Knoche, Chairman WNA and its Director General Sama Bilbao Leon. The first session launched the 20th Edition of the *The Nuclear Fuel Report: Global Scenarios for Demand and Supply Availability 2021 – 2040.* James Nevling, Manager, Nuclear Fuels, Exelon Generation Company and Alexander Boytsov, Advisor to the First Deputy Director General, TENEX shared the essential content of the Nuclear Fuel report.

Emerging trends

World Uranium production which was 63207 tonnes in 2016 declined to 47731 tonnes in 2020

indicating an idled capacity of about 20,000 tonne in 2020 Seven countries namely Kazakhstan, Australia, Namibia, Canada, Uzbekistan, Niger and Russia provided 93% of total world production of Uranium. In Canada, annual production declined by 72% and in Kazakhstan by 21 % . The current view is that there are more than adequate resources of uranium to meet future requirements but it is necessary to explore new projects to address to the near to midterm demands owing to the depletion of commercially held inventories as well as the decline of the yield from present mines. In the nuclear fuel fabrication sector, intense competition is projected from both technological and commercial perspectives due to the heightened interest in development of advanced fuels. In the enrichment sector excess capacity is used for underfeeding and tails re-enrichment bringing about 7000 tonne Uranium equivalent to the market.

On the carbon neutrality front, many countries pursuing net-zero carbon emission are convinced of the inevitability of nuclear power for securing their target goal. Extensive utilization of nuclear energy for desalination, hydrogen production and high quality industrial use is anticipated. Generation 1V reactors which India, China, France, Russia and Japan are planning will significantly reduce the amount of high-level radioactive waste. The nuclear fuel market has identified two distinct regions namely evolutionary fuel for existing reactors and new fuel for the advanced reactors.

Prospects for SMRs

The small continues to be tantalizingly beautiful and useful. How can SMRs help in a transition away from coal? Could SMRs deliver a more resilient power supply to the grid? What needs to be done to meet the paramount need for greater international harmonization and coordination in nuclear energy regulation. Rumina Velshi, President and Chief Executive Officer, Canadian Nuclear Safety Commission, Eddie M. Guerra, Senior Engineer and Arup Staffan Qvist, Qvist Consulting Limited participated and painted a fairly hopeful technical picture. A number of SMR projects have made significant progress in several countries and the industry is optimistic about its development.

Modularization technology, the signature feature of SMRs was known to nuclear engineers in mid-1990s and is the mainstay of mature industries such as aerospace, automobile and shipbuilding. SMRs have shot into limelight due to climate change considerations, price volatility of energy and inherent limitations of renewable energy. They offer flexible baseload and coupled with renewables provide energy supply security. Additionally the potential for cogeneration is high. Technology road map for SMR has been released by IAEA.

Nuclear Money

The pressing issues facing the industry today were delineated after historical reflections on the second day of the symposium and the most vexing problems identified were barriers to financing nuclear power projects. Askar Batybayev, Bernard Fontana Marylyn Kra, Ming Guang Zheng and Mohamed Al Hammadi were the panellists. Al Hammadi summed up thus. “All nuclear technologies need fair access to green funding. Access to Environmental, Social and Governance (ESG) funds will transform the nuclear sector by allowing it to access around 53 trillion dollar funding and that will change the game for financing the projects globally”. There was a lingering fear that taxonomies influence assessment which can be negative. All energy projects have an impact and should be fully assessed against ESG through company reporting. Nuclear energy as an asset class has a good report card in ESG metrics but companies have to assume responsibility. The critical role of political and public support was emphasized in ESG assessment. Principles of Responsible Investment (PRI) of the UN need to be dovetailed to the needs of the investment community setting out principles linking to ESG. The community is 3657 + strong and signifies 104 trillion dollars. The need for a voluntary and aspirational set of investment principles that offer a menu for possible actions for incorporating ESG issues into investment practices was highlighted.

Sustainable Development

The triangular relation between and among sustainable development ,climate change and nuclear energy was analyzed by a panel consisting of Rodolfo Lacy, Director for the Environment Directorate, OECD, Gilles Récoché, Director Responsibility, Commitment and Communications, Orano Mining. The roles of nuclear technologies in meeting cli-

mate change objectives and sustainable development goals were clarified and nuclear companies were called upon to demonstrate their responsibility and commitment to operating nuclear power stations in a sustainable manner.

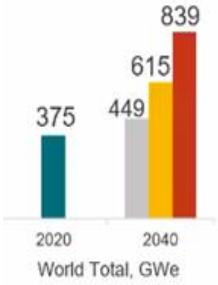
Focussing on the forthcoming 26th session of the Conference of the Parties (COP 26) to the UNFCCC, a high power panel consisting of Kathryn Huff, Principal Deputy Assistant Secretary, U.S. DOE Office of Nuclear Energy, Adam Guibourgé-Czetwertyński, Undersecretary of State in Ministry of Climate and Environment, Poland and Laurent Odeh, Chief Commercial Officer, Urenco deliberated the roles nuclear energy should serve in meeting our environmental, economic and development objectives.

The US official voice was sober and forward looking on nuclear energy. Kathryn said: "Our focus in the United States on nuclear energy is not just to talk. Our scientists and engineers are working in tandem with experts from universities and the national laboratories, and in many cases, in partnership with industry. We are engaged in research development and demonstration activities that are going to allow the full potential of nuclear energy systems to be realized in the United States and abroad."

Striking a different note on Nuclear Communications Miklos Gaspar, Head, Digital Communications, IAEA narrated the imperative need for a new strategy to reach beyond nuclear energy's usual audience stressing on the younger generation. He cited the initiative of Global Atomic Quiz in 11 languages with 11 international experts which attracted over 12000 visitors from more than 70 countries.

WORLD NUCLEAR ASSOCIATION | 20 YEARS

Three scenarios for nuclear generating capacity 2040 vs 2020



Country/Region	2020 (GWe)	Lower Scenario (GWe)		Reference Scenario (GWe)		Upper Scenario (GWe)	
		2040	Change	2040	Change	2040	Change
China	47	154	106	206	158	301	253
India	6	25	18	42	35	52	46
Japan	9	14	5	29	20	33	24
Korea	23	23	0	23	0	37	14
Russia	30	33	3	36	7	40	10
United States	98	66	-32	91	-7	119	21
Latin America	5	6	1	13	8	19	14
Middle East & Central Asia	3	17	15	24	21	43	40
West & Central Europe	119	80	-39	102	-17	132	13
Africa	2	7	6	10	9	15	14
World total	**375**	**449**	**74**	**615**	**241**	**839**	**464**
Total number of countries	**33**	**32**	**-1**	**37**	**4**	**48**	**15**

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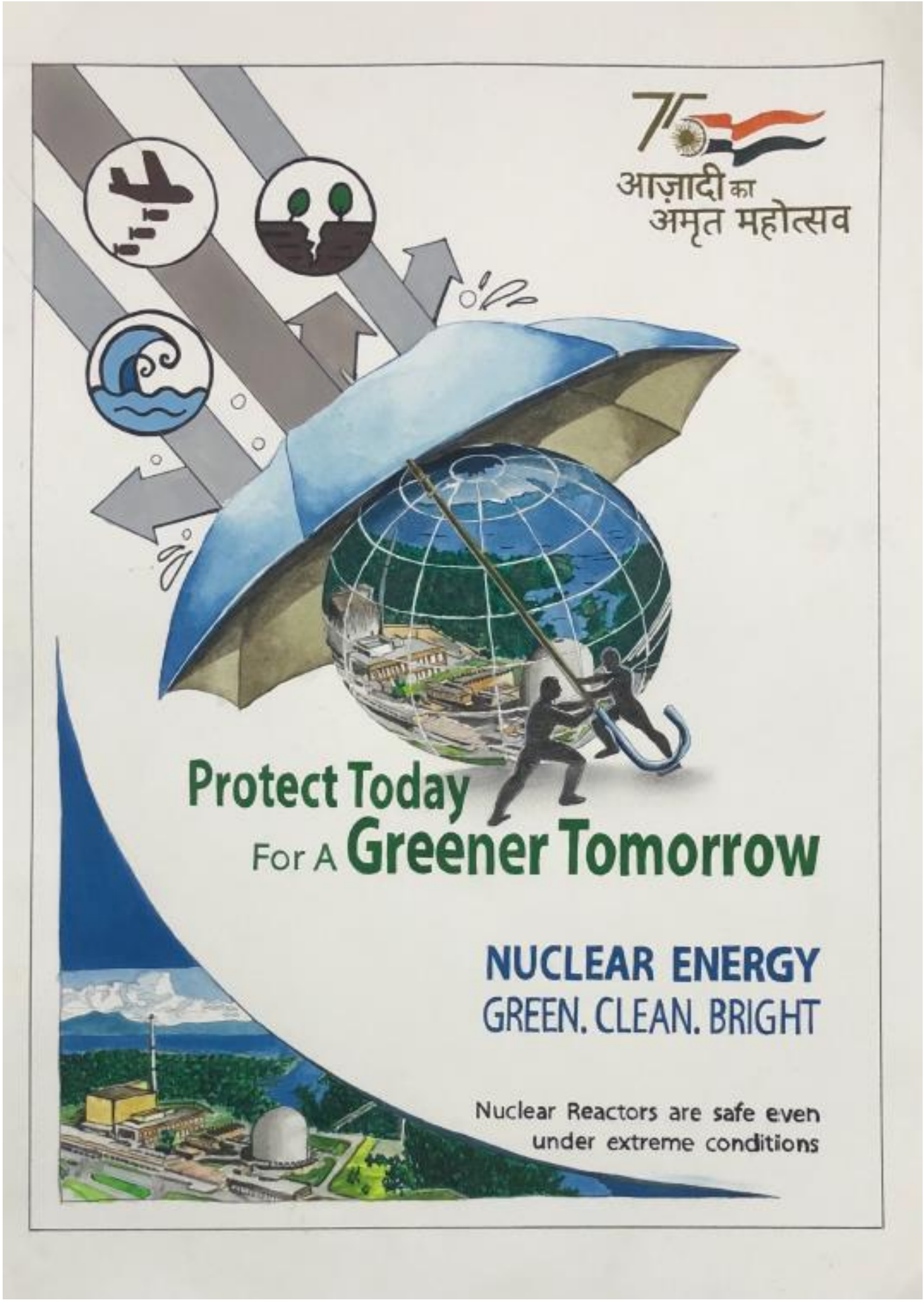
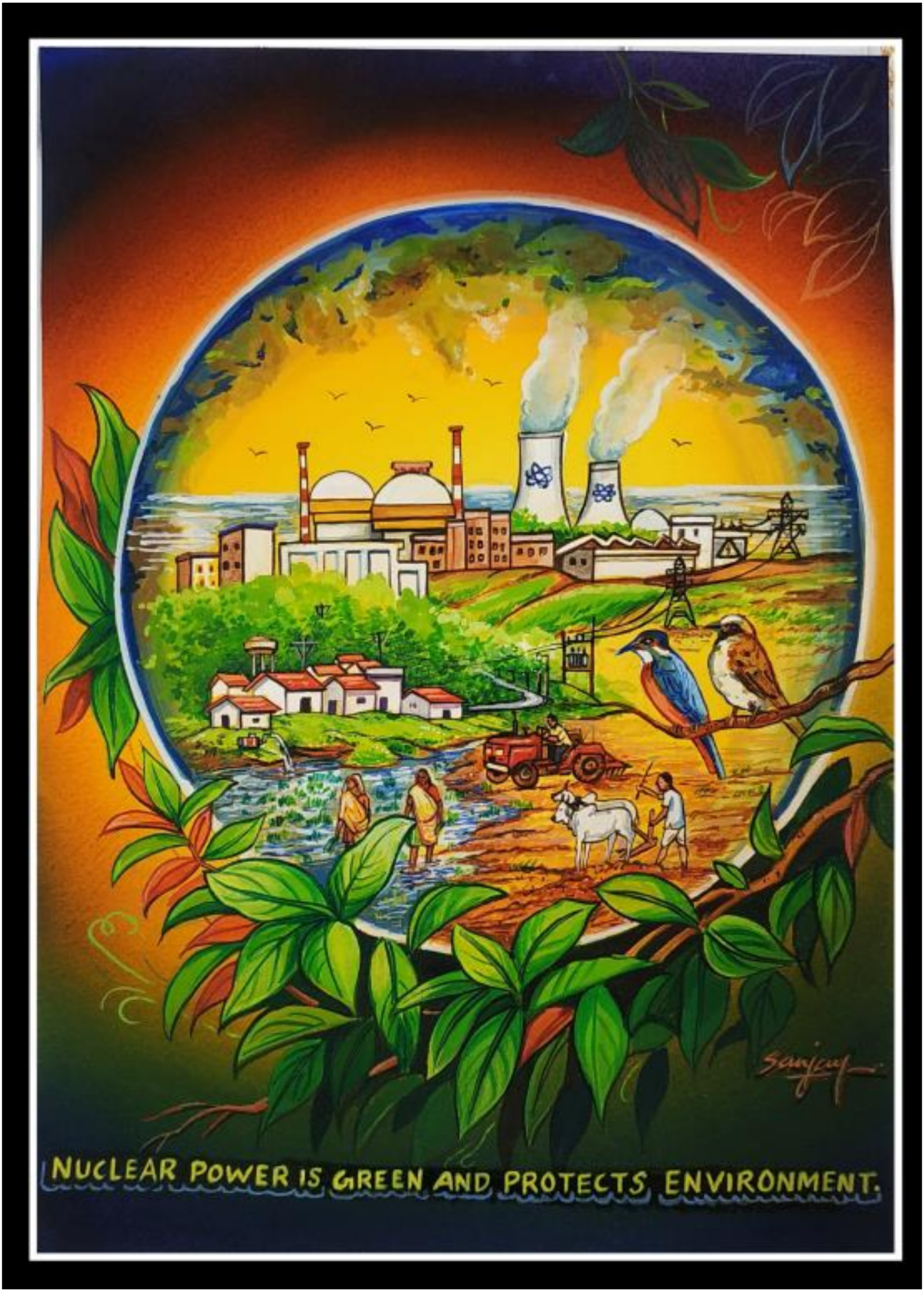
This report is prepared by Dr.A.P.Jayaraman who was invited to attend the 3-day WNA 2021 Symposium as a science journalist. He is the President of STEAM Academy and the Chairman of National Centre for Science Communicators. He had served several divisions of BARC and DAE in his nearly forty year career.

The science of today is the technology of tomorrow.

Edward Teller



First Prize in the INS Poster/Cartoon Competition 2021 (INSPC21)



Second Prize (A) in the INS Poster/Cartoon Competition 2021 (INSPC21)

Second Prize (B) in the INS Poster/Cartoon Competition 2021 (INSPC21)

Results of the INS Poster/Cartoon Competition

Vijay Manchanda (Convenor INSPC21)

	Name	Affiliation
1st Prize	Kawya Kailash Gharat	Final Year BSA, JJ School of Arts , Mumbai
2nd Prize (A)	Sanjay Kumar	AECS, Kudankulam (Teacher)
2nd Prize (B)	Aaryamaan Borgohain	AECS, Anushakati Nagar (Student Class 12)
3rd Prize (A)	Anusree Dey	BARC, Mumbai
3rd Prize (B)	Nagesh Hanmantu Sirsal	Visual Designer , Tilak Nagar , Mumbai (Family)
3rd Prize (C)	Mrittika Chakraborty	AECS , Anushakti Nagar (Student Class 9)
Consolation Prize		
C1	Sunidhi Sharma	AECS , Anushakti Nagar (Student Class 9)
C2	Aanchal Patra	AECS, Visakhapatnam (Student Class 6)
C3	K. Sai Satvika	AECS, Kaiga (Student Class 10)
C4	Amishi Nuwad	AECS, Anushakti Nagar (Student Class 8)
C5	Asmita Sagar	AECS, Narora (Student Class 6)
C6	A. Roshan	AECS, Kudankulam (Student Class 9)
C7	Ishika Singh	AECS ,Narora (Student Class 12)
C8	B.Alderin Rio	AECS, Kalpakkam (Student Class 4)
C9	Tanvi Bhattacharya	AECS, Hyderabad (Student Class 12)
C10	Manomay Gupta	AECS, Anushakti Nagar (Student Class 5)

Nuclear News Snippets

Welcome nuclear newcomer countries to the nuclear family

world-nuclear-news.org/Articles/Viewpoint-Welcome-nuclear-newcomer-countries-to-th

IAEA takes the case for nuclear to COP26

world-nuclear-news.org/Articles/IAEA-takes-the-case-for-nuclear-to-COP26

Canada-South Korea MoU to leverage used fuel experience

world-nuclear-news.org/Articles/Canada-South-Korea-MoU-to-leverage-used-fuel-exper

Germans asked to keep reactors in operation

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Energy crisis spurs Bulgaria's nuclear debate

world-nuclear-news.org/Articles/Energy-crisis-spurs-Bulgaria-s-nuclear-debate

Nuclear helps tackle high energy prices, Foratom says

world-nuclear-news.org/Articles/Nuclear-helps-tackle-high-energy-prices,-Foratom-s

France makes nuclear offer to Poland

world-nuclear-news.org/Articles/France-makes-nuclear-offer-to-Poland

IEA calls for commitments at COP26 to reach net-zero

world-nuclear-news.org/Articles/IEA-calls-for-commitments-at-COP26-to-reach-net-ze

Macron: Nuclear 'absolutely key' to France's future

world-nuclear-news.org/Articles/Macron-Nuclear-absolutely-key-to-France-s-future

Time for nuclear, Australian union says

world-nuclear-news.org/Articles/Time-for-nuclear-Australian-union-says

UK nuclear insurers provide 'certainty' to support decarbonisation

world-nuclear-news.org/Articles/UK-nuclear-insurers-provide-certainty-to-support-d

Nuclear to power remote gold mine

world-nuclear-news.org/Articles/Nuclear-to-power-remote-gold-mine

Orano completes new stable isotopes laboratory

world-nuclear-news.org/Articles/Orano-completes-new-stable-isotopes-laboratory

British nuclear transport ship fully recycled

world-nuclear-news.org/Articles/British-nuclear-transport-ship-fully-recycled

Energy crisis demands quickly-scalable SMRs

world-nuclear-news.org/Articles/Viewpoint-Energy-crisis-demands-quickly-scalable-S

Ten EU nations call for nuclear's inclusion in taxonomy

https://www.world-nuclear-news.org/Articles/Ten-EU-nations-call-for-nuclear-s-inclusion-in-tax

Bangladesh plans another nuclear power plant

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UK commits to decarbonise electricity system by 2035

https://www.world-nuclear-news.org/Articles/UK-commits-to-decarbonise-electricity-system-by-20

US DOE funds hydrogen production from nuclear power

https://www.world-nuclear-news.org/Articles/US-DOE-funds-hydrogen-production-from-nuclear-powe

New Brunswick fast reactor operational 'within the decade'

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SMRs 'ideal fit' for Australian market, report finds

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New Belgian transport vehicle for solid wastes

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Romanian energy policy will see nuclear double

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UK needs new nuclear, says Prime Minister

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UK government sets out fusion ambitions

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U-Battery unveils full-scale SMR mock-up

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Cabinet approval for new South African research reactor

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New nuclear medicine facilities announced for Australia

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Czech support for nuclear becomes law

https://www.world-nuclear-news.org/Articles/Czech-support-for-nuclear-becomes-law

European medical isotope network launched

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Pressure vessel used in Russian world-record attempt

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UKAEA opens new fusion research centre

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Renewable fuel additive created in radiation process

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NuScale signs agreement with new Polish partners to replace coal

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Tokamak Energy develops new magnet protection technology

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Uranium mining goes digital in Russia

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Trial of advanced fuel begins at Rostov

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International event focuses on nuclear supply chain

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Second Belarusian reactor nears operation

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New Orano research centre inaugurated

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Gorleben shuts after exclusion from repository site search

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IAEA assesses safety of upgraded Dutch research reactor

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Doubling of nuclear capacity by 2050 requires 'concerted action', says IAEA

world-nuclear-news.org/Articles/Doubling-of-nuclear-capacity-by-2050-requires-conc

Cameco, X-energy join up to support SMR deployment

world-nuclear-news.org/Articles/Cameco-X-energy-join-up-to-support-SMR-deployment

Successful test of recycled fuel

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Trilateral partnership launches Australia nuclear submarine programme

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Helium-3 to be extracted from Canadian tritium

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NuScale 'builds out' Canadian SMR supply chain

world-nuclear-news.org/Articles/NuScale-builds-out-Canadian-SMR-supply-chain

Second Barakah unit connected to the grid

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Illinois plants to continue operating as energy bill is passed

world-nuclear-news.org/Articles/Illinois-plants-to-continue-operating-as-energy-bi

US regulator issues licence for interim storage facility

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China's HTR-PM reactor achieves first criticality

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Iran agrees to continued surveillance of nuclear sites

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Investment funds change the shape of uranium market

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Chemical giant looks to nuclear heat to decarbonise

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Former US enrichment site ready for redevelopment

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Nuclear fuel report sees positive long-term future

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Italy launches national debate on waste repository

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Nuclear 'optimal solution' for decarbonising Kazakhstan, says President

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SMRs to power Arctic development

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US, Norway work together to eliminate HEU

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2020 highlighted nuclear's resilience, says World Nuclear Association

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BHEL receives orders for turbine islands

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IAEA and ISO reaffirm cooperation on standards

https://www.world-nuclear-news.org/Articles/IAEA-and-ISO-reaffirm-cooperation-on-standards

US-Ukrainian energy partnership foresees five new reactors

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Partners to study deployment of SMRs at Polish coal plant

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Doosan to assess manufacturability of Xe-100

https://www.world-nuclear-news.org/Articles/Doosan-to-assess-manufacturability-of-Xe-100

NNSA initiatives support domestic nuclear security

world-nuclear-news.org/Articles/NNSA-initiatives-support-domestic-nuclear-security

Why is Sweden's government sacrificing its democratic tradition on nuclear waste?

world-nuclear-news.org/Articles/Viewpoint-Why-is-Sweden-s-government-sacrificing-i

Undersea tunnel to discharge Fukushima Daiichi water

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Niger government expresses support for uranium project

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Biden urged to take 'emergency' measures to save nuclear plants

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New transport casks delivered to KHNP

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Argentina reveals its nuclear new build plans

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Sandia extends computer modelling code to advanced reactors

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Orano signs contracts for return of German waste

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Wyoming committee considers Natrium reactor plans

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Nine Mile Point to produce hydrogen for self-supply

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Utilities lead in US decarbonisation, says ClearPath

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Swiss underground laboratory stands in as Moon base

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Partnership set up for IMSR fuel supply

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Urenco moves forward with metal recycling facility

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Laser fusion approaches the milestone of ignition

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New nuclear reactor will make Slovakia a power exporter

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UK introducing regulation for nuclear shipping

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US laboratory to re-use legacy radioactive source

world-nuclear-news.org/Articles/US-laboratory-to-re-use-legacy-radioactive-source

Australian researchers step into new nuclear technologies

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3D-printed components in service at TVA reactor

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Dark matter research provides starting point for radiation detector

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India's Comptroller and Auditor General becomes xternal auditor of IAEA

https://www.indiatoday.in/world/story/india-comptroller-and-auditor-general-becomes-external-auditor-of-iaea-1856933-2021-09-24

IAEA develops drone technology for radiation monitoring

https://www.world-nuclear-news.org/Articles/Radiation-detecting-drone-developed

French grid: New nuclear reactors crucial for net-zero path

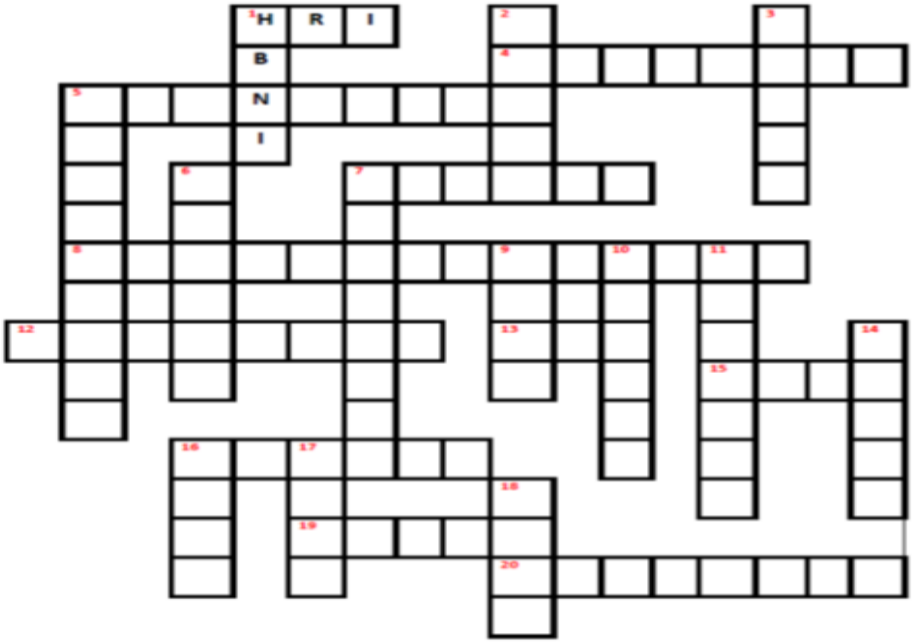
https://www.aljazeera.com/economy/2021/10/25/french-grid-new-nuclear-reactors-crucial-for-net-zero-path

Intellectuals plead with Germany to keep remaining nuclear

https://www.ans.org/news/article-3352/intellectuals-plead-with-germany-to-keep-remaining-nuclear/

Compiled by S.K.Malhotra

Crossword



Down

1. The deemed university of DAE. (4)
2. The isotope with atomic mass 135 of this element is the most powerful known neutron poison. (5)
3. The 'butterfly effect' is the most popular image of -----. (5)
5. The recoilless nuclear resonance fluorescence is popularly called --------- Effect in honour of its discoverer. (9)
6. In a nuclear fuel rod, the hollow portion that does not contain fuel pellets (6)
7. The antiparticle of electron. (8)
9. The Indian reactor design that burns thorium in its fuel core employing heavy water as moderator and light water as coolant. (4)
10. An elementary particle with half integer spin that does not undergo strong nuclear interactions. (6)
11. Element added to Zirconium for making the coolant channels in Indian PHWRs (post MAPS). (7)
14. The nuclear derived method for testing genetic material to confirm COVID-19. (2-3)
16. The nuclear stress test for detecting cardiovascular diseases, involves use of a radiopharmaceutical as tracer. (4)
17. The SI unit of absorbed radiation dose equal to 1 Joule per kg. (4)
18. Unit of digital information that most commonly consists of eight bits. (4)

Across

1. An Aided Institute of DAE, located at the City of Sangam. (3)
4. ---------- uranium is used as fuel in Light Water Reactors (LWRs). (8)
5. An electron tube for amplifying or generating microwaves, with flow of electrons controlled by an external magnetic field. (9)
7. A definite discrete unit or quantum of vibrational mechanical energy in condensed matter physics. (6)
8. Electromagnetic radiation produced by the deceleration of a charged particle when deflected by another charged particle, also called braking radiation. (14)
12. Hydrated Calcium Uranyl Phosphate, a yellow greenish fluorescent phosphate mineral of uranium. (8)
13. A plant for management of radioactive liquid waste generated in PP, BARC. (3)
15. DAE unit engaged in bringing the benefits of radiation technology in areas such as industry, healthcare, agriculture etc. (4)
16. A type of gas cooled nuclear reactor that uses natural uranium as fuel, graphite as moderator and carbon dioxide as coolant. (6)
19. GMRT is an ----- of thirty fully steerable parabolic radio telescopes. (5)
20. A chemical element also known as Wolfram used as filament in light bulbs and cathode ray tubes. (8)

Contributed by S.K.Malhotra

Solution to the Cross word puzzle in INS NL Aug ,2021 (Vol 21 Issue 3)

DOWN

1. BUOYANCY
2. DECIBEL
3. SIGMA
4. DIELECTRIC
6. MYOPIC
11. ACTION
12. HOOKE
15. AEROFOIL
16. INDUCTOR

ACROSS

5. CARBON DATING
7. COUPLE
8. ENTROPY
9. CONVECTION
10. CROSS
11. AMORPHOUS
13. SUPERHEAT
14. REFRIGERATOR
17. TENSION
18. CONDUCTOR

Congratulations to the winners

Dr S.G. Marathe, Retired, BARC
Dr S.K. Saxena, BARC
Shri Ashish Mangal, NPCIL
Dr S.K. Agarwal, Retired, BARC

Editor

INS Round Up

1. INS Head Quarters

1.1 INS Trust Board Reconstituted : INS Board of Trustees has been reconstituted. It now comprises of Shri S.K. Mehta, President INS, Shri K.N. Vyas, Chairman, Atomic Energy Commission and Secretary, Department of Atomic Energy, Dr Anil Kakodkar, Chancellor, HBNI and Chairman, Rajiv Gandhi Science & Technology Commission, Former Chairman, Atomic Energy Commission and Shri Anil V. Parab, Executive Vice President - Process Plant & Nuclear, Larsen & Toubro Ltd., Chairman, Process Plant & Machinery Association of India.

1.2 INS Poster/Cartoon Competition : As a part of Azadi ka Amrit Mahotsav, INS organised a Poster/Cartoon Competition (INSPC21) on themes revolving around nuclear power and societal applications of Radiation/ Radioisotopes. The competition was open for INS members and their families and serving / retired employees of DAE and their families. There was overwhelming response as 410 posters were received from almost all the units of DAE. Entries were evaluated by a panel of Judges who had excellent background in painting apart from being professional nuclear scientists. Prize winning posters are given on pages 19,20,21 and the list of prize winners (total prize money is Rs.75,000/-) is given on page 22.It is proposed to give certificate to all participants. INSPC21 subcommittee comprised Dr Indira Priyadarsini, Dr A. Rama Rao and Dr Vijay Manchanda. Support of Mrs Reshma Sapkal from INS office in compilation work is deeply acknowledged.

1.3 INS Webinar Series : Following four talks were arranged by the INS under its Webinar Series-

The 5th INS Webinar Talk was delivered by Dr. B. Venkatraman, Director, IGCAR on September 9, 2021 on 'Glimpses into Applications of Ionising Radiation and Non-ionising Radiation in NDE.'

The 6th INS Webinar Talk was delivered by Prof. Sandip Trivedi, Former Director, TIFR on September 18, 2021 on 'The Accelerating Universe and its Consequences.

'

The 7th INS Webinar Talk was delivered by Dr. Rajendra Badwe, Director, TMC on October 9, 2021on 'Cancer in India'.

The 8th INS Webinar Talk was held in collaboration with HSNC Univ., Mumbai on October 23, 2021. It was delivered by Dr. Meera Venkatesh, Former Head, Radiopharmaceuticals Division, Bhabha Atomic Research Centre, Former Senior General Manager, Board of Radiation & Isotope Technology and Former Director, Physical and Chemical Sciences, IAEA, Vienna on topic, 'Applications of Nuclear Radiations for Societal Welfare'.

2.0 INS Branches

2.1 INS Hyderabad Branch, launched Azadi ka Amrit Mahotsav Webinar Series under which they organised following 3 invited talks -

The first Invited Talk was delivered by Dr. Anil Kakodkar, Former Chairman, AEC on August 25, 2021 on topic, 'Atmanirbhar in Atomic Energy to Atmanirbhar in Clean Energy.

The second Invited Talk was delivered by Dr. M.Y.S. Prasad, V.C. , Vignan Univ. and Former Director, SHAR (ISRO, Sriharikota) on September 17, 2021 on 'Development of Space Activities in India since 1960s.

The third Invited Talk was delivered by Dr. R. Chidambaram, Former Chairman, AEC on October 27, 2021 on 'The Many Dimensions of Nuclear Energy.

2.2 INS Hyderabad Branch, under its Webinar Series 2021, organised talk 'The Legend Lives on : The Story of Dr. Bhabha', delivered by Dr. G. Amarendra, Former Director, Materials Group, IGCAR on October 12, 2021

3. Programmes organised by other institutions to disseminate information related to nuclear science and technology where INS members actively participated -

3.1 On the occasion of International Youth Day on August 12, 2021, Department of Physics, University of Mumbai in association with Na-

tional Centre for Science Communicators, organised a special event– 'Conversation with Dr. Anil Kakodkar' on his book titled Fire and Fury.

3.2 V.G. Vaze College of Arts, Science and Commerce, Mulund, Mumbai in association with National Centre for Science Communicators, as part of celebration of Azadi ka Amrit Mahotsav, organised an event – 'Discussion on Indian Nuclear Programme' on August 15, 2021. Dr. Suresh Gangotra, Raja Ramanna Fellow, DAE and Shri S.K. Malhotra, Secretary, INS were in discussion with Shri Sivaprasad Khened, Former Director, Nehru Science Centre, Mumbai.

3.3 Shri S.K. Malhotra, Secretary INS delivered a thematic webinar on "Nuclear Power for Sustainable Development" organised by Pt. Ravishankar Shukla University, Raipur on September 4, 2021 as part of their Azadi Ka Amrit Mahotsav celebrations.

3.4 As part of Engineers' Day celebration by Indian National Academy of Engineering (INAE) on 15th September 2021**,** Dr Anil Kakodkar, Chairman, Rajiv Gandhi Science & Technology Commission, Govt. of Maharashtra; Former President, INAE delivered a Keynote Address titled "Closing Research-Entrepreneurship Gaps"

3.5 Dr. V.K. Manchanda, Vice President, INS was the Chief Guest in a webinar organised by Indian Society of Analytical Scientists (ISAS) on September 18, 2021. He presented a brief overview of the societal benefits of nuclear radiations. Dr S.K.Patil , VC, Indira Gandhi Krishi Vishwavidyalaya delivered the webinar on "Peaceful Applications of Radiation Techniques in Crop Improvement and Food Processing".

3.6 Dr.Anil Kakodkar, AICTE Distinguished Chair Professor, Chairman, Rajiv Gandhi Science & Technology Commission and former Chairman, Atomic Energy Commission delivered the second lecture of a series of lectures arranged by HBNI as part of their celebration of AZADI KA AMRIT MAHOTSAV. The lecture titled "India's Energy Security in a carbon constrained world" was delivered on Friday, 24th September, 2021.

3.7 Shri S.K. Malhotra, Secretary, INS delivered a webinar titled "Splitting Atoms for the Progress and Prosperity of the Nation" on October 3, 2021 as part of the mentorship programme organised by Vikram Sarabhai Science Foundation, Kochin, Kerala for their Science Promotion Orient Test (SPOT) for the students of Kendriya Vidyalayas & CBSE / ICSE schools in the country

3.8 A media company - Revered Media has launched a Talk Show on Iconic Personalities from the field of Atomic Energy. In its inaugural episode lasting for about 2 hours on October 22, 2021, Dr. Anil Kakodkar was in conversation with Shri S. K. Malhotra.

3.9 On October 26, 2021 Shri S.K. Malhotra delivered a marathon Webinar of 6 hours in four sessions of 90 minutes each. The topics of the sessions of this webinar organised by Administrative Training Institute of DAE were "Department of Atomic Energy & its Constituent Units", "General Information about Atoms, Radioactivity, Radiation, Fission & Nuclear Power", "Non-power Applications of Atomic Energy" and "*Nuclear Power : The Need, The Public Perceptions and The Realities".*

Compiled by S.K.Malhotra

The views and opinions expressed by the authors may not necessarily be that of INS

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