IGC Newsletter

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Director's Message

Foundation Day Address of Director, IGCAR

IGCAR Lecture Series

- Experimental Activities related to Safety of Sodium cooled Fast Reactors
- Civil Engineering Aspects for Siting of NPP & NF
- Condition Survey & Assessment of Radiological Facility
- Performance Assessment of FBR Materials through Post-Irradiation Examinations (PIE)
- Health Physics Aspects in Nuclear Facilities at IGCAR : Practices and Emerging Challenges
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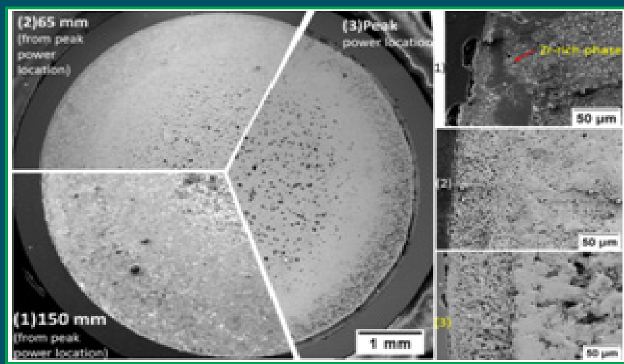

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http://www.igcar.gov.in/lis/nl144/igc144.pdf

Editor's Desk

Dear Reader

Greetings

It is my pleasant privilege to forward the latest issue of IGC Newsletter (Volume 144, July 2025, Issue 3). I thank my team for their timely inputs, cooperation, and support in bringing out this issue.

Foundation Day Address of Director, IGCAR is given in Director's Message.

The IGCAR Lectures series articles on "Experimental Activities Related to Safety of Sodium-cooled Fast Reactors" by Shri E. Hemanth Rao, "Civil Engineering Aspects for Siting of NPP & NF" by Shri Sudipta Chattopadhyaya, "Condition Survey & Assessment of Radiological Facility" by Smt. R. Preetha, "Performance Assessment of FBR Materials through Post-Irradiation Examinations (PIE)" by Dr. V. Karthik, "Health Physics Aspects in Nuclear Facilities at IGCAR : Practices and Emerging Challenges" by Dr. S. Chandrasekaran, "Radiation and Life: From Evolution to Therapy – Lessons from *Drosophila*" by Dr. Nilamadhab Prasad Indradyumna Das, "In-Plant Radioactive Waste Management of FBR" by Shri B. Anoop, "Nanofluids and Nanocomposites for Industrial and Societal Applications" by Shri Barid Baran Lahiri, "Role of Wireless Sensor Networks in Nuclear & Non-nuclear Applications" by Smt. Jemimah Ebenezer are included in this Newsletter.

In the back cover, We have Common Moorhens bird found in IGCAR campus. The Editorial Committee would like to thank all the contributors. We look forward to receiving constructive suggestions from readers towards improving the IGC Newsletter content.

We express our deepest gratitude to Director IGCAR for his keen interest and guidance.

With best wishes and regards

Shri J. Rajan
Chairman, Editorial Committee, IGC Newsletter and
Head, Scientific Information & Networking Division, IGCAR

Foundation Day Address of Director, IGCAR

Shri. C.G. Karhadkar

Distingushed Scientist & Director , IGCAR

Good morning, everyone.

Distinguished invitees, senior colleagues of DAE family, ladies and gentlemen.

I welcome you all, on this august occasion of 54th Foundation Day celebration, of our centre.

Looking back at the path travelled, it is time to remember the enormous efforts put in by many seniors from 1971 in creating various facilities, infrastructure, path breaking developments towards the growth of IGCAR to its present day. I think, it is the time for reflecting on some of the significant achievements during the last year and carrying out course corrections, which are commensurate with the changing scenarios of the country and the world.

I take this opportunity to share some of the notable achievements during the last year.

- Fast Breeder Test Reactor, an important fast neutron irradiation facility serving towards development of advanced structural materials, fast reactor fuels & production of radioisotopes, has crossed 39 years of safe & successful operation and has completed 33 irradiation campaigns with 4 irradiation campaigns at its rated power of 40 MWt. Currently the reactor is being prepared for the upcoming 34th irradiation campaign.
- Since this reactor inherently operates at temperatures in excess of 500 °C, it is amenable to production of green hydrogen using Copper Chlorine thermo-chemical cycle. A plant for producing 10 NLPH of hydrogen has been in operation at BARC since June 2024, based on the technology developed by Chemical Engineering Group of BARC. It is now proposed to integrate this facility with Fast Breeder Test Reactor (FBTR) for the demonstration of clean hydrogen generation at a rate of 50 NLPH. It is expected that we may be in a position to commission this facility before the year end.
- The indigenous production of Sr-89, used for palliative care of bone metastatic cancer, is an important societal need and a valuable import substitute. Production of Sr-89 with high specific activity at FBTR was successfully demonstrated. The product satisfied all the Quality Control Parameters as per US, European & International Pharmacopeia. Animal distribution studies have been recently completed on the same.
- Pilot scale production of radio isotope of Y-90 & P-32 for the benefits of society were initiated during April 2024 and has made good progress.
- I am happy to inform that a proposal is being put up to Atomic Energy Commission, for in principal approval of a 100 MWt FBTR-II. This reactor will be mainly utilized for qualification, complete testing, performance studies and evaluation of a full-size metal fuel, deployable in a 1000 or 500 MWe Fast Breeder Reactor. The core of FBTR-II will have a Plutonium Carbide or Oxide as the driver fuel and a central core of metallic test fuel.

Other than this primary objective, the reactor will also target several secondary objectives such as

- Demonstration of co-generation of electric power and hydrogen on fairly large scale.
- Demonstration of minor actinide burning, for nuclear waste incineration.
- This reactor will also have a material test facility at controlled temperature. It will have the capability to induce about 25 dpa per year for a reasonable sample size. This will help in supporting future advanced reactor programmes and enhancing the life of present reactors.
- A good variety of isotopes of economic and strategic value, can also be produced in Fast Reactors by providing a local flux trap to optimize the neutron flux spectrum.

Other than FBTR-II, it is also proposed to have the following Front and Back-end facilities in this mega project to close the fuel cycle such as

- Metal Fuel Fabrication Facility.
- Post-Irradiation Examination Facility for metallic fuel.
- Pyro-Processing Facility for reprocessing of metallic fuel.
- And Isotope Processing Facility.

- U^{233} based KAMINI continued to operate up to 30 kWt and served as a national facility for Neutron Radiography, Neutron Shielding, Neutron Activation of materials & Conducting neutron beam experiments.
- The Prototype Fast Breeder Reactor (PFBR) at BHAVINI is in an advanced stage of integrated commissioning. IGCAR continues to provide the required technical support with many colleagues from various groups collaborating closely with the BHAVINI team for regulatory clearances and commissioning activities. In this connection it may be noted that approvals have been obtained from AERB for Initial Fuel Loading, First approach to criticality and Low Power Physics experiments.
- Subsequent to loading of the blanket assemblies in the reactor we have been facing some problems with respect to the lowering of the pot using the inclined fuel transfer machine.
- An Under sodium ultrasonic scanner was developed and deployed in the reactor for imaging the internals of the Primary Tilting Mechanism of Inclined Fuel Transfer Machine, to determine the root cause. To circumvent the problem, it has been decided to resort to direct fuelling of the reactor through vertical route. In last 4 months the new vertical fuelling machine has been designed and various components of the same are being fabricated in IGCAR Central Workshop, Zonal Work Shop of IGCAR, Bhavani Work Shop as well as BARC Central Work Shop. Almost 70-80% of the fabrication work has been completed. It may be noted that if everything goes well, we may be able to resume fueling operations for PFBR in another 2-3 months' time.
- Modifications of 376 actual subassemblies to address issues like higher extraction force and hexcan scoring observed during the handling of dummy subassemblies was carried out. Smoothening of sharp edges of 109 blanket subassemblies and 41 fuel subassemblies, along with discriminator diameter machining for 52 blanket subassemblies and 24 fuel subassemblies was successfully completed.
- Non-Destructive Examination module DISHA-V2, in-service inspection vehicle was successfully qualified at room temperature and high temperature of 120 °C at a 1:1 mock-up facility at BHAVINI, and is now ready for deployment.
- Demonstration Fast Reactor Fuel Reprocessing Plant, a unique facility which can handle both carbide and oxide fuel, was dedicated to the nation by Honourable Prime Minister during January 2024. DFRP was hot commissioned during April 2024. The strategic material recovered by processing the balance dissolver solution has been dedicated to the nation in the presence of Chairman, AEC and Secretary, DAE during June 2024. Three campaigns for processing FBTR spent fuel have been completed successfully, touching the rated capacity of DFRP.
- Distribution of Neptunium-237 in PUREX process streams at DFRP have been studied. Significant amount of Neptunium is noted to be present in the uranium product. About 1800 mg of Np-237 has been separated from the uranium product stream. Workouts have been carried out for its irradiations either at Dhruva at BARC or at FBTR for its conversion to Pu-238, which is an essential power source for deep space exploratory missions.
- CORAL facility is the only plant operating in the world to handle carbide fuel. It has been relicensed by AERB up to 2028 for its continuous Operation. Sixty six number of campaigns for the reprocessing of FBTR fuel with different burn-ups up to 155 GWd/t have been successfully completed and the 67^{th} campaign has been initiated in March 2025.
- Towards the metal fuel development program, the 'Sub-assembly Level Metal Fuel Fabrication Facility' to fabricate 1.0-meter-long sodium bonded metal fuel pins for sub-assembly level irradiation in FBTR was inaugurated by Dr. Ajit Kumar Mohanty, Chairman, AEC & Secretary, DAE on May 28, 2024. On the same day a new experimental facility for demonstration of pyro-processing operations using U-Pu-Zr alloy in maximum 250 g per batch was inaugurated by Chairman, AEC.
- In our endeavour towards indigenous development of improved materials and processes, small punch test technique using miniaturized specimens has been developed and employed for evaluating mechanical properties of neutron irradiated and service exposed materials. For the first time, Digital Image Correlation (DIC) technique has been successfully integrated with small punch experiments for online monitoring of the strains and identifying the location of instability during deformation.
- As part of the National Quantum Mission, in-house development works on the deployment of a novel quantum secure direct communication scheme, is in progress.
- Towards the emergency preparedness, C-Band Doppler Weather Radar and 205 MHz Wind Profiler are installed and commissioned at Kalpakkam site under 'Application of Space Science & Technology' initiative between DAE & ISRO.

- A Fission Product Noble Gas (FPNG) monitor is installed in one of the predominant wind sectors of Kalpakkam site and commissioned. Online Isotope Monitoring System consisting of dedicated detectors for detecting alpha, beta and gamma radiations & associated electronics has been installed in one of the pre-dominant wind sectors of Kalpakkam site.
- Cadmium Zinc Telluride (CZT) single crystals for Gamma Radiation Detection and Lead Zinc Niobate-Lead Titanate (PZN-PT) single crystals for transducer applications have been developed.
- Towards promoting the application of DAE Health Care Technologies for Society, a "Mobile Health – Wellness Program for the Rural Population" is being implemented in the rural areas in and around Tamil Nadu.
- Anu Yatra (Phase-3) was organized during January-February 2025 to highlight India's advancements in nuclear technology, aligning with the vision of Atmanirbhar Bharat. This year, the yatra commenced from Kalpakkam, Tamil Nadu, and concluded at Kaiga, Karnataka, covering 1,100 km and many educational institutions. Overall, around 10,000 students & more than 500 faculty members and teachers actively engaged in Anu Yatra-2025.

I wish to highlight a few of the many events conducted at IGCAR to commemorate key occasions:

- As part of the National Science Day-2025, the Brilliant Bharath Hackathon-2025 was organized during February 28 & March 1, 2025. Nearly 160 students & faculty participated in this hackathon from 20 colleges across North Tamil Nadu.
- Visits by School Children on weekly basis to IGCAR as part of platinum jubilee celebration of DAE has commenced from August 2024 and about 1,500 students & 100 teachers from 30 schools have visited till April 2025.
- As part of the Swachhata Hi Seva-2024 campaign, various activities including special beach cleaning drive, Health Screening for Housekeeping Staff, cyclothon, Tree Plantation campaign of nearly 2,500 trees over 60,000 sq.m, under the theme 'Ek Pedh maa ke naam' and water management measures were accomplished.
- Installation of major solar PV plant of capacity 2.29 MWp has been completed taking the total installed capacity to 3.1 MWp.

DAE Incubation Centre of IGCAR functioning since October 2020 has been registered as an Atal Incubation Centre with the name "AIC-IGCAR-FAST Foundation" on October 08, 2024.

- Technologies developed at IGCAR to meet the Aatmanirbhar objectives such as: 'High Efficiency Particulate Filter (HEPA) Test Rig Technology', 'Pulsating Sensor based Conductivity Meter Technology', Autonomous Gamma Dose Logger (AGDL) and 'Leak Tight Flange and Gasket Assembly for Instrumentation/Power Cables for Chemical and Radiochemical Facility' were transferred to start-ups and private industries.

I would like to take this opportunity to acknowledge the role played by every individual, section, division and group, who have contributed collectively to this magnificent team effort. I acknowledge the excellent support rendered by engineering and medical services of General Services Organization. The Administration, Accounts and Auxiliary Departments of IGCAR and GSO have continued to provide commendable services guiding and supporting the execution of various programmes.

I take this opportunity to place on records our thanks to the principals, teachers and staff of Atomic Energy Central Schools and Kendriya Vidayalayas within our township premises for providing holistic education to our wards. Compliments are due to the CISF for their continued support towards ensuring the security of the site and the townships. I acknowledge the Banks and Post Office at Kalpakkam & Anupuram for providing valuable service to our employees. Special thanks are also due to the unions and associations for their support and cooperation.

Towards the way forward in 2025, apart from the other R&D and regular activities at the various groups of IGCAR, our focus would continue to provide support for the following:

- Integrated commissioning activities of PFBR towards various activities required for Initial Fuel Loading and subsequent First Approach to Criticality.
- The operation of DFRP with spent fuel from fast reactor and recovery of strategic materials.
- Continuing to operate FBTR at 40 MWt, irradiation of advanced FBR structural materials and metal fuels, taking up activities for producing hydrogen at FBTR in collaboration with BARC.
- Obtaining approvals and taking up the detailed design of FBTR-II along with the proposed front end and the back-end facilities, would be the milestones to completed in 2025.

Thank you and Jai Hind

Lecture Series

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Experimental Activities Related to Safety of Sodium-cooled Fast Reactors

Sodium-cooled Fast Reactors (SFRs) are equipped with multiple inherent and engineered safety features adhering to the defence-in-depth philosophy to ensure safe operation and minimize the likelihood of accidents. However, thorough safety assessments are essential, involving detailed analyses of both anticipated operational events and severe accident scenarios to validate safety systems and demonstrate effective mitigation strategies. Following the Fukushima incident, new safety criteria now mandate that severe accidents be addressed within the reactor design itself under Design Extension Conditions (DECs). Consequently, a robust R&D program on reactor safety is critical for the development and large-scale deployment of SFRs. In this context, Safety Engineering Division at FRTG, IGCAR is actively engaged in experimental research focusing on severe accident behaviour and sodium fire safety in SFRs.

Severe Accidents and Sodium Fires in SFRs

Severe accidents are hypothetical events that could involve a partial or complete core meltdown, Core Disruptive Accident (CDA), Molten Fuel-Coolant Interaction (MFCI), and formation of a debris bed at the bottom of the reactor vessel. To mitigate these risks, SFRs are designed with an in-vessel core catcher, which provides a sub-critical and coolable geometry for the debris bed. Decay heat from the bed is dissipated by sodium via natural convection, which establishes a flow between the bed and safety-grade decay heat exchangers positioned at the top of the reactor vessel. In the event of a core meltdown, the Reactor Containment Building (RCB) is not expected to experience sodium leakage or fire. However, a small amount of sodium (few kilograms) may be released into the RCB during a CDA, where it could combust instantly, causing pressure buildup. Except this scenario, no sodium fires are envisaged in the RCB as all the sodium capacities are enclosed in guard pipe or inert cells. Sodium fires are more likely to occur in the secondary sodium circuits or the Steam Generator Building (SGB) under both normal and accident scenarios. To address this, the SGB is equipped with Leak Collection Trays (LCT) beneath the sodium equipment, designed to capture leaking sodium and suppress fires by limiting oxygen exposure. Additionally, the SGB floors are protected by a limestone layer over the structural concrete, preventing degradation from potential sodium leaks. Dry Chemical Powder (DCP) dispensing systems are also strategically placed throughout the plant to provide rapid fire suppression when needed.

Experimental Activities Related to Severe Accidents

For supporting the severe accident research, dedicated facilities such as Sodium Fuel Interaction facility (SOFI), Thermite Melt facility (THEME), and Post-Accident Thermal Hydraulic facility (PATH) have been developed. The SOFI facility comprises cold crucible induction melting system (shown in **Fig. 1**) for generating the molten metal composition while the THEME facility utilises aluminothermy reaction for producing the simulated MOX fuel composition at high temperatures upto 2500 °C, for investigating MFCI in sodium. Several experiments were conducted in

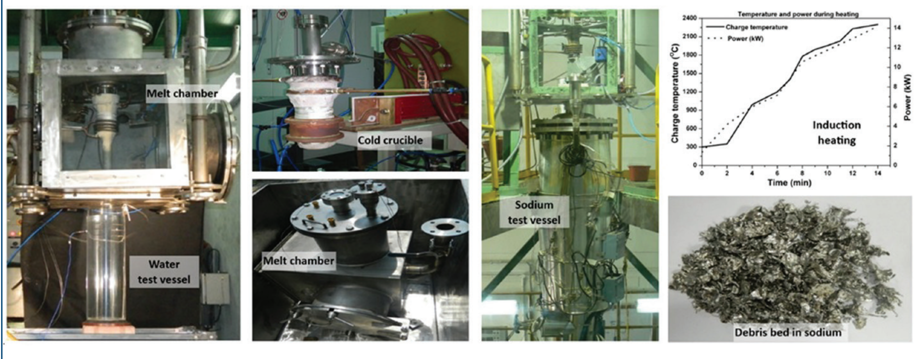

Figure 1: Experimental Setup with Cold Crucible and Melt Chamber at SOFI Facility

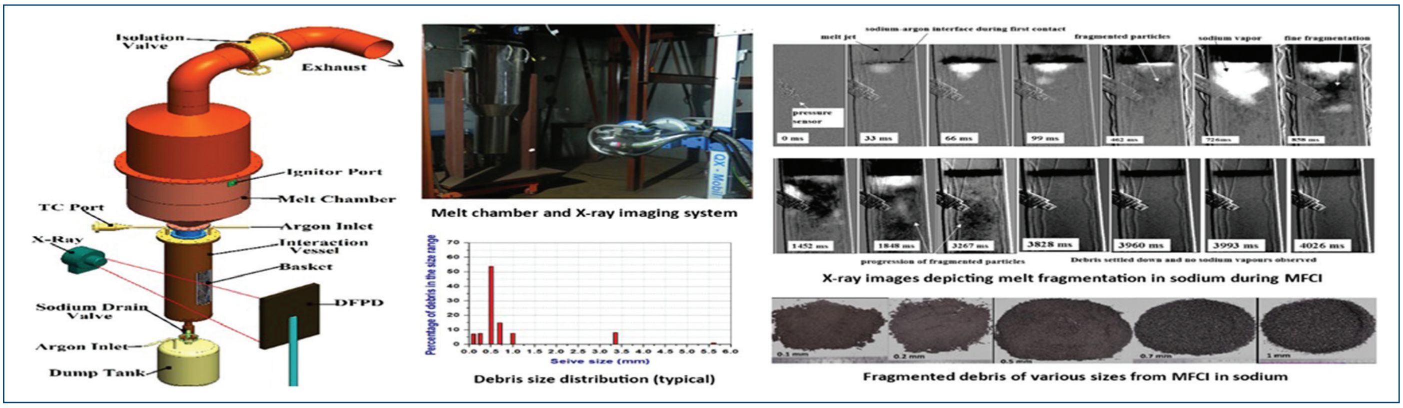

Figure 2: Setup with X-ray Imaging System at THEME Facility and MFCI Experiment in Sodium

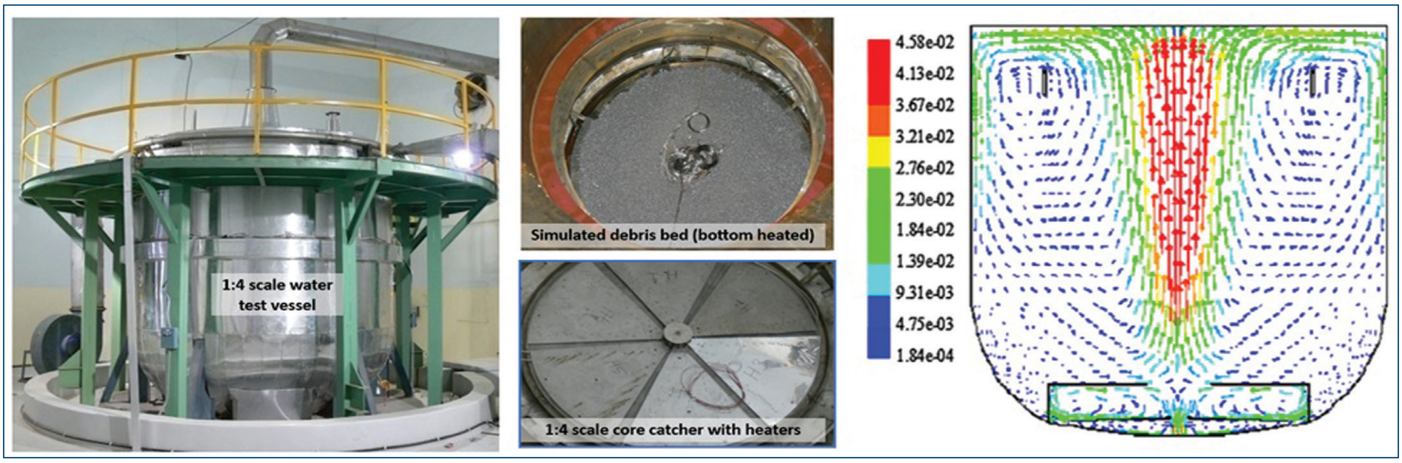

Figure 3: PATH Facility: Experiments on Natural Circulation from Simulated Heat Generating Debris Bed

the above facilities using molten stainless steel, mixture of alumina and iron as melt compositions to study MFCI in sodium at various simulated conditions. A real-time X-ray imaging system consisting of an X-ray source and a Digital Flat Panel Detector (DFPD) is deployed along with an image processing tool 'VISTA' developed in-house, to investigate the melt fragmentation behaviour in sodium. The results showed the melt to fragment instantaneously in sodium (shown in **Fig. 2**) resulting in a non-energetic MFCI, which is a vital input to the safety of SFRs.

The experiments on post-accident heat removal include determination of the effective thermal conductivity of the simulated debris bed in sodium, single phase and boiling heat transfer from the heat generating debris bed in 1-D, 2-D geometries, and confirmation of natural convection flow from a heat generating debris bed formed on core catcher in a 1:4 scale water test vessel in PATH facility as shown in **Fig. 3**. The experimental findings were found to be in good agreement with the numerical predictions. Additionally, experiments are also taken up on melt progression in simulated fuel subassembly, sodium boiling in simulated fuel subassemblies, and benchmark MFCI tests for validation of codes being developed in RDG, IGCAR. An advanced core catcher with a refractory magnesia as a protection layer for the core catcher, which can safely mitigate a whole core melt relocation, is also designed, developed and tested in sodium environment for deployment in future SFRs.

Experimental Activities Related to Sodium Fire Safety

For the sodium fire studies, various facilities such as Mini Sodium fire (MINA) facility, Sodium Cable interaction (SOCA) facility, Sodium Fire Experimental Facility (SFEF) and Sodium Disposal Facility (SDF) have been setup. The MINA facility comprises a rectangular steel test chamber of 150 m^3 volume for simulation studies on aerosol dispersion in RCB, sodium spray fire consequences and for qualification of concrete protection layer for the SGB flooring. The SOCA facility consists of a simulated top shield platform structure of PFBR for studies on CDA resultant sodium fires, and studies on sodium disposal using water mist for development of environment friendly sodium disposal method.

The SFEF is equipped with a RCC test chamber with 570 m^3 volume for qualification of the LCT systems for deployment in the reactors while the SDF houses a facility with inert test chamber for characterization of particle size distribution of a sodium spray, and test setups for studies on Iodine retention in sodium. Various experiments were carried out in the above facilities for supporting the sodium fire safety in PFBR and the sodium utilities. Few notable milestones are confirming adequacy of limestone layer thickness on structural concrete in PFBR (**Fig. 4**), determination of spatio-temporal behaviour of sodium combustion aerosol in closed containments, quantification of leak and assessment of burning potential of the CDA resultant sodium leak for PFBR (**Fig. 5**), qualification of PFBR LCT system using 100 kg sodium (**Fig. 6**) and demonstration of conservatism in the design basis sodium

Figure 4: MINA Facility: Experiments on Sodium Fire & Sodium Concrete Interaction

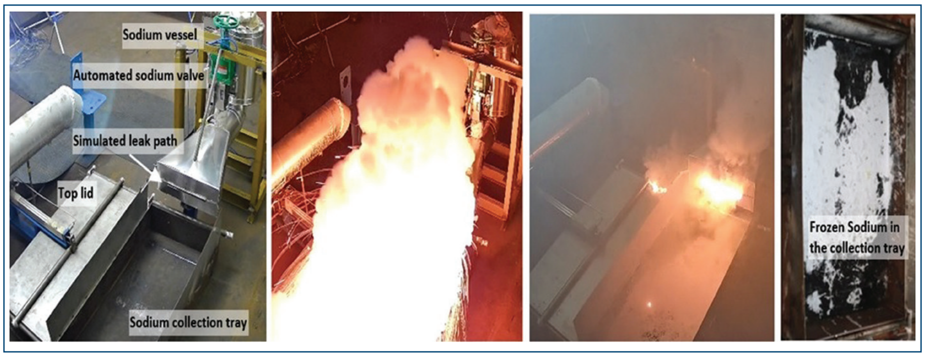

Figure 5: Determination of Sodium Burning Potential in Containment Building during HCDA

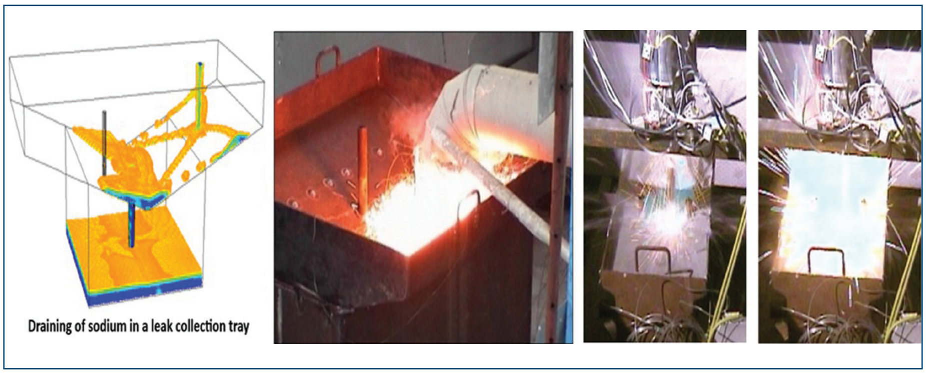

Figure 6: Qualification of Sodium Leak Collection Tray System with 100 kg Sodium leak.

Additionally, several developmental activities are also taken up. A Class-D powder of new composition is developed and qualified for effective sodium fire mitigation. Safe disposal of used solid sodium was demonstrated by mist technique with effective aerosol filtration using wet scrubbers. Geo Polymer Concrete, which is known as green concrete is being developed in collaboration with CEG, IGCAR for deployment as a sodium resistant protection layer in the SGBs and secondary sodium circuits of the future SFRs.

Future Activities and Way Forward

Though the experiments provided key data for the PFBR and demonstrated various critical phenomena related to severe accidents and sodium fire events, few uncertainties still prevail due to differences in scaling ratios and simulation parameters. Several assumptions in the current safety analyses also need to be relooked to eliminate the conservatism. This calls for development of advanced numerical models and validation with extensive experimental data under realistic simulation of actual conditions. Additionally, there is a need for advanced test facilities for supporting development and qualification of enhanced safety features towards deployment in the upcoming reactors. In this context a large-scale severe accident test facility, which caters for the severe accident research of all Indian power reactors including SFRs and LWRs is being designed and developed at IGCAR in collaboration with BARC and NPCIL. The facility will be setup at IGCAR and will be equipped with a cold crucible induction system for melting prototypic corium and dedicated test bays (**Fig. 7**) for studies on fuel slumping, melt relocation, MFCI and performance of core catcher etc. for qualification of accident mitigation strategies and effective implementation of SAMG in water cooled as well as sodium cooled reactors. For future activities related to sodium fires and environment friendly disposal of sodium, design of Integrated Sodium Management Facility (ISMF) is also taken up.

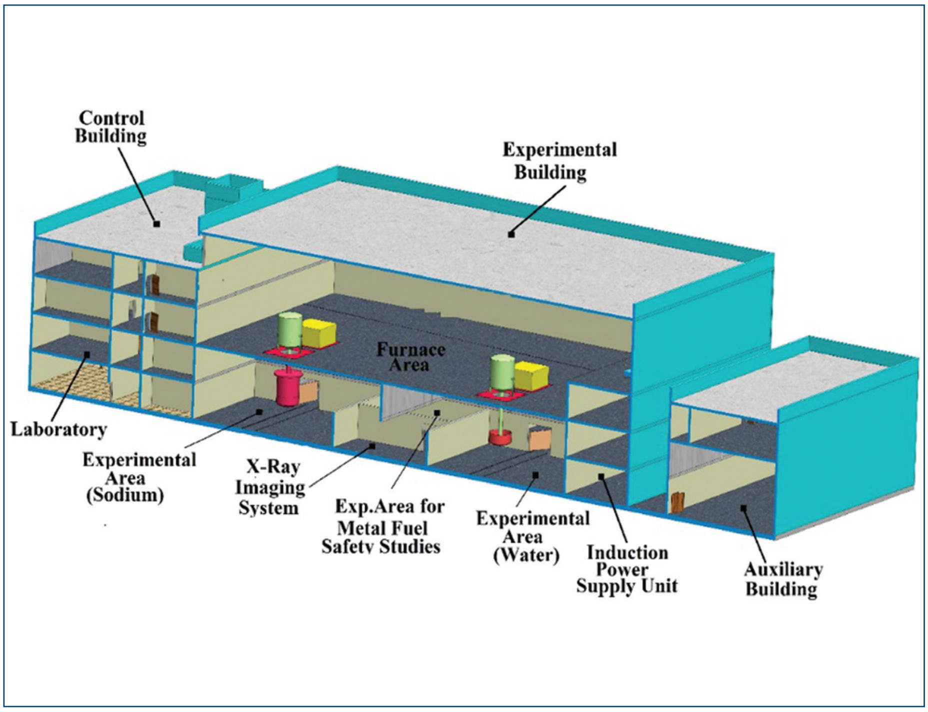

Figure 7: Proposed Prototypic Corium Facility for Severe Accident Research

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Civil Engineering Aspects for Siting of NPP & NF

Like other Nuclear Power Plant (NPP) for PFBR project, as first step of pre-project activities, all site studies/ investigations have been carried out to prepare Site Evaluation Report & obtain Site Clarence from Atomic Energy Regulatory Board (AERB). Similar procedure are followed for Nuclear Facility (NF) project like FRFCF project at DAE Kalpakkam also. Safety is an important factor that is comprehensively dealt with in siting of these NPP & NF both during its normal operation of the facility as well as during and postulated accident scenarios. The requirements to be met during of siting & site evaluation of NPP/NF for assuring safety are delineated in 'Site Evaluation of Nuclear Facilities' AERB/NF/SC/S (Rev.1). The siting process consists of a site survey, site selection and site evaluation, and ends with the fundamental milestone of the site licensing award. Site Evaluation is the analysis of those factors at a site that could affect the safety of a facility or activity on that site. Following are the civil engineering site specific parameters as indicated in **Table 1**, whose effects have been studied for while site evaluation of projects like PFBR & FRFCF and approval are obtained from AERB. Civil/Structural design & engineering process are linked with site evaluation as explained in the flow chart indicated in **Fig. 1**.

All the hazards and conditions that are considered and pertinent to safety of the nuclear plant/ facility need to be monitored and assessed throughout the

Sl. No.	Site Specific Studies	Linkage to Civil Engineering
1	Geology and Seismicity: Design Basis Ground Motion Parameters	Structural Analysis & Design of Plant Buildings
2	Site Specific Wind: Design Basis Wind Speed	Structural Analysis & Design of Plant Buildings
3	Site Specific Flood: Design Basis Flood Level	Fixation of FGL & FFL, Stability Check
4	Rainfall Study: Design Basis Rainfall Intensity	DBFL, Design of Storm Water Drainage for Plant Area
5	Geotechnical Investigation: Geotechnical Parameter	Subsurface Profiling, Foundation Design, Soil Structure Interaction
6	Topographic Survey: Site Ground Contour	Base Data for Site-Specific Studies, Design & Construction

Table 1: Civil Engineering Site Specific Parameters

life time of the plant. Site Evaluation is a continuous process for NPP/NF since its site selection to entire operational phase till decommissioning. Siting Review process for obtaining siting clearance in indicated in **Fig. 2**.

Similar kind of site-specific studies are envisaged for upcoming reactors at DAE Kalpakkam based on applicability/ consideration indicated in the prevailing siting code & Regulatory requirement for consenting process.

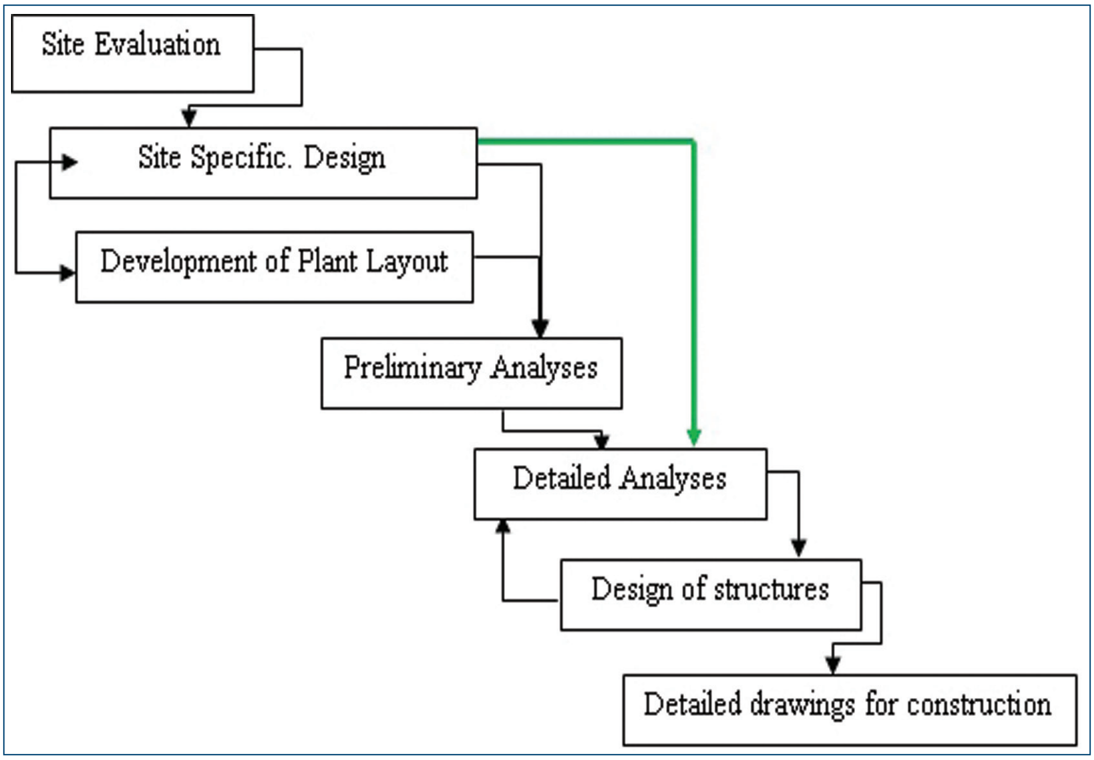

Figure 1: Linkage to Civil Design & Engineering Process with Site Evaluation

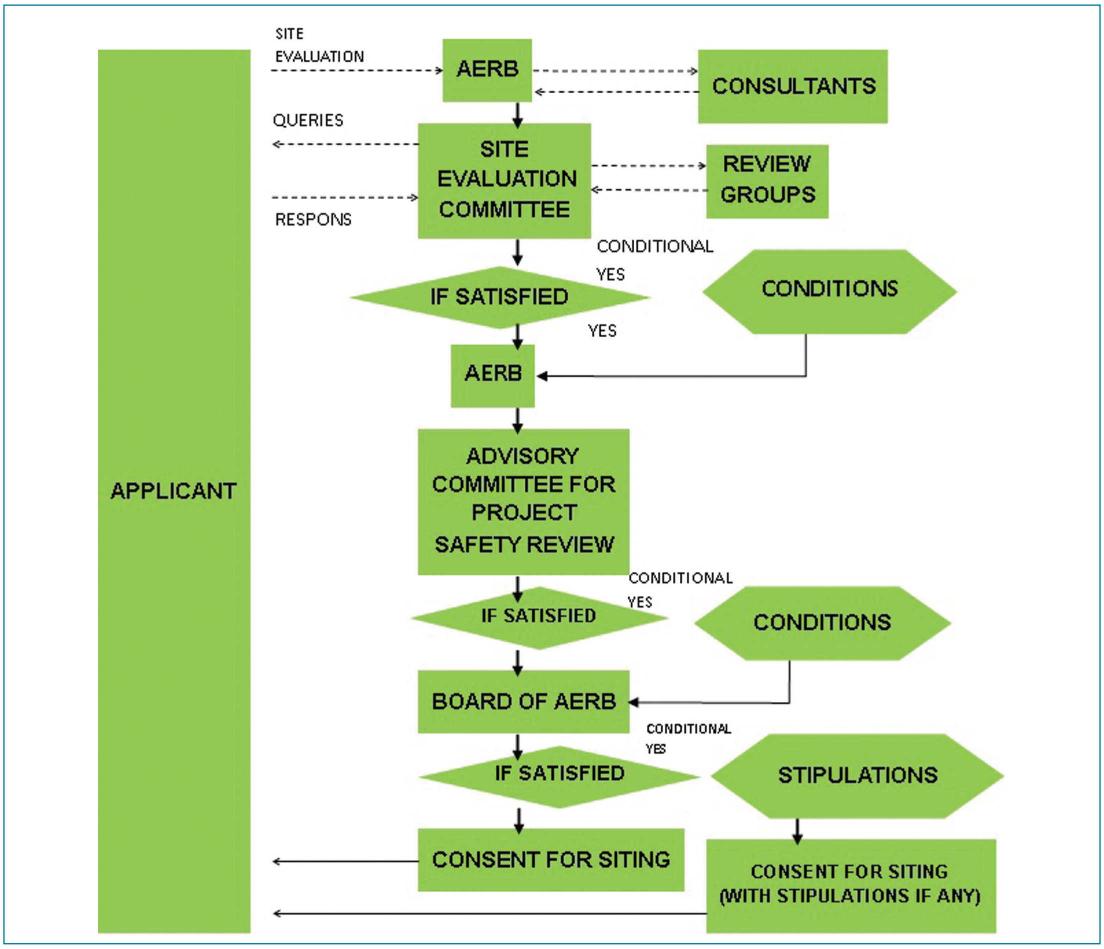

Figure 2: Review Process for Obtaining Siting Clearance

Lecture Series

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Condition Survey & Assessment of Radiological Facility

IGCAR located at Kalpakkam near sea coast of Bay of Bengal includes various radiological/nuclear facilities such as Fast Breeder Test Reactor, Radiochemistry and Radio Metallurgy Labs, Pilot Reprocessing Plants etc. (**Fig. 1**). As the reinforced concrete (RCC) buildings in these facilites have crossed more than 40 years of service life it calls for ageing management exercises. This is to ensure the adequacy and periodic re-qualification of the safety of these installations by the regulatory authorities. Worldwide experience also shows that a structural/condition assessment of an existing operating facility can be prompted by evidence of a greater level of hazard/aggressive environment at the site, owing to new or additional data or new methods or due to regulatory requirements and it is known that time dependent changes that occur in RCC may impact the ability of a structure further reducing the design margins.

As directed, periodic condition surveillance of these facilities is conducted; through visual inspection and non-destructive tests consisting of sonic and electrochemical methods (**Figs. 2 & 3**). Chemical tests of cored samples and strength tests are also resorted to. Further if mandated by regulatory authorities, capacity assessments of the structures are made by conservative deterministic failure margin method or a pushover analysis. The realistic material property as assessed above is used in the analysis.

The objective of visual inspection is to make a preliminary assessment of the existing condition of the structure, to identify any cracking, scaling, spallation, stains etc. (**Fig. 2**) on the structural members.

Keeping in view of the visual observations, the techniques mentioned above are planned to identify the extent of the problem both in terms of location and spread. Other locations identified for conducting the tests (**Fig. 3**) are based on extent of the facility, variation

Figure 1: Nuclear Facility

Figure 2: Visual Inspection Depicting Cracking, Leaching, Spallation

Figure 3: Non-destructive and Semi-destructive Testing of Containment Building

in material properties, critical areas based on safety, loading and operating environment (such as radiation, temperature, microclimate etc.) and accessibility.

The outliers are identified from the above graph which indicates the deficiencies in RCC elements; hence further tests are adopted (**Figs. 4 & 5**). Five year frequency for in service inspections mandated by the regulatory authority is found to be appropriate as assessments could capture any distress in time to take suitable remedial measures to extend the service life of the structure.

Due to higher importance factor adopted in design and high quality in construction overall results obtained from the above studies are very encouraging. Wherever, ageing effects/ inferior strength is analyzed, appropriate repair methodology (**Fig. 6**) is being adopted.

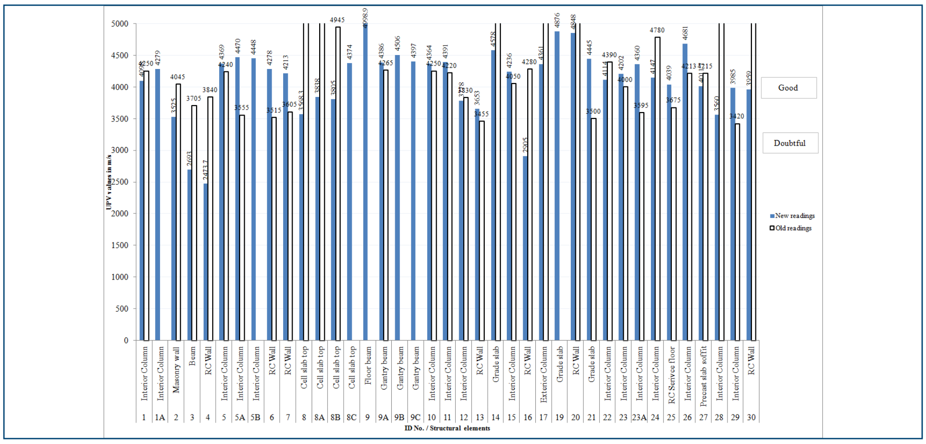

Figure 4: Comparison of Periodic Data on Ultrasonic Pulse Velocity

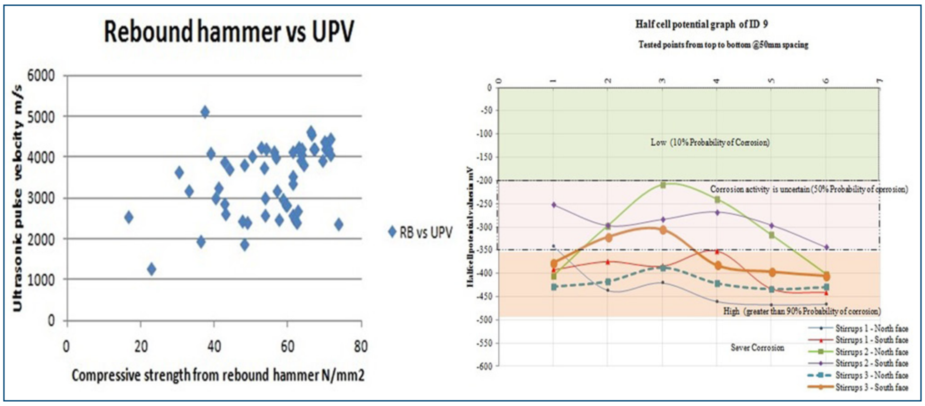

Figure 5: Assessment of Areas to be Repaired

Figure 6: Repair for Corrosion of Reinforcement due to Coastal Environment

Lecture Series

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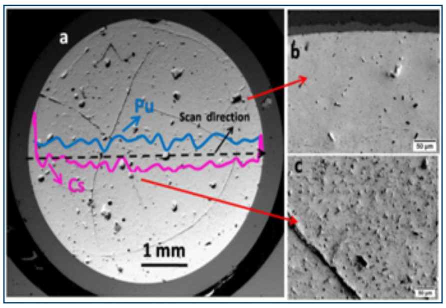
Performance Assessment of FBR Materials through Post-Irradiation Examinations (PIE)

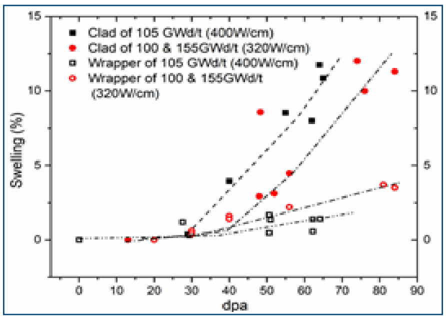
Post-Irradiation Examinations (PIE) of fast reactor fuels and structural materials serves to assess the irradiation performance of various candidate fuels (MOX, carbide and metal) alloys and associated structural materials (of clad/wrapper/vessel), and validate the operational and safety limits on maximum powers, burn-ups and neutron damage. The PIE facility at Radio-Metallurgy Laboratory (RML) of IGCAR, in operation over the last three decades, has catered to evaluating the performance and generating irradiation data on (i) mixed carbide fuel of FBTR at various burn-ups and linear powers, MOX fuel (PFBR annular pellet and sphere-pac forms), (ii) structural materials (SS316, Alloy D9, SS316LN, SS304LN) and (iii) absorber (B4C), reflector (Ni) and shielding materials (WC, FeB).

The PIE facility has been enhanced with several advanced capabilities, including: (i) a glove box-integrated Scanning Electron Microscope (SEM) tailored for micro-analytical characterization of irradiated fuels and structural materials; (ii) a vacuum distillation system designed for the removal of bond sodium from metal fuel pins; and (iii) the incorporation of small punch technique for evaluating the mechanical properties of irradiated steels. Recently PIE of 14.8%EU-6%Zr metal fuel pins irradiated in FBTR to a burn-up of 26 GWd/t have demonstrated satisfactory performance of both fuel and the ferritic steel cladding in terms of swelling, fission gas behavior, microstructural stability, and mechanical properties.

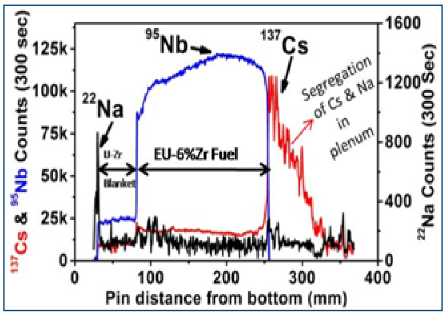
In addition to PIE of irradiated assemblies, the hot cell facility also caters to (i) dismantling fuel subassemblies and dispatch of fuel pins to reprocessing facility, (ii) supporting medical isotope irradiation programs and (iii) failure investigations of radioactive components. The hot cell support systems such as remote handling (MSM, Cranes), fuel transfer systems, ventilation systems, E&I systems, characterization equipment etc. are being refurbished, to ensure continuous utility of the hot cells.



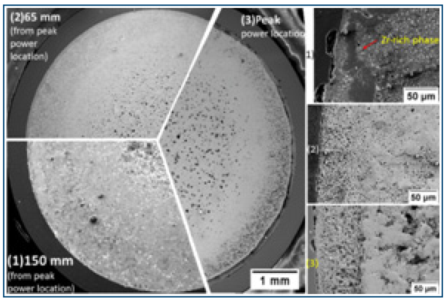
Microstructure of Irradiated High LHR (400 W/cm) Mixed Carbide Fuel of FBTR Showing (a) Elemental Distribution and (b & c) Porosity at Periphery and Center of the Fuel-Clad Cross Section



Comparison of Swelling of SS316 Cladding and Wrapper of 105 GWd/t (400 W/cm) with that of 155 GWd/t (320 W/cm)



Axial Gamma Scan Profile of Nb, Cs and Na in Irradiated EU-6%Zr Metal Fuel Pin



Photomosaic of Irradiated EU-6%Zr Metal Fuel from Three Axial Locations and their Magnified View Near the Fuel-Clad Indicating Interconnected Porosity

Lecture Series

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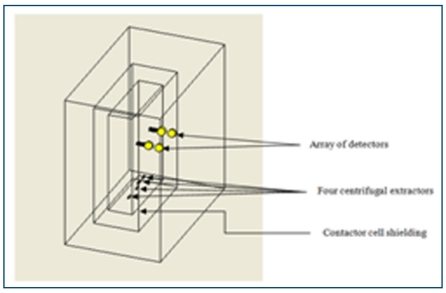
Health Physics Aspects in Nuclear Facilities at IGCAR : Practices and Emerging Challenges

The safe handling of radioactive materials in nuclear facilities depends on the deployment of rigorous health physics practices, that require sustained advancement to adapt to evolving operational challenges. At IGCAR, as a wide range of radioactive materials is handled and stored, it is essential to follow stringent health physics protocols and consistently enhance these practice to meet the emerging challenges. Also, it is mandatory to follow robust radiation protection measure during all the phases of handling and storage of radioactive material. In line with this, this article outlines the key challenges encountered and resolved over decades, including the innovative measures implemented to strengthen safety and radiation protection across various facilities at IGCAR.

Shielding Design of Hot Cells

The processing of spent fuel with a high burn-up of 155 GWd/t in hot cells, posed a significant challenge due to the intense gamma radiation it emits, with a photon source of approximately 10^{15} photons per second, particularly in the energy range of 2–3 MeV. To mitigate this, a thick concrete shield was introduced in hot cell, designed based on detailed point-kernel calculations



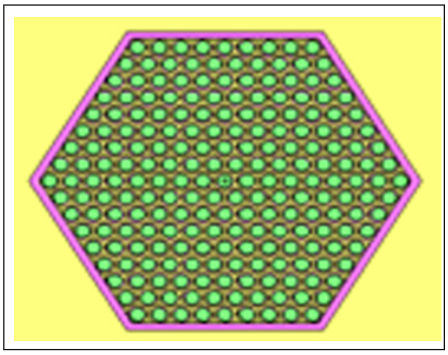
Shielding Design - Modeling

using the in-house **IGSHIELD** code.

Verification of shielding integrity is essential to ensure adequate radiation protection. Radiometry techniques are used to evaluate the attenuation performance of shielding materials. In the DFRP hot cells, a **90 Ci Co-60** source has been used to validate the integrity of shielding integrity, for ensuring there were no voids and reduction of shielding thickness.

Safety Analysis in Fuel Reprocessing

In fuel reprocessing plant, the presence of plutonium as nitrate in solution form, necessitates rigorous criticality safety assessments, because of low values of critical mass in solution form. Criticality calculations are carried out for process cells of Fast Reactor fuel reprocessing plants using established Monte Carlo based codes like **KENO**, **MCNP4C**, and newer open-source Monte Carlo (MC) codes. These are

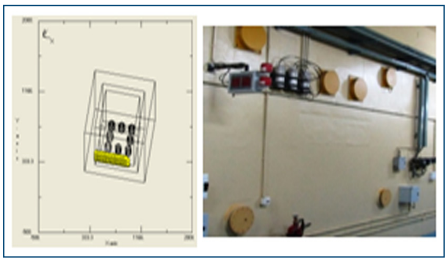


MCNP Model – Fuel Sub-Assembly – PFBR

employed to compute the effective neutron multiplication factor k_{eff} ensuring subcritical margins in process designs.

Design Basis Analysis for Identification of Criticality Alarm System Locations in Fuel Reprocessing Plant (FRP)

In addition, gamma dose rates resulting from hypothetical criticality events in unsafe process tanks are modelled using the IGSHIELD gamma transport code. This modelling is vital for identifying the optimal locations for Criticality Alarm Systems (CAS) around plutonium process cells in FRP and



CAS Location – Modeling and Placement

FRFCF. CAS placement is guided by the criterion that alarm thresholds (typically 4 R/h) are met in these simulations, ensuring prompt detection and response to potential criticality incidents.

Localization of Gas Leaker Fuel Sub-Assembly (GLFSA)

In the absence of Delayed Neutron Detection (DND) counts, identifying gas leaks in the reactor core of FBTR becomes complex. During short-duration operations, the detection of isotopes such as ^{133}Xe, ^{138}Xe, ^{135m}Xe, and ^{87}Kr in Reactor Ventilation Cover Gas (RVCG) samples serve as a key indicator for fuel leakage. By comparing the specific activities of these gases against baseline data, potential GLFSA can be effectively localized, enhancing the reliability of reactor safety diagnostics.

Development of Customized Detection Systems

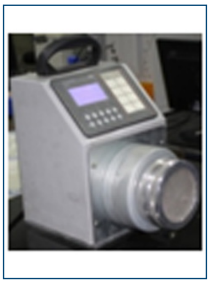
Radiation monitoring has been strengthened through the in-house development of various detector systems tailored to specific operational needs, as shown below. These innovations play a vital role in enhancing the robustness of the radiation protection program at nuclear facilities.

Simulation of Detector Response Functions

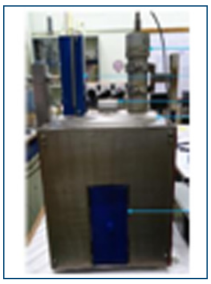
Monte Carlo simulations are increasingly used to model the response functions of **NaI(Tl)** and **HPGe detectors**. These simulations enable accurate determination of detector efficiency over a wide energy range, especially when matching calibration sources are unavailable. Such modelling enhances the precision of in-situ gamma spectroscopy and quantitative analysis.

Dual Phosphor Counter

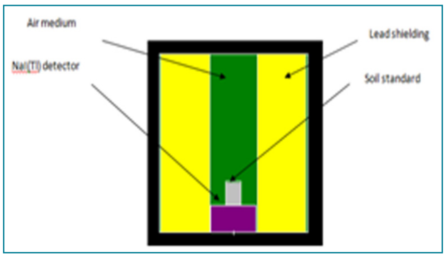
Virtual Reality Model – Radioactive Lab



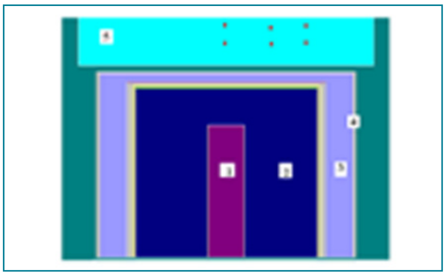
High-Volume Air Samplers



TLD Contamination Monitor



MCNP Model – NaI(Tl)



MCNP Model – HpGe

Radiation Safety Training: Virtual Reality (VR) Integration

Training remains a cornerstone of strong radiation safety culture. A recent innovation in this area is the integration of Virtual Reality (VR) technology into radiation safety training modules. Health Physicist can now experience interactive environments that simulate radiation interactions and safety scenarios, significantly enhancing their comprehension and preparedness. The use of VR headsets enables immersive learning experience that complements traditional training methods.

Conclusion

The health physics practices at IGCAR reflect a proactive approach to radiation safety leveraging advanced modelling, in-house innovations and cutting-edge training methodologies. As nuclear operations continue to advance, the role of health physics professionals in ensuring effective radiation protection becomes increasingly crucial. Continuous and steady focus on innovation, monitoring and simulation is imperative to effectively meet and overcome the emerging challenges in the health physics aspects.

Lecture Series

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Radiation and Life: From Evolution to Therapy - Lessons from *Drosophila*

Drosophila melanogaster serves as a powerful model organism to study the biological effects of ionizing radiation due to its well-characterized genetics, short life cycle, and conserved DNA damage response pathways. Historically used in Hermann Muller's pioneering work, it has provided initial evidence for radiation-induced mutations, which lead to the Linear No-Threshold (LNT) model of radiation effect. Contemporary studies leverage *Drosophila* to investigate low-dose radiation responses, offering insights into non-linear dose-response relationships. These findings challenge the traditional LNT model by suggesting possible thresholds or adaptive responses. Similarly studies from High Background radiation areas of India also challenge the LNT model, suggesting that low-dose chronic exposure may not be as harmful as once believed, and might even induce adaptive protective responses. Thus, studies on *Drosophila* remain essential in revisiting and refining our understanding of the effects of radiation on biological systems. The preliminary studies at RDS, IGCAR also finds similar supportive results related to effect of LDIR on *Drosophila*. Initial studies on the impact of Low-Dose Ionizing Radiation (LDIR) on disease resistance and lifespan showed a mild increase in disease resistance following LDIR exposure. Similarly, *Drosophila* samples were exposed to varying doses of cobalt-60 (^{60}Co) γ-rays, ranging from 0.1 Gy to 100 Gy, to evaluate the effect of radiation on DNA damage. The study was conducted on the haemolymph cells of *Drosophila*. The cells were lysed, and the DNA fragments were electrophoresed in low-melting agarose gel, creating a "comet" with a head (intact DNA) and a tail (fragmented DNA). Electrophoresis was performed under conditions of 12 V and 50 mA. DNA was stained with acridine orange fluorescent dye, and the comet structures were visualized using a Zeiss Axio Observer A1 fluorescence microscope. Based on the comet assay analysis, detectable DNA damage was observed at doses above 10 Gy, where a clear comet tail was measurable. The study results indicated that DNA damage becomes detectable at doses of 10 Gy and above in *Drosophila*. However, changes in the dose rate had a negligible impact on the study outcomes at this dose. Supporting evidence was also obtained from DNA repair-associated marker genes. These findings suggest that the foundational assumptions of the Linear No-Threshold (LNT) model, which posits that any amount of ionizing radiation poses a risk, may not fully account for biological responses observed at low doses. The detectable DNA damage only at higher thresholds and the minimal impact of dose rate indicate the need for a more nuanced understanding of radiation effects. Therefore, further well-designed experiments using *Drosophila* as a model organism are essential to reevaluate and possibly refine the LNT hypothesis.

Figure 1: Experimental Set up for Irradiation of *Drosophila*

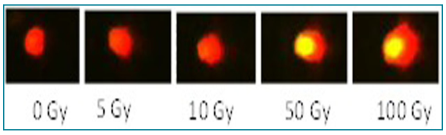

Figure 2: Images of Comets of *Drosophila* haemolymph exposed to γ-rays

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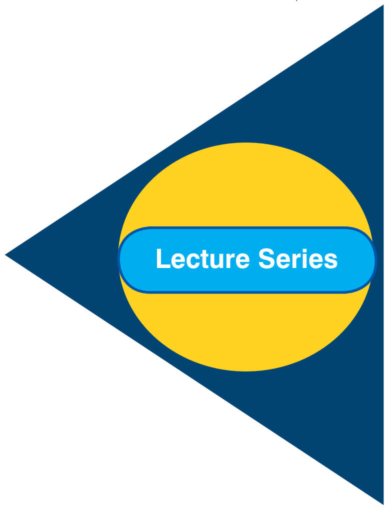

In-Plant Radioactive Waste Management of FBR

Radioactive wastes generated during operation, maintenance and decommissioning of Fast Breeder Reactor have to be managed in a safe manner to ensure protection of human health and the environment from the undue effects of ionising radiation without imposing undue burden on future generations. Solid, liquid and gaseous wastes generated in the plant are handled and stored in the plant and after required treatment they are safely discharged / disposed through terrestrial route, aquatic route and atmospheric route respectively. Important aspects of FBR waste management are the presence of sodium isotopes (Na^{22} and Na^{24}) in the wastes, requirement of reactor operation with failed fuel pin in the form of gas leaker in the core, high concentration of activity in components, handling of discarded core subassemblies, deposition of radioactivity on primary components, high cover gas activity, etc. Main sources of radioactive solid wastes are discarded core subassemblies (SA), discarded reactor/auxiliary system components/mechanical parts, active filters/resins/tools/PPE, etc. Based on the radioactivity content and surface dose, the solid wastes including discarded core subassemblies are disposed in brick wall trenches, RCC Trenches and tile holes of Waste Management Facility after required cooling in the storage facilities and dismantling. Typically, four streams of radioactive liquid wastes generated in the plant. Potentially active liquid effluents are generated from showers and wash basins in the change rooms of active buildings and active laundry. Active low level liquid wastes comprise of the leakages and drains from radioactive equipment/systems. These two streams are treated by filtration and ion-exchange process in Liquid Waste Management Plant. Medium level liquid effluents generated from washing of spent subassemblies during fuel handling campaign and occasional chemical decontamination of primary sodium wetted components are processed as two separate streams due to the difference in chemistry and radioactivity. Specific treatment process involving combination of chemical precipitation, ion-exchange and filtration is planned for medium level effluents in the treatment facility. Liquid effluents after treatment are discharged to sea with dilution as required. Sources of radioactive gaseous effluents are Ar^{41} and fission gases (in case of fuel pin failure) released from primary argon cover system, vents from other primary gas systems, fuel and component handling systems and ventilation exhausts from radioactive buildings. Radioactive gaseous waste management is done by three systems. Cover Gas Purification System removes Fission Product Noble Gases (FPNG) from the reactor cover gas in the event of fuel pin failure by means of cryogenically cooled charcoal adsorption column. Radioactive Gaseous Effluent Circuit stores high activity effluents for sufficient time in delay tanks. Plant ventilation system maintains the required air changes in radioactive buildings and exhausts are passed through filtration system. All gaseous releases to atmosphere are through a stack of sufficient height.

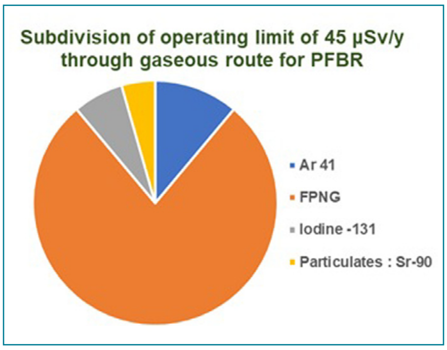

Figure 1: Specified Operating Limits for Expected Constituents of Gaseous Effluents from PFBR

Final aim of the radioactive waste management systems is to control the radioactive discharges to environment well within the apportioned dose limits allotted to the plant by the regulatory body. The total apportionment is subdivided for releases of effluents in aquatic route and atmospheric route and within these subdivisions, safe operating limits are specified for the plant. In case of Prototype Fast Breeder Reactor (PFBR), total apportioned dose is 100 μSv/year which is divided as 10 μSv/year for liquid route and 100 μSv/year for gaseous route with operating limits of 2.5 μSv/year and 45 μSv/year respectively. Effluent discharges within operating limits are ensured by adequate treatment systems. Subdivision of operating limits for various categories of gaseous releases from PFBR is shown in **Fig. 1**.

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Nanofluids and Nanocomposites for Industrial and Societal Applications

The Smart Materials Section in PMD/MCG/MMG works on the development of novel functional nanomaterials directed towards various industrial and societal applications. A wet chemical synthesis facility has been developed over the years for the preparation of surface-functionalized nanoparticles, nanoemulsions and nanocomposites with a special focus on developing colloidally stable ferrofluids and magnetic nanoemulsions for magnetic fluid hyperthermia, ferrofluid-based sealant development, colloidal force measurements and sensor applications.

When exposed to an external static magnetic field, the dispersed magnetic nanoparticles or nanoemulsion droplets form linear chain-like structures demonstrating unique optical, thermal, rheological, and magnetic properties which can be employed for various applications such as ferrofluid-based sealants and optical defect detection sensor. Ferrofluid-based sealants are being developed as an alternate to the conventional mechanical sealing for the primary sodium pumps of future breeder reactors, where colloidally stable ferrofluids undergo disorder-to-order transition under a strong static magnetic field to provide dynamic sealing (Fig. 1). Further research is in

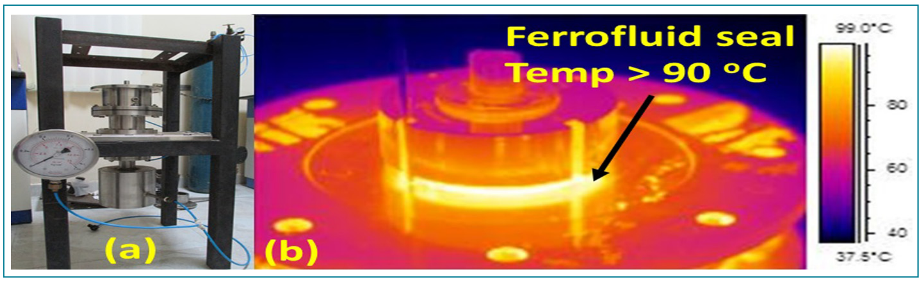

Figure 1: (a) Set-up for Testing Ferrofluid-based Sealants (in Collaboration with FRTG). (b) Typical Infrared Image of the Seal-Region

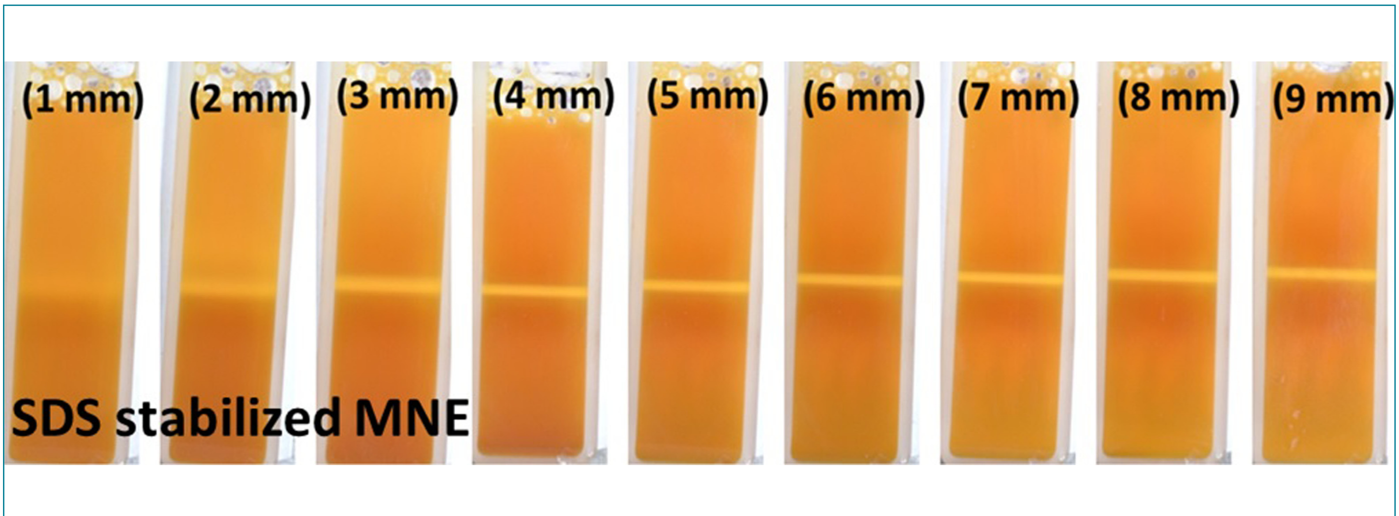

Figure 2: Typical Optical Patterns in the Magnetic Nanoemulsion Sensor for Defects of Varied Depths (Sample Thickness ~ 10 mm). With Increasing Defect Depth, the Amplitude of Flux Leakage Increases Leading to Higher Contrast between the Optical Signatures from the Defect and Defect-Free Regions

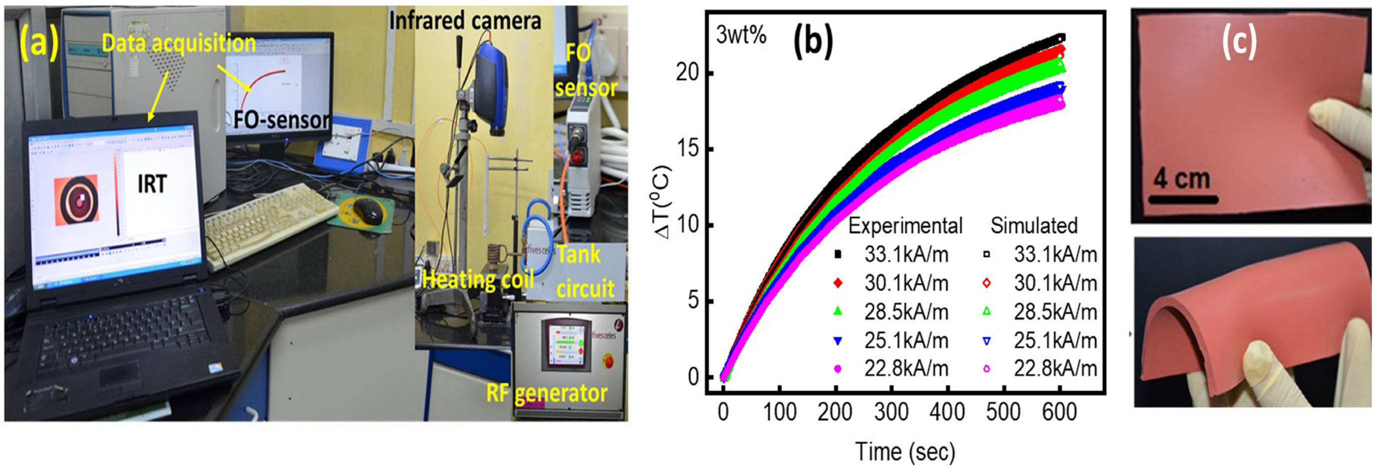

Figure 3: (a) Magnetic Fluid Hyperthermia Set-up at Smart Materials Section. (b) Typical Experimental and Theoretical Curves showing Alternating Magnetic Field-induced Temperature Rise in Ferrofluids. (c) Lightweight and Flexible Polymer Nanocomposites Developed for Diagnostic X-ray Shielding

progress in collaboration with FRTG to develop high temperature stable ferrofluids with long dwelling time.

Magnetic nanoemulsion-based large area optical defect sensors have been demonstrated, where the magnetic flux leakage from the defect region in a magnetizable material (like carbon steel) causes orientational ordering in the magnetic nanoemulsion, with inter-droplet spacing commensurate with the amplitude of the leakage flux. This gives rise to optically discernible patterns over the defect regions (**Fig. 2**).

Apart from the above-mentioned industrial applications, magnetic nanoparticles and ferrofluids are widely used in various societal and bio-medical applications, such as magnetic fluid hyperthermia, which is being actively studied. Under the action of an alternating magnetic field, superparamagnetic nanoparticles generate heat due to the Neel-Brown relaxation losses. The magneto-thermal energy conversion is beneficial for localized cancer therapy, where surface-functionalized and bio-compatible magnetic nanoparticles are proposed to be injected into the cancerous tissues and subjected to the alternating magnetic field resulting in thermal therapy (localized temperature rise beyond ~42 °C). To probe the hyperthermia efficiency, a magnetic fluid hyperthermia set-up has been developed (**Fig. 3a**), and surface functionalized iron oxide, cobalt ferrite and other magnetic nanoparticles have been prepared in-house. Detailed magneto-structural characterizations have been performed to correlate the hyperthermia efficiency with the size, shape, and magnetic properties of the nanoparticles. In addition, numerical simulations are being carried out to understand the structure-property correlations and magneto-thermal energy conversion (**Fig. 3b**) and the resultant temperature distributions. Further work is in progress to develop bio-compatible magnetic nanoparticles suitable for multi-modal applications like magneto-thermal drug delivery and magnetic resonance imaging in addition to magnetic hyperthermia. Lightweight, flexible, and lead-free polymer nanocomposites are being developed with Gd_2O_3, Bi, and Bi_2O_3 nanoparticles loaded in different concentrations for the use in diagnostic X-ray shielding (**Fig. 3c**). These silicone polymer nanocomposites exhibit ~92% attenuation in the diagnostic dental X-ray range (at ~50 keV) and were prepared at room temperature using solution casting. The nano-filler composition is optimized to make use of the dual k-edge effects over an extended diagnostic X-ray range up to ~125 keV. Further works are in progress to develop polymer nanocomposites suitable for high energy X-ray and gamma ray shielding in collaboration with SQRMG.

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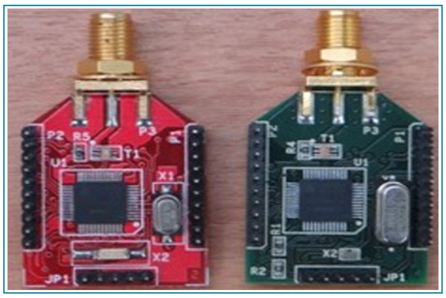
Role of Wireless Sensor Networks in Nuclear & Non-nuclear Applications

Wireless Sensor Network (WSN) refers to network of spatially dispersed sensor nodes that monitor and record the physical conditions of the environment and forward the collected data to a central location. WSN technology has a potential to revolutionize the way we sense and transmit the information. Some of the significant applications are process monitoring, military surveillance, structural health monitoring, environment monitoring, medical monitoring, wild-life monitoring, ocean monitoring, etc. Among the innumerous applications, the WSN team in IGCAR is mainly working towards nuclear applications and also as offshoot non-nuclear applications.

In-house Developed WSN Sensor Node

The components involved in WSN are sensor nodes- to sense the parameter, process and transmit, basestation- to collect data and connect the outside world and router nodes- to route the data towards basestation. The PHY and MAC layers of WSN are defined by IEEE 802.15.4 standard. WSN is operating with 16 channels at 2.4 GHz (unlicensed ISM band) in 250 kbps data rate.



In-house Developed Transceiver

As commercially available nodes are not suited for establishing WSN in nuclear facilities due to stringent requirements for reliability and safety, WSN nodes were designed and developed in-house. They have IP rated enclosures, industrial grade components, battery backup, solar power options, etc. They are qualified for EMI/EMC, environmental and seismic qualifications as per PFBR standard. IEEE 802.15.4 transceiver, wireless network debugging and monitoring tools, quad patch antennas, fault tolerant advance basestation and large scale test-bed facility were also designed and developed in-house.

Sodium Leak Detection WSN at INSOT

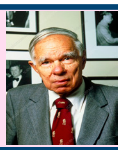
Wireless sensor networks were deployed for radiation monitoring at DAE complex, sodium leak detection at INSOT, temperature and humidity monitoring at SADHANA & Computer Centre, temperature, flow, pressure and vibration monitoring at FBTR, pump control at DFRP & CORAL, Temperature monitoring at SGTF, Intrusion detection at DFRP fuel gate and also for water quality monitoring at RO desalination plant and multiple water bodies of IGCAR.

Water Quality Monitoring WSN at Reservoir

Experimental studies were initiated on signal penetration across RCB, FBTR, performance analysis on various WSN protocols, secure wireless communication, irradiation experiments, energy harvesting and LoRa - long range wireless protocol. The collaborative projects such as WSN for explosive detection, detection of slope stability at avalanche site and development of pattern switching patch antenna for RCB, FBTR were successfully completed. Presently, to improve the data security, the quantum key distribution algorithms are being explored.

Seaborg Memorial Lecture – 2025

May 21, 2025, Sarabhai Auditorium, IGCAR



The Indian Association of Nuclear Chemists and Allied Scientists, Southern Regional Chapter (IANCAS-SRC), organized a technical talk, namely the "Seaborg Memorial Lecture-2025," on May 21, 2025, at Sarabhai Auditorium, IGCAR. The "Seaborg Memorial Lecture" is an annual technical talk series conducted in the honor of birth anniversary of **Dr. Glenn Theodore Seaborg**, born on April 19, 1912. Dr. Seaborg was an eminent American chemist whose pioneering contributions to the discovery of several transuranium elements laid the foundation for the modern actinide research. This year, around 100 audience members attended the talk from various groups across IGCAR.

Dr. K. Sundararajan, Welcome Address and Introduction to IANCAS

Dr. K. Sundararajan, Head, Analytical Chemistry & Spectroscopy Division, and President, IANCAS-SRC, delivered the welcome address and also highlighted the IANCAS-SRC activities, intended to popularize the nuclear sciences among the scientific and student communities in the country. He stressed on the mandates of the IANCAS main body headquartered in Mumbai towards the promotion of the subject of nuclear and radiochemistry, and the uses of radioisotopes and radiation sources in academics, research, agriculture, medicine, and industry. He also stressed up on the Southern Regional Chapter of IANCAS (IANCAS-SRC) activities that focus on organizing the workshops for the students of schools and colleges across South India, and in conducting two technical talks annually, namely, "Seaborg Memorial Lecture" and "Curie Memorial Lecture".

Dr. Sapna Nangia, Speaker of the Seaborg Memorial Lecture – 2025

The speaker of the Seaborg Memorial Lecture-2025 was **Dr. Sapna Nangia**, Director, Head-Neck and Breast, at Apollo Proton Cancer Centre, South and South East Asia's first proton therapy facility. She oversees Proton Therapy and Radiotherapy for skull base, head and neck, breast, and gynecological cancers. Dr. Nangia has pioneered the development of proton therapy for the cancer treatment applications. Her talk was titled 'Democratizing Proton Therapy for Cancer Treatment: How and Why? In her talk, Dr. Sapna discussed the different types of cancer, their causes, treatment protocols, and a survey of cancer types across different regions of the country, along with the relevance of proton therapy in cancer treatment. She also emphasized the advantages of proton therapy in treating various cancers without post-therapeutic side effects. She also stressed the importance of democratizing the proton therapy by popularizing the treatment procedure, reduced toxicity and increasing the number of treatment centers. She discussed the latest developments in this field, shared the cost comparison of treatment, and highlighted its benefits compared to other treatment procedures. She also spoke about her initiatives in establishing proton therapy center, the first-of-its-kind facility in the country. The talk was well received by the audience. She was honored by Dr. V. Jayaraman, Director, Materials Chemistry & Metal Fuel Cycle Group. Dr. A.S. Suneesh, Secretary, IANCAS-SRC, proposed the vote of thanks. He thanked the executive committee members of IANCAS-SRC, Dr. N. Desigan, Dr. G.V.S. Ashok Kumar, Dr. Jammu Ravi and Mrs. Sushmita Dey for their sincere efforts for the successful execution of the event.

Reported by:

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Theme Meeting on "Quantum Frontiers: Mechanics, Information & Entanglement: QMINENT-2025"

A two days theme meeting titled "Quantum Frontiers: Mechanics, Information & Entanglement: QMINENT-2025" was held on 19th to 20th June 2025 and was jointly organised by Materials Science Group (MSG) & Engineering Physics Group (EPG) of RDG in association with Kalpakkam chapter of Material Research Society and Indian Physics Association at Sarabhai Auditorium, IGCAR, Kalpakkam. **Prof Emeritus V. Balakrishnan**, IIT-Madras was the chief guest of the event. This theme meeting was organized to commemorate the centenary year of the development of foundational theories and mathematical frameworks of quantum mechanics, established around 1925. The year 2025, declared by the United Nations as the International Year of Quantum Science and Technology to mark this significant milestone in scientific history.

The theme meeting brought together leading researchers and experts from premier institutions such as IIT Madras, IGCAR Kalpakkam, and KREA University. The event featured keynote lectures and insightful talks covering a broad spectrum of topics, including quantum optics, information theory, quantum simulations, entanglement, error correction, and cutting-edge developments in quantum materials and technologies. With engaging discussions on foundational aspects like symmetry principles, Bell's inequalities and Wigner functions, as well as practical themes like quantum tomography and polarization qubits. The meeting concluded with a panel discussion on the future of quantum science in the coming decades. The panel explored questions related to the direction of quantum computing, the most promising types of quantum bits (qubits), the potential for task-specific quantum machines, and whether the current excitement around quantum technology is justified. While acknowledging the surrounding hype, the discussion highlighted the value of public interest and emphasized the need for more research, regular scientific gatherings, collaboration between institutes, and active participation by young scientists to support the goals of the National Quantum Mission.

Reported by

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Engineering Physics Group
Reactor Design Group

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Materials Science Group

AWARDS & HONORS

- **Shri S. Shyam Kumar** bagged the STT-Hillert Scholarship for presenting a poster titled "Isopiestic Vapour Pressure Measurements and Thermodynamic Modelling of the La-Te System" by S. Shyam Kumar, Soumya Sridar, Rajesh Ganesan at the CALPHAD 2025, 52nd International Conference on Computer Coupling of Phase Diagrams and Thermochemistry, conference in Paradise Hotel, Busan, South Korea held between May 25–30, 2025.
- He won the Best Poster Award for presenting a poster titled "Vapour Pressure Measurements in Nd-Te System" by S. Shyam Kumar, Rajesh Ganesan at the Thermans–2024, BARC, Mumbai, held between January 16–18, 2024.
- **Shri K. Palani**, B.P. Arun, G. Elaiyaraja, Vasanthi Sekar, S. Manickam, Pratik Bhardwaj, R.V. Satheeshkumar, C. Murugesan, J.W. Reuben Daniel, A. Palanivel, N. Subramanian, A.K. Karthi, M.S. Gopikrishna, M. Dhananjeyakumar, M. Mathews Geo, K. Rajan, received First Prize for Poster Presentation titled "Development, Installation and Commissioning of Modular Remote Sampling Station Title for Sampling Cell of DFRP" in the 4th Triennial DAE-BRNS National Symposium on Recent Advances in Nuclear Fuel Cycle activities (NUFUC-2025), February 6–8, Tarapur, India.
- **Dr. Anees P.**, MMS, DDSD, MSG delivered an invited talk at the International Conference on "Electronic Structure Theory and Applications" held at IISER Pune during May 18–21, 2025.
- **Dr. Julie** from ARDSS, DDSD, MSG has been awarded certificate of appreciation under the aegis of HBNI's constituent institution, IGCAR in the discipline of physical sciences for the year 2024 for her Ph.D. thesis titled "The Impact of Ion Irradiation on the Texture, Grain Boundary Characteristics, Void Swelling Behavior and Surface Morphology of Nano Crystalline Ni".
- **Dr. Gopinath Shit**, SO/E, CSTD received the IIM Kalpakkam Chapter – Best Journal Paper – General Category – 2024 for the paper titled "Improvement of Intergranular Corrosion Resistance of SS 304L by Grain Refinement Followed by Gamma-ray Irradiation Treatment for the Application in the Back End of the Nuclear Fuel Cycle", Materials Chemistry and Physics 313 (2024) 128750. Authors: Gopinath Shit, A. Poonguzhali, S. Ningshen..
- **Dr. Chanchal Ghosh**, SO/F, PMD received the IIM Kalpakkam Chapter – Best Journal Paper – General Category – 2024 for the paper titled "Atom Column Analysis of (Fe,Cr)2B Phase in High B Containing Ferritic Steel", Materialia 33 (2024) 102007. Authors: Chanchal Ghosh, Akhil G. Nair, Arup Dasgupta, R. Mythili, R. Divakar.
- **Dr. Veerababu J.**, SO/E, MMD received the IIM Kalpakkam Chapter – Best Journal Paper – General Category – 2024 for the paper titled "Slip to Twinning to Slip Transition in Polycrystalline BCC-Fe: Effect of Grain Size", Physica B: Condensed Matter 694 (2024) 416465. Authors: Veerababu J., A. Nagesha, Vani Shankar.
- **Ms. Athulya V.**, SRF, HBNI received the IIM Kalpakkam Chapter – Best Paper Award (Young Researcher Category) – 2024 for the paper titled "Electrodeposition of Myristate based Superhydrophobic Coatings on Steel with Enhanced Corrosion Resistance and Self-Cleaning Property", Surface and Coatings Technology 489 (2024) 131114. Authors: Athulya V., S.C. Vanithakumari, A. Ravi Shankar, S. Ningshen.
- **Ms. Aishwary Vardhan Pandey**, SRF, HBNI received the IIM Kalpakkam Chapter – Best Paper Award (Young Researcher Category) – 2024 for the paper titled "Development of a Novel Approach to Correlate Small Punch Fatigue with Uniaxial Ratcheting Fatigue", International Journal of Fatigue 190 (2025) 108585. Authors: Aishwarya Vardhan Pandey, K. Mariappan, V. Karthik, Vani Shankar, R. Divakar.

Bio-diversity @ DAE Campus, Kalpakkam

Common Moorhens is a hen like bird with yellow-tipped red bill and red fronted shield, red irises, blackish head and neck, slate grey underparts and dark olive-brown upperparts, white under tail feathers and white thigh and yellow-green legs and red above the knee. They are found singly or in pairs or in small parties.

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