IGC newsletter

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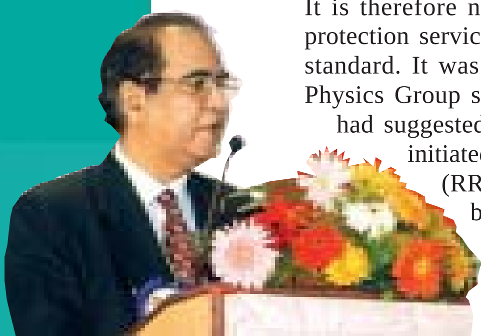
From the Director's Desk

Safety Research at IGCAR

Department of Atomic Energy places high emphasis on safety of the operating personnel, public and the environment in all its operations. In line with DAE's policy, Indira Gandhi Centre for Atomic Research (IGCAR) has laid strong emphasis on all safety related work. Safety Research and Development was one of the programmes which were inscripted in the very founding document of the Centre. It is therefore not surprising that the operational radiation protection services in the Centre have always been of world standard. It was Dr. A.K. Ganguly's vision that the Health Physics Group should think beyond its operational role. He had suggested that activities in safety research should be initiated at the then called Reactor Research Centre (RRC). Chosen by Dr. A.K. Ganguly, the team led by Shri L.V.Krishnan sowed the seeds for the Safety Research activities at Kalpakkam. Way back in 1972-73, an exclusive study programme of fast reactor safety was established in the Centre with the mandate given to Dr. D.V. Gopinath for actively pursuing front line research in safety sciences and technologies. Appreciating that no scientific programme can be complete and vibrant without the back up of relevant basic research associated with it, he along with his group of colleagues, envisaged a healthy blend of basic research and application oriented programmes in safety studies at the Centre. A full-fledged laboratory dedicated for the radiation safety related activities was inaugurated in the name "Safety Research Laboratory (SRL)" in 1976.



The most prominent research issues taken up at the inception of SRL were investigations of theoretical and experimental radiation physics problems in complex media, development of computer codes in radiation physics, characterisation of shielding properties for fast neutrons and hard gamma rays, environmental research for radiological impact assessment, research in dosimetry for developing personal monitoring and assessment techniques, engineering issues related to mitigation of hazards from fuel coolant interactions, reactor

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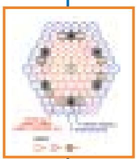
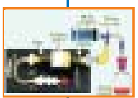


Status of FBTR



A novel and simple technique to irradiate blood cells in vitro with alpha radiation for cytogenetic analysis

Forum for Young Officers

Thermal Hydraulic Investigation of IFTM Shield Plug

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Technical Meeting (Third Research Coordination Meeting) of the IAEA CRP

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vessel response under core disruptive accident, radioactivity transport in coolant streams, sodium fire study for safety and higher transient power dissipation. Various pertinent issues of technology related activities were also taken up. These include nuclear facilities site evaluation, leak testing of radioactive containments, radiation instrumentation etc.

Theoretical Research and Code Development

Upon his arrival in Kalpakkam, Dr. D.V. Gopinath continued his theoretical and computer code developmental work for radiation transport calculations. Radiation streaming through ducts within a shield was extensively studied yielding valuable insights into the problem and providing innovative means of its mitigation. The computer code ASFIT, developed by the group is considered to be one of the most accurate and efficient tools for gamma ray transport. A comprehensive experimental system was designed and implemented for validating the code. Spearheaded by Dr. V.M. Raghunath and Dr. P.K. Bhatnagar, the experimental program yielded sustained successes for validating the ASFIT code. Build up factors derived from the calculations using ASFIT code have gained international recognition. The code and the results are listed in Radiation Shielding Information Centre (RSIC) in Oak Ridge National Laboratory, USA for worldwide utility. Most of the data that has gone into the ANSI Standard for gamma ray attenuation coefficients, ANSI/ANS-6.4.3, were either provided by this group or generated by others using the code ASFIT.

ASFIT code and build up factors derived from experiments have gained international recognition and the results have been listed in Radiation Shielding Information Centre (RSIC) in Oak Ridge National Laboratory, USA for world-wide utility. Most of the data that has gone into the ANSI Standard for gamma ray attenuation coefficients, ANSI/ANS-6.4.3, were either provided by this group or generated by others using the code ASFIT

As a part of the radiation transport experimental programme, a 14 MeV Neutron Generator was commissioned and a spectrometer based on NE-213 liquid scintillation with a pulse shape discriminator designed in-house, was set up. Various combinations of concrete wall blocks were tested for effective dose reduction. Gadolinium doped high density concrete was found suitable for biological shielding of fast reactors. Another equally significant outcome of the experimental study on the spectral distribution of scattered radiation was the optimized economic shield design. A byproduct of this study beneficial to the nuclear industry and X-ray installations, is the introduction of just 2-mm lead lining at the corner locations of the ducts (for photon energies upto 1.25 MeV) which reduces the radiation exposures by 93%.

The 'Burst-Studies' programme started at Bhabha Atomic Research Centre by Dr. D.V. Gopinath, Shri L.V. Krishnan and Shri K. Santhanam (who later became Chief Adviser (Technology) in Defence Research and Development Organisation), in collaboration with Explosives Research & Development Laboratory, Poona, was actively pursued at SRL. Experimental studies on the response of reactor vessel during a Core Disruptive Accident situation were carried out by Shri L.V. Krishnan and others with simulation of reactor accidents by chemical explosives in simple geometry. With the development of computer facilities at IGCAR, a computer code for prediction of structural response under dynamic stress conditions was developed and validated with the experiments conducted at Terminal Ballistics Research Laboratory, Chandigarh.

The code development activities pursued at SRL had its academic spin-offs. With active involvement of Dr. A. Natarajan, several algorithms for computing mathematical functions related to physical sciences were developed and tested. Algorithms for a variety of Fermi-Dirac integrals, X and H functions, Randles Sevcik function, Hadamard finite part integral and Cauchy singular integral were developed. It is a matter of pride that IGCAR Fermi-Dirac integral algorithm needed less than a minute on a humble PC-386 while a Los Alamos algorithm took 2-1/2 minutes on mighty CRAY. No doubt that the team got noticed by international peers who built collaborations for extensive interactions. An indigenous code for radioactivity transport in FBR coolant circuits has been developed and transport of radioactive gases in interconnected buildings has been studied using PHOENIX code.

Criticality safety is also one of the theoretical aspects focused by the Group, keeping in mind safety of reprocessing facilities. International codes were commissioned in shortest possible time for immediate applications of neutron transport calculations in complex geometries. At Tarapur, the spent fuel storage pool was full and a more compact stacking arrangement was needed. In order to ensure safety against accidental criticality, Monte Carlo code was initially applied for Tarapur case. Measurements of neutron levels in the pool were taken up in parallel, to correlate with calculations and a safety case was established for the compact configuration proposed. The expertise thus gained led to more and more criticality calculations for the Reprocessing Program by Dr. C.R. Gopalakrishnan. After his untimely demise, this expertise is being nurtured with same vigour by his colleagues, for the current programme at the Centre.

Facilities for Radiation Research

Setting up of a Health and Safety Laboratory (HASL) to house various facilities for operational health physics and radiation research, was a priority area of the Group. The task was taken up by Shri A.R. Sundararajan, the main architect of the present HASL laboratory. State of the art facilities such as counting room, whole body monitoring, bio-assay laboratory, health physics instrumentation laboratory, a safe radioactive source room have been built at HASL. Involving the operational health physicists in R&D programs was also his initiative and this continues to provide avenues for academic achievement and intellectual pursuits. It is noteworthy to mention that many of our members are part of the faculty in institutions such as Oil and Natural Gas Corporation Ltd., Sri Ramachandra Medical College, Anna University, Madras University and Bharathidasan University for topics related to radiation physics and radiation protection.

> **When the National Calibration Reference Centre, Canada undertook an intercomparison exercise for lung counting, our whole body counting facility was able to identify the radioisotopes with great ease and quantify them with an associated error of ± 3.0 % and joined the club of top 10 laboratories in the world.**

An arc chair geometry wholebody counter, and a shadow shield bed detector were the first major Health Physics facilities commissioned in the year 1982. A shielded room for whole body counter, which existed in Old Yatch Club, Mumbai was also transported and is installed at HASL. The specialty of the steel room is that the steel has been extracted from old ships, which were built prior to World War II, known to contain inherently very low levels of fallout activity. The shielded room is essentially for establishing a plutonium lung counting facility, an uphill task that demands ultra low background environment. The baseline whole body dose data generation of all the radiation workers at IGCAR started in the year 1983. Meanwhile International Atomic Energy Agency had organized an intercomparison exercise to validate the realistic chest phantom developed by Lawrence Livermore National Laboratory for Plutonium and Americium lung measurement. An international workshop to discuss the results of this was held at RRC, now IGCAR, during the period Nov, 1984. Since then, HASL has participated in National and International intercomparison exercises periodically. In 1996, when the National Calibration Reference Centre, Canada undertook a similar exercise, our facility was able to identify the radioisotopes with great ease and quantify them within an error of ± 3.0 % and joined the club of top 10 laboratories in the world. The third periodical intercomparison exercise by IAEA is currently on. On a routine, about 700 persons from hot facilities of the Centre are scanned annually by this facility.

Bio-assay technique to estimate the amount of radioactive material ingested by the worker has been established. Various biodosimetry techniques to measure accidental exposures of radiation workers due to any inadvertent accident, such as chromosome dicentric assay, micronuclei assay, translocation using fluorescence in-situ hybridization (FISH) assay, comet assay and Hypoxanthine Guanine Phospho Ribosyltransferase (HPRT) mutation assay have been standardized to evaluate accidental exposures of radiation workers. Similarly various bioassay techniques for estimating uranium, thorium and plutonium in urine samples have been standardised. The biodosimetry laboratory is focusing research in the frontier areas of modern molecular biology to establish new techniques to measure genetic changes and gene expressions following exposures to low doses of gamma and alpha radiations. Our facility has participated in two international inter-comparison exercises, one organized by the European Commission in the year 1996 and the other by IAEA in the year 2003. The results of inter-comparison exercises have confirmed that our performance has been on par with other countries, which are pursuing such activities.

Radon laboratory facility at Radiological Safety Division is yet another premier lab in the country involved in multifaceted activities such as estimation of radioactivity content in fly ash (a current topic of national importance) and diffusion properties of noble radioactive gases through concrete etc. Gamma irradiation facility with two Gamma Chambers with 900 and 5000 ml irradiation volume respectively has been commissioned for irradiation of different types of specimens and materials. These are being extensively used by researchers and engineers in the Centre as well as by various educational institutions, universities, laboratories and industries. Thanks to continuous upgradation and excellent maintenance, the whole-body counting lab, nuclear counting lab, Radon lab and the Thermoluminescent Dosimetry Lab have been accredited by Atomic Energy Regulatory Board.

The Compton Profile Spectrometer facility, arguably the first of its kind in India, is the result of research in Bremmstrahlung spectroscopy and gamma scattering. This facility has been successfully utilised for the measurement of isotropic and directional profiles of 3d and 4d group of metals, gallium arsenide semiconductor, a few ionic solids and important shielding materials. An unique non-destructive testing method based on gamma scattering has been

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established for determining density anomalies, radiation shielding integrity, moisture profile, detection and location of flaws and for assessment of structural damage, irradiation and temperature effects in reactor concrete structures, etc. A transportable gamma scanning device has been designed to serve as a non-destructive testing device for in-situ testing of reactor structural materials.

For a thorough and systematic study of aerosol behavior in a containment building, an Aerosol Test Facility (ATF) has been designed, fabricated and made operational. The study is essential in the analysis of reactor accident and source term evaluation. A validated aerosol code has been developed for post accident fast reactor safety studies. The sodium oxide aerosol behavior in closed vessel and the empirical formulae derived on the basis of sodium fire experiments have been used for estimating aerosol source term for a hypothetical core disruptive accident (CDA). Experiments such as (i) agglomeration of aerosol and settling pattern in a closed chamber and (ii) deposition of aerosol in the presence of gamma field have been conducted. It has been observed that the aerosol agglomeration is much faster in the presence of radiation field.

Safety Group has vigorously pursued collaborative research in frontier areas; the emergence of atmospheric study programme is an example of a systematic and synergetic multi institutional activity. An operational Decision Support System (DSS) functioning in real-time in live mode has been a dream hitherto unfulfilled in India. The DSS development was taken up in mission mode in collaboration with institutions like National Centre for Medium Range Weather Forecasting, India Meteorological Department, Indian Space Research Organisation, National Bureau of Soil Survey - Land Use Classification, Indian Agricultural Research Institute, Survey of India and Safety Research Institute – Atomic Energy Regulatory Board. The team has developed an atmospheric dispersion model working in tandem with the state of art meteorological model MM5 that provides input to the DSS. The system is functioning as a 'Live Tool' predicting 24 hour plume spread for a hypothetical release. The massively parallel high resolution numerical forecast model has been tested in various cluster configurations at Institute of Mathematical Sciences and has been running for the past couple of years in a tiny distributed memory (DM) cluster, perhaps the first of its kind at IGCAR. Further, with the advent of information technology, a splendid combination of three 'S' systems namely the Remote Sensing, Global Positioning System and Geographic Information System could be comprehended through software. Thus the dream could be realised and a Web enabled DSS for nuclear emergency management and mitigation is in place. In order to fulfill requirements of site specific meteorological measurements and field experiments for model validation, a series of experiments known as CABLE (Coastal Atmospheric Boundary Layer Exp.) were initiated eight years ago in which country's premier institutions like Institute of Information Technology & Management - Pune, IIT-Chennai, National Aeronautical Laboratory - Bangalore and BARC have participated. In a subsequent campaign, a team of scientists from Universitat fùr Bodenkultur (BOKU)-Vienna took part along with their mini-Sodar and other instruments. Special towers were designed by Structural Engineering Research Centre, Chennai for wind load study. Meteorological field measurement facility with multiple towers, sonic sensors, tethered balloon sondes, automatic weather stations (AWS-ISRO), acoustic sounders (SODAR) etc. is a versatile facility at IGCAR most sought after by many a researchers and organisations in the country for mesoscale meteorological study. The Centre is participating as a nodal agency in an Indian Space Research Organisation initiated regional scale weather research, modelling and validation programme.

Basic Research in Radiological Safety

R&D activities on the development of Thermoluminescent Phosphors for radiation dosimetry was initiated

The Safety Group has always encouraged collaborative research. The emergence of atmospheric study programme is an example of a systematic synergetic multi institutional activity. Meteorological field measurement facility of IGCAR is the most sought after by many a researchers and organizations in the nation for mesoscale meteorological study. The Centre is participating as a nodal agency in an Indian Space Research Organisation initiated regional scale weather research, modelling and validation program.

which resulted in the development of new phosphors and a large number of research publications including a review article on $CaSO_4$ phosphors in Materials Science Journal. A new TLD phosphor based on $CaSO_4$:Ag,Tm with a high temperature glow peak around 648 K and capable of measuring low levels of radiation doses even at 523 K has been developed. This has practical applications for dose measurement in reactor environments. Usually such high temperature glow peaks exhibit thermal quenching but in this phosphor it is different. A collaboration with BARC resulted in the exact identification of electron and hole traps in this phosphor, for the first time in a

A simple method of preparing a high sensitive $CaSO_4$:Dy TLD phosphor based on co-precipitation technique that could overcome the cumbersome procedure of acid evaporation, is being patented.

$CaSO_4$ system. A simple method of preparing a highly sensitive $CaSO_4$:Dy TLD phosphor based on co-precipitation technique which avoids the cumbersome procedure of acid evaporation, has been developed. This technique is being patented. Another ongoing activity is the indigenous development of X-ray storage phosphor based on BaFBr:Eu photostimulated luminescent phosphor. An imaging plate made with this phosphor shows promising characteristics.

Shri P. Krishnamoorthy had developed superheated drop detector (renamed later as bubble detector) for neutron dosimetry. After his premature demise, the work was continued and a reusable detector with high neutron sensitivity was successfully developed. Recently, bubble detector based criticality incident detection and alarm system has been developed and is being tested in Compact Facility for Reprocessing of Advanced Fuels in Lead Cells (CORAL). In collaboration with Metallurgy & Materials Group of IGCAR, ultrasonic based residual monomer measurement technique and an acrylamide based gamma ray dosimeter has been developed and patented.

Assay of fissile material in wastes from reprocessing facilities is a matter of importance. It needs high flux neutron sources like an intense pulsed power D-T neutron source. A critical issue in this is achieving high current of deuteron ions. Radiological Safety Division has developed a novel technique to produce Deuterium beam by a single ring cup magnetic field ion source. This technique has been patented and the pulsed neutron source development is being developed. Another significant development is Electron Cyclotron Resonance (ECR) X-ray source.

Public Awareness , Emergency Preparedness Plan and Environmental Impact Assessment Studies

The probability of severe nuclear incidents and accidents is very low. However, the Department must have robust preparedness. The nuclear accidents at Three Mile Island and Chernobyl brought into focus the need for a well - prepared and rehearsed plan to effectively handle radiation emergencies arising out of severe nuclear accidents. However, even before the occurrence of these two accidents, the Centre had recognised the importance of this issue and started developing an elaborate plan to manage on-site as well as off-site radiation emergencies. Since Kalpakkam is a multi-facility site, the plan was aimed at taking care of all radiation emergencies at plant, site and off-site, a formidable task indeed. In the context of off-site emergency, it involves extensive interaction with the District Authorities. The dedicated efforts, spread over a few years, of all the concerned groups at the Centre, Madras Atomic Power Station and the District Authorities has resulted in a comprehensive and well structured

The Emergency Preparedness plan of the Centre has earned appreciation at all levels. It has been accepted as a model plan for all the nuclear facilities of the Department. RRC then and IGCAR now, organized, at the request of the International Atomic Energy Agency, a two-week workshop on Radiation Emergency Preparedness for Asia Pacific Nations.

Radiation Emergency Preparedness Plan. Further, the plan was well established by elaborate site and off-site emergency drills. The plan has earned appreciation at all levels. It has been accepted as a model plan for all the nuclear facilities of the Department. RRC organized, at the request of the International Atomic Energy Agency, a two-week workshop on Radiation Emergency Preparedness for countries in Asia and the Pacific. In the years that followed, the need for development of instruments and techniques for rapid monitoring of the environment has acquired importance. An aerial survey with an helicopter has demonstrated rapid assessment of contaminated land in case of large-scale accident of a release from the nuclear facility.

A well structured cyclone emergency plan has been developed at the Centre. This emergency plan has also become a model for other coast-based installations of DAE such as the Indian Rare Earths plants in Orissa and Kerala. At the national level, this plan has been the basis for the 'Guidelines for Cyclone Emergency Preparedness of Coastal Industrial Installations' drawn up under the guidance of Dr. D.V. Gopinath and issued by National Safety Council. It is easily visualized that this Centre is a leader in mastering the emergency plan in case of disasters.

Rapid Environmental Impact Assessment report for PFBR project was the first report of its kind to be submitted to Ministry of Environment & Forests from DAE. This report has earned appreciation of all the authorities. Public hearing organized for Prototype Fast Breeder Project was again the first to be conducted in DAE. Public awareness lectures on the radiation safety measures for nuclear industry are periodically organised to inform the local civilian population and general public, the facts about nuclear energy and the installations at Kalpakkam.

Marine environmental study for safe operation of power plant cooling system is an active program of the Safety Group. This programme involves intensive field sampling and analysis. The study is to understand the biofouling in the cooling water system of Prototype Fast Breeder Project. Biogrowth studies on panels exposed to coastal waters are being carried out to assess their seasonal and annual trend and variations. Moreover, an experimental test facility has been set up at Madras Atomic Power Station pump house to study the biogrowth rate at different flow rates using plate type heat exchanger, first of its kind facility in the country. As a part of our environmental research, a monitoring programme on coastal ecology is underway to understand various physico-chemical and biological processes occurring in the coastal waters of Kalpakkam.

Challenges Overcome

Many challenging problems of the Centre have been earnestly addressed and solutions realized. To cite an example, transgression of radioactivity from its containment at Centralized Waste Management Facility (CWMF) and its leakage to the ground, and subsequent transport through sub-soil water movement has been studied. Towards this, about 222 GBq of tritium was injected into a bore hole located at CWMF and the tritium activity has been monitored in a matrix of bore holes set up for this purpose over the entire area of IGCAR-CWMF. Continuous monitoring over two monsoons has not shown any tritium activity in any of the bore holes other than the source bore hole indicating insignificant movement of activity.

Another example is testing shielding integrity of a large numbers of lead casks and shield vessels for Fast Breeder Test Reactor. The thickness was so large that it was beyond the scope of X- radiography testing. Gammatography, a technique developed in house, was effectively utilized for the purpose. This technique was later adopted for testing of Kaiga Nuclear Power Plant dome after repair of the delamination. It has also been used to validate concrete pouring technique for Prototype Fast Breeder Project roof shielding block. Other notable contributions are studies related to moisture content in concrete (within ± 0.25% by weight) and paddy (within 1%) using gamma backscattering technique. These technologies are of high relevance to construction industry and Food Corporation of India.

Transient high pressure loading of reactor components due to hydrogen explosion is a safety study carried out for Light Water Reactors / Boiling Water Reactors. Hydrogen is generated under postulated Loss Of Coolant Accident (LOCA) conditions due to chemical reaction between overheated cladding and water. Interestingly, ignition of hydrogen–air mixture requires spark energy as small as 0.017 mJ and under certain conditions the resulting reaction could be fast and destructive in nature. In the absence of standard design guidelines, experimental investigations assumes high significence. Studies have been carried out in long cylindrical pipes simulating off–gas release system of Boiling Water Reactors. Measurements related to the pressure generation, propagation and mechanical loading characteristics have been carried out. Rapid energy deposition in a metal wire by fast condenser discharge was used to study transient over pressure reactions.

Safety Studies in Design and Operation of Fast Reactor

FBTR was first of its kind reactor in India and due to the foresight of Dr. A.K. Ganguly and Sri N. Srinivasan, the then Project Director, RRC, at the very beginning of the safety program at the Centre and much before Atomic Energy Regulatory Board (AERB) came into existence, Safety Evaluation Working Group (SEWG) was constituted to study all design safety aspects of fast reactor systems. The Group was chaired by Dr. D.V. Gopinath and was able to draw young and energetic experts from different disciplines at the Centre – Shri S.B. Bhoje for Reactor Engineering, Dr. Baldev Raj for Metallurgy, Shri R.D. Kale for Sodium handling, Shri D.B.

Physical simulation experiments through scale-down models is an established method of studying naturally complex systems and to develop semi-empirical relationships between parameters of interests. Simulation of Core Disruptive Accident condition, cooling characteristic of core-catcher, fuel-coolant interaction, physical transport of radionuclides through sodium loops, sodium concrete interaction experiments are some of the major experimental programmes related to engineering safety of 500 MW(e) PFBR.

Sangodkar & Shri Sankar Singh for reactor control and Shri L.V. Krishnan & Dr. V.M. Raghunath for radiation safety. Extended over a period of a few years, the Group made an in-depth and objective study of all the design aspects of FBTR system. Such a thorough study did result in smooth and fast clearances from the regulatory authorities. This approval contributed to the long history of safe and trouble free operation of FBTR.

From the very beginning, it was recognised that the safety problems of fast reactors and associated systems are quite different (from those of thermal reactors) due to their compact cores with high energy density and handling of large quantities of high temperature sodium. The studies related to fast reactor safety are specific and complex.

Transient two-phase material disintegration characteristics were investigated through controlled energy deposition in copper wire material. The exploding wire technique (EWT) with fast condenser discharge served as an excellent tool to generate reproducible transient pressures. The EWT has been successfully employed to generate spatial pressure pulse decay data and to study structural deformation of thin walled aluminum and austenitic stainless steel clad tube materials. Slumping characteristics of cylindrical fuel pellet due to power transients in a fast reactor is another important safety concern as the molten fuel can form a reactive configuration. Studies have been carried out through electrical heating of a single pellet. The results have established threshold enthalpy deposition required for onset of fuel downward motion and associated response times. Efforts are in progress to take up similar studies with annular pellets.

Physical simulation experiments through scale-down models is an established method of studying complex systems and develop semi-empirical relationships between parameters of interests. Simulated experiments have been conducted using a novel approach for studying pressure propagation from the core/ sodium bubble after a Core Disruptive Accident in sodium cooled fast reactors. The liquid slug impact on the top cover of the reactor following pressure propagation is simulated using pressurized gas bubble released by rupture disc. Water is used as the working fluid since density, bulk modulus and sonic velocity of water are comparable to that of sodium. The relationship between slug velocity and driving source pressure has been obtained. This experimental approach has facilitated conservative estimate of sodium spillage through a given leak area in the rotatable plugs of the reactor roof slab using experimentally determined slug velocity.

Generally, pool type fast reactors have internal core-catcher assemblies as passive safety devices to accommodate molten fuel in a non-critical coolable configuration. Studies related to core-catchers have been taken up to investigate continuous heat removal capacity of the PFBR 500 MW(e) core-catcher geometry through natural convection. A scale factor of 1: 4 water model is selected for the experimental set-up to bring out the temperature profile of core-catcher and in confined coolant zone above it. Two dimensional, axi-symetric analysis of buoyancy driven natural convection has been accomplished using Computational Fluid Dynamics code. Agreement between measured temperature values and computed values is very good. The computational tool will enable us to assess condition of actual reactor with coolant sodium. A preliminary scale down experimental study carried out on sodium fires on a small scale has determined characteristics of generated aerosols. Role of humidity on change in particle size distribution of sodium aerosols in contained atmosphere and release coefficients for radioiodine in sodium fires have been studied. A computer model for estimation of radionuclide concentrations in sodium loops has been developed.

Knowledge of debris bed forming characteristics after a postulated Molten Fuel Coolant Interaction is essential towards achieving coolable core-configuration. Thermal interaction studies with water as coolant has advantages of easy parametric experimentation. These studies provide an insight into various processes associated with molten fuel fragmentation. Conditions for explosion and consequent fine debris generation have been obtained from extensive experimentation with tin–water simulant system. Role played by the melt physical properties has been also investigated with different melts to model fragmentation mechanisms. Development of a mathematical model is in progress to explain entire observed phenomenon and to have predictive capability for reactor scenarios. A small natural convection loop to study physical transport of radionuclide driven by temperature differences, has given useful data for developing a good model.

Industrial Safety for all the research laboratory premises of Kalpakkam site is an important responsibility of Safety Group. Periodic training programs, awareness campaigns, first aid classes and special lectures have been arranged with vigour and imagination to meet magic number of zero accident level for our Centre. After Orissa Super Cyclone, the group organized a national seminar on Cyclone Emergency Preparedness and an updated storm action plan was put into practice.

Defining the Path Ahead

Safety research at IGCAR has matured and has high relevance to sodium cooled fast reactors and associated fuel cycle facilities. Development of linear accelerator based compact neutron sources and high pulsed power D-D neutron sources for active neutron assay of waste from fast reactor reprocessing plants, development of a tomography system with gamma sources for a 3-d picture of the waste drums, studies on the behaviour of various volatile fission product aerosols in the reactor containment building during core disruptive accident for realistic source term assessment are some of the

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experimental programmes on which we have decided to focus our efforts. Based on our strength in atmospheric dispersion forecasting, we are embarking upon an integrated tool for site specific forecasting and management of cyclone, storm surge and aquatic dispersion. This activity is taken up as a joint effort with the experts in academic institutions such as Indian Institute of Technology, national bodies such as Indian Space Research Organisation, National Institute of Ocean Technology etc.

Since metallic fuel has been planned for the future FBRs to achieve high breeding to meet faster energy growth scenario in the country, safety issues related to metal fuel are being evaluated. Better understanding of in-vessel core degradation phenomena will help to define more precisely preventive and mitigation actions for severe accident management strategy, in order to limit or eliminate the consequences of severe accidents and reduce the risk. The other areas of core safety include characterisation of interactions between molten metallic alloy fuel and liquid sodium, assessment of clad deformation characteristics and typical failure modes under rapid transient heating. R&D is being pursued to develop improved core catcher geometries of coated steel material for enhanced heat transfer capabilities and to withstand higher temperature loading.

It is obvious that the research programmes of Safety Group are inter disciplinary in nature and multi-dimensional in application, thus offering challenging opportunities in radiation science and safety technology.

Sodium aerosol removal system is essential for effective sodium fire fighting. Effective means of managing large scale sodium fire consequences through design of a wet scrubber systems and a mobile sodium aerosol removal system are under investigations. A major experimental facility is being established to study effect of large scale sodium fire (both pool and spray fires) in a closed chamber, simulating the conditions of the secondary systems of the reactor.

Safety programmes of Safety Group are inter-disciplinary in nature and multi-dimensional in applications. Opportunities and challenges in radiation science and safety technology inspire and motivate us to achieve higher levels of relevance and excellence.

(Baldev Raj)
Director
IGCAR

STATUS OF FBTR

The 13th irradiation campaign with 43 fuel subassemblies (29 MK-I, 13 MK-II and one PFBR fuel test SA) was completed in July 2006, when four MK-I SA in the first ring reached the allowable burn-up of 155 GWd/t. This was a gratifying campaign, with a campaign availability factor of 94% and continuous operation of 36 days, testifying to the efficacy of the various modifications done in the steam-water system to improve plant availability.

A function commemorating 20 years of successful operation of FBTR was conducted on July 18, 2006 at Vikram Sarabhai Auditorium. Hon'ble Raksha Mantri Shri Pranab Mukherjee, Hon'ble Minister of State Shri Prithviraj Chavan, Dr. Georges Vendryes, Hon'ble Executive Vice President, French Atomic Energy Commission and Dr. Anil Kakodkar, Chairman, AEC graced the function. Ex. Chairmen of the department, Ex-Directors of IGCAR, Heads of various DAE units and about 40 senior retired officers from IGCAR who worked for FBTR attended the function along with senior officers from IGCAR.

Safety clearance for the 14th irradiation campaign was obtained in Sep 2006. The core for this campaign, shown in fig. 1, is the first stage of transition to the hybrid core and has 49 fuel subassemblies (SA) - viz. 27 MK-I, 13 MK-II, 8 MOX and one PFBR test fuel SA. Transition from the 43 SA core to the 49 SA core involved discharging one high burn-up MK-I from the first ring for PIE, transferring three high burn-up MK-I from the first ring to the storage location (for possible reuse if PIE results are encouraging), transferring four MK-I SA from the third ring to the first ring, loading two fresh MK-I SA in the third ring, transferring two MK-II SA from the fourth ring to the third ring and loading eight MOX SA in the fourth ring. Due to the large uncertainties in estimating the core reactivity for these major changes, it was decided to effect the transition from 43 SA core to 49 SA core in four stages with intermediate measurement of critical heights after each fuel handling campaign. At the end of the second fuel handling campaign, the lower part of one Control Rod Drive Mechanism was replaced due to failure of its gripper bellows, and the fuel handling operations resumed.

The fourth fuel handling campaign was completed in Feb, and reference flows through the subassemblies

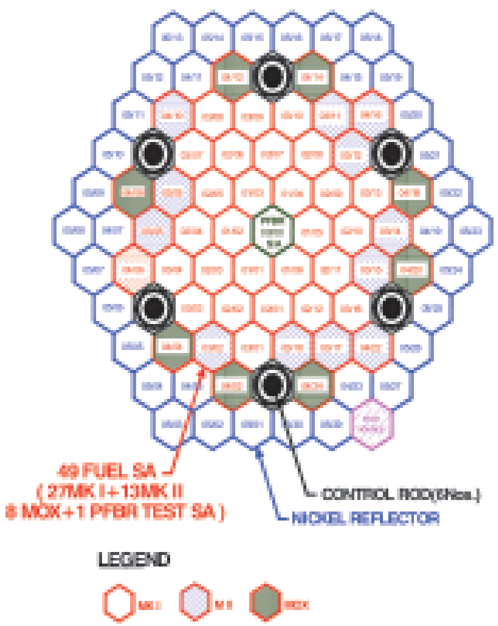


Fig. 1 : Core configuration for 14th irradiation campaign

Dr. Anil Kakodkar, Chairman, AEC addressing the gathering during the Commemoration function to celebrate twenty years of successful operation of FBTR on July 18, 2006. Seen on the dais (from left to right), Dr. Baldev Raj, Director, IGCAR, Dr. Georges Vendryes, Hon'ble Executive Vice President, French Atomic Energy Commission, Honorable Defence Minister, Shri Pranab Mukherjee, Honorable Minister of State, Shri Prithivraj Chavan

were measured using the Eddy Current Flow Meter. The 14th irradiation campaign was started on February 17, 2007 and power was raised to the target value of 16.6 MWt. TG was rolled and synchronized to the grid for studying some anomalies noted during surveillance checks. The newly commissioned ED-20 sub-system of CDPS has been put in service for on-power testing of its performance.

The present campaign will be dedicated to carrying out a series of experiments before resuming the irradiation of the PFBR test fuel SA to its target burn-up of 100 GWd/t. The performance of the Delayed Neutron Detection system will be studied by loading a specially fabricated test SA having 19 perforated pins of natural uranium. The SA will be sequentially loaded in five locations (central location and two locations each in the second and fourth rings) and the contrast ratios measured at power levels upto 10 MWt. The results of this experiment are expected to throw light on the ability of the DND system to localize failed fuel.

To study the initial restructuring of the PFBR fuel, it is planned to carry out the irradiation of a single PFBR test fuel pin at 450 W/cm for 20 days. The flux at the grid plate location will be measured using a specially designed subassembly with foils of Np, natural U, depleted U, Ni & Ti. The results of this irradiation will help in a realistic estimate of the neutron dose seen by the grid plate and assessing its residual life. Concurrently, it is also planned to load two SA with samples of stainless steel and D-9 for material irradiation. At the end of 20 days operation, the single pin of PFBR test fuel and grid plate flux measurement SA will be discharged, and the irradiation of the 37 pin PFBR test fuel SA and SS & D9 alloys continued.

The campaign duration with the estimated available excess reactivity will be 145 days. However, the MK-I in the second ring inner radius will reach a burn-up of 155 GWd/t in 80 days and we will require six fresh MK-I to start the 15th campaign. If PIE results of the high burn-up MK-I SA indicate the feasibility of enhancing the allowable burn-up, reactor operation can be continued beyond 80 days by utilizing the three high burn-up MK-I SA presently kept in the storage location, after obtaining the necessary clearance from SC & SARCOP.

At the end of the 14th campaign, it is proposed to isolate one Steam Generator module from each secondary loop to enable realizing the design temperatures at the present power levels. This will be a major activity involving cutting the modules from the header, blanking the headers, sodium decontamination and preservation of the modules. The seismic re-evaluation is in progress and the first walk-down completed. The plant will also get relicensed before starting the 15th irradiation campaign by end 2007.

(Reported by G. Srinivasan and P.V. Ramalingam, ROMG)

Pioneers in the construction, commissioning and operation of FBTR, gathered on the occasion of the commemoration function on July 18, 2006

A Novel And Simple Technique To Irradiate Blood Cells *In Vitro* With Alpha Radiation For Cytogenetic Analysis

The need for determining a reliable Radiobiological Effectiveness (RBE) value for alpha exposures has become important as reports remain controversial. Moreover, increasing nuclear reprocessing facilities world-over calls for measures to estimate alpha radiation doses during a criticality accident such as the one that occurred at Tokaimura, Japan in 1999. In order to construct dose-response curves and calculate RBE factors for risk estimation required for purposes of radiation protection, human blood cells need to be irradiated in vitro. However, unlike gamma radiation sources, it has always been a challenge for radiation biologists to handle alpha sources. This is mainly because of the low penetrating power of alpha rays that demand an intimate mixing of the radioactive source like plutonium with live biological cells for a stipulated period and then its removal by aseptic means for further cell culturing. Efforts made to develop irradiation methods necessitated handling radioactive washings or the construction of fixed facilities in specialized hoods. Here we describe a simple and novel method to irradiate human blood lymphocytes *in vitro* using radon gas emanating from a solid radium source. The difficulties in delivering and estimating exact activity concentrations have been handled in a unique and safe way. Such a method was used to score chromosome aberrations induced by radon and progeny.

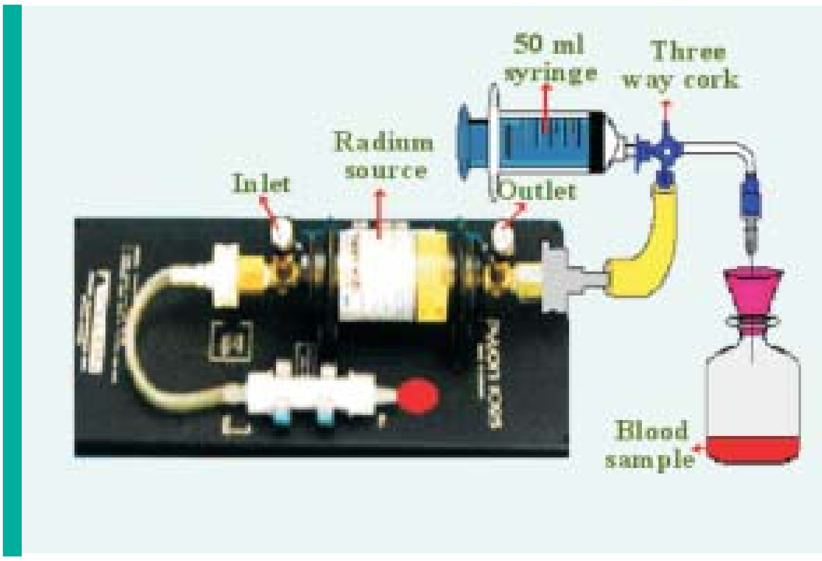


Fig 1. Irradiation of Blood sample using the Radon Source

Radon Exposure

The radon source used in the present study was procured from Pylon (Model RN-1025, Canada). The source was developed and calibrated by Pylon, and possess feature reliable rate of emanation, high accuracy and ease of use. It contains dry radium ^{226}Ra in powder form and provides calibrated quantities of radon ^{222}Rn for laboratory or field use.

Irradiation of Blood Sample

About 10ml of blood collected from a healthy individual was transferred to two airtight glass bottles. One was kept as control and the other used for radon exposure. A three-way cock, used for passing blood, saline and glucose, was used for evacuation of air from the bottle containing blood sample and for radon exposure. One end of the three-way cock was connected to the bottle containing blood through a needle and the other two ends to a 50 ml syringe and to the radium source or a vacuum pump. Such a set-up facilitates sequential evacuation and radon exposure without any loss of radon during exposure. The set-up used for irradiation is shown in Fig 1. The air in the bottle was partially evacuated

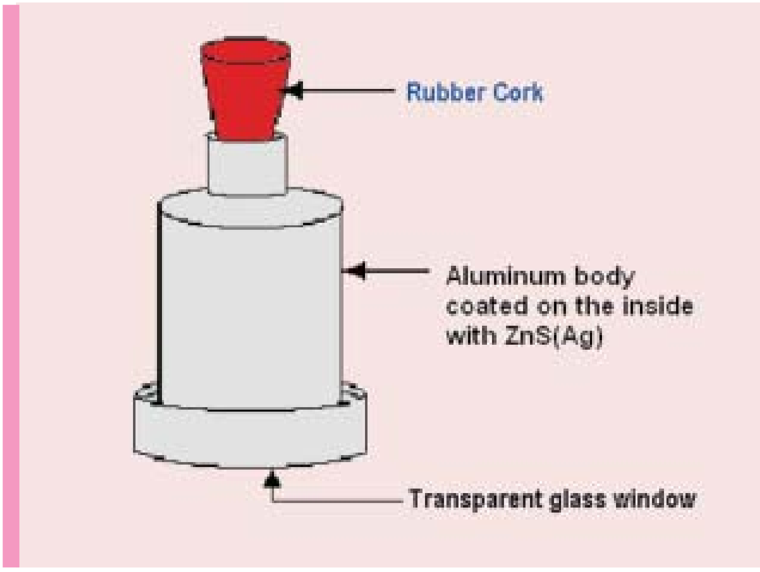


Fig. 2. Lucas cell

using a vacuum pump and exactly 50 ml of radon gas was drawn into the syringe from the radium source. Exactly 40 ml of the gas was transferred to the bottle containing blood and the remaining 10 ml was transferred to an evacuated Lucas cell and the activity counted immediately as well as after three hours using an alpha counter. The second bottle containing blood was kept as control and sham exposed. Bottles were incubated at 37ºC for 3 hours in a shaker-incubator for uniform irradiation. Excess radon gas was released from the bottle after the exposure period by merely opening the lid. Activity was determined using a Lucas cell.

Activity Estimation by Lucas Cell

A Lucas cell, made of aluminum and having a volume of 140ml was designed and custom fabricated. The inner surface with the exception of transparent glass window was coated with a thin layer (10mg/cm^2) of ZnS (Ag) phosphor. The glass window allows the scintillations to pass through and be viewed by the photo multiplier tube in the alpha counter, to which the cell is coupled. Diagrammatic representation of Lucas cell is shown Fig.2.

The radon concentration was calculated using the equation:

$$\text{Activity (Bq)} = \frac{0.06967 \times \text{netcounts}}{\text{Eff} \times 0.141 \; e^{(-0.00012584 \times DT)} \times 1 - e^{(-0.00012584 \times CT)}}$$

Where, Eff is the efficiency of Lucas cell – a value of 70

Delay time(DT)= Duration of Radon exposure - 180 min

Counting time(CT) = 10 minutes.

0.141 m^3 = volume of the Lucas cell.

Net counts = value obtained from the alpha counter.

Cell culturing and Scoring Chromosome aberrations

About 0.5 ml of the blood sample was mixed with 4.5 ml RPMI 1640 medium supplemented with 20% serum and 50ml of antibiotics. About 100ml of Phytohaemagglutinin and 100ml of bromodeoxyuridine was added to stimulate the culture and to distinguish first division metaphases. Cultures were incubated at 37ºC for 48 hours. Colchicine was added at 46 hours to arrest cells at metaphase stage of the cell cycle. Cells were harvested at 48th hour after hypotonic treatment with KCl for 20 minutes, followed by fixation with Carnoy's fixative. Cells were washed twice in the same fixative, cast on microscope slides, stained using 5% Giemsa in Sorenson's buffer, mounted with a cover- slip and scored for aberrations.

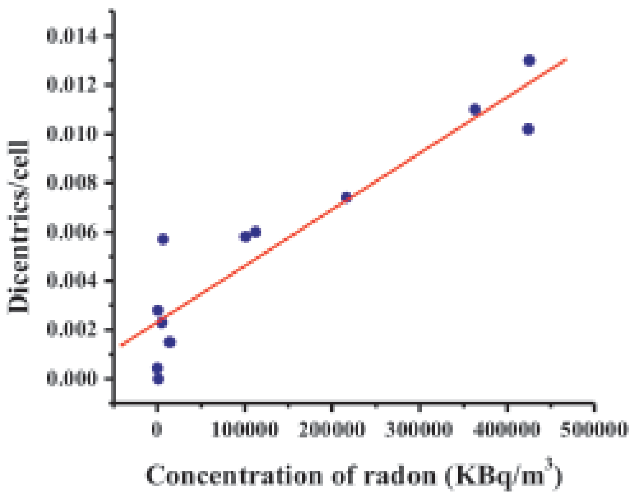


Fig. 3. Regression analysis showing the effect of increasing concentration of radon gas on the yield of dicentrics

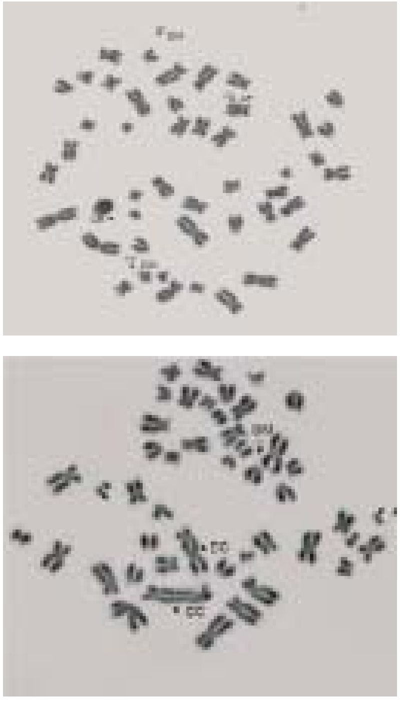


Fig 4.a. Metaphase containing centric ring (CR) and double minutes (DM)- intra-chromosome aberrations, signatures of alpha exposure. b. Metaphase containing dicentrics (DC) - inter-chromosome aberrations.

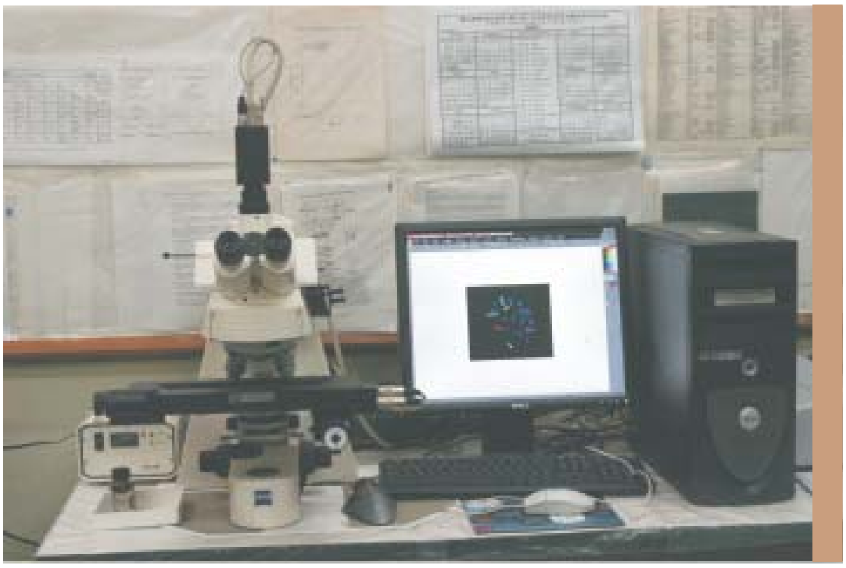


Fig. 5. Microscope equipped with the metaphase finder software at RSD

Metaphases were captured using a Metaphase finder (Metasystems, Zeiss) available at RSD. (Fig.5). Individual metaphases obtained from non-exposed as well as *in vitro* radon exposed samples were carefully analysed and the aberrations were noted on to scoring sheets. A linear increase in the frequency of dicentrics with increase in concentration of radon was observed. The data on dicentric/cell was plotted against the concentration of radon Fig 3. Regression analysis of dicentric/cell yielded a coefficient value of 0.92.

Highlights of the new technique

The new technique designed to irradiate blood, medium and other cells has the following features

- Portable alpha irradiation facility, unlike those designed earlier
- Safe to handle as it does not involve liquid alpha source
- Can be easily set up and dismantled.
- Samples can be irradiated under sterile conditions.

The irradiation facility also serves as an excellent *in vitro* method to characterize the DNA damaging effects of radon and its progeny, proved to be a major cause of lung cancer among miners and people living in areas with high natural background radiation.

(Reported by Mary N. Mohankumar, V.Zareena Hamza and R.K.Jeevanram, Radiological Safety Division)

Forum for Young Officers

Thermal Hydraulic Investigation of IFTM Shield Plug

Shri R. Arul Baskar

Shri R. Arul Baskar obtained his B.E. (Mechanical Engineering) from Annamalai University, in 1995 and M.E. (Power Plant Equipment Design) from REC, Trichi in 1997. He worked as Design Engineer in Thermal – Systems (P) Ltd, Hyderabad. He joined IGCAR as Scientific Officer (SO/C) in November, 2003.

Mr. R. Arul Baskar and Colleagues, Mechanics and Hydraulics Division, Reactor Engineering Group

In the 500 MWe sodium cooled pool type fast breeder reactor, Inclined Fuel Transfer Machine (IFTM) transfers sub-assembly between the reactor and fuel building. Roof slab covers the top of the reactor and contains radioactivity within main vessel. Primary ramp of IFTM (Fig.**1**) is the pipe that penetrates through roof slab for transferring subassembly. Thus forms the communication passage between the reactor and fuel building. A Shield plug is provided in the primary ramp to shield the reactor containment building from radioactivity leak from the reactor through this passage. A penetrating shell attached to the roof slab for inserting primary ramp is called liner. Air is circulated through the annular space between the liner and cooling shell of roof slab to remove the heat load received by the primary ramp from hot pool by thermal radiation and natural convection of Argon cover gas. A cooling airflow rate of 940 m^3/hr is provided through this passage from the consideration of effective heat removal during transfer pot struck up condition at this location. Sodium vapor evolved from the surface of hot pool mixes with cover gas argon, enters the penetration and condenses at colder surfaces. During normal operation of reactor the shield plug is in closed condition. Sodium aerosol may get deposited in the interface between the sliding contact surfaces of shield plug and makes it difficult to open during fuel handling. To avoid this situation the possibility of sodium aerosol deposition on the shield plug during normal operation has been investigated through detailed 3D thermal hydraulic analysis.

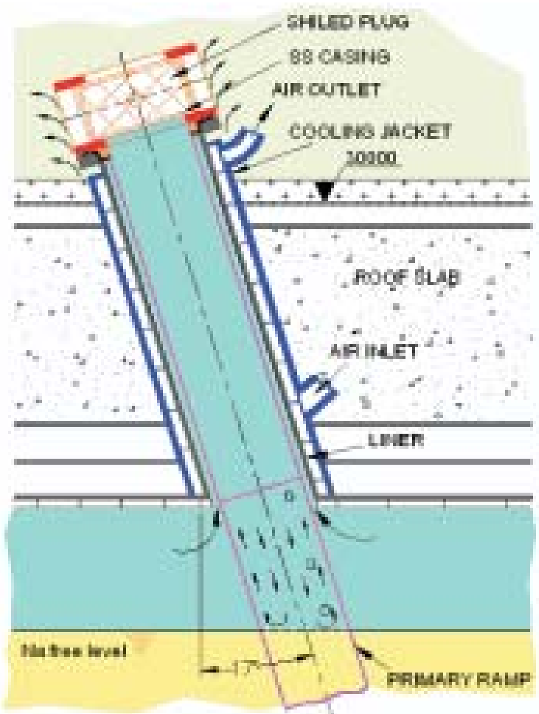


Fig. 1: Schematic of IFTM at Roof Slab

The thermal hydraulic study of IFTM has been carried out using the commercial CFD software PHOENICS.

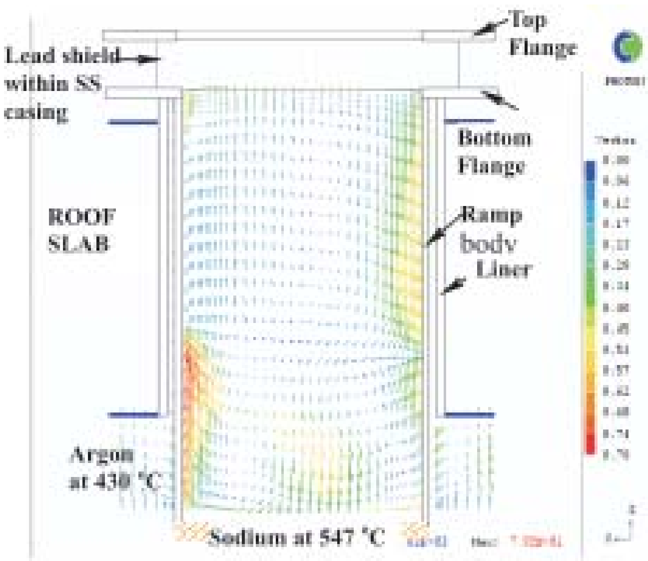


Fig. 2: Velocity Profile in side IFTM

Buoyancy driven natural convection flow of cover gas has been modeled by simulating the density variation with respect to temperature of cover gas employing ideal gas relation. Turbulence in the flow has been modeled by standard k-ε turbulent model. Heat conduction in the solid structures and the convection in argon have been solved employing conjugate heat transfer option. Radiation heat transfer between the solid surfaces is modeled using immersol-model.

Natural convection flow of argon predicted inside the IFTM body, for the design-cooling rate of 940 m^3/hr with the inlet temperature of 90 °C is shown in Fig.**2**. It can be seen from the figure that, above the bottom plate of roof slab, hot argon flows up through one sector of the cylinder close to the wall, reach the bottom of shield plug and then flows down through the diametrically opposite sector. Cellular convection pattern has been observed in the annulus between ramp and liner. The temperature of argon in the annulus reduces to that of cooling air flow within very short axial length itself. So heat transfer to cooling jacket is more (1062 W) than that has been transferred (351 W) to top part of the assembly. This leads to the temperature of 356 K (83 °C Fig.**3**) at shield plug's bottom surface, which is less than the condensation temperature of sodium. So there is a possibility for sodium solidification on the shield plug.

Analysis has also been carried out for the case without considering cooling flow in the cooling jacket. This leads to the temperature of 433 K (160 °C) at the bottom of shield plug. Thus it can be concluded that by adjusting the airflow rate in the cooling jacket that cools the ramp body in the roof slab location, desirable temperature in the shield plug can be achieved. In order to achieve a temperature of ~ 120 °C at the bottom of the shield plug, the cooling flow is estimated to be 80 m^3/hr. The amount of heat transfer to the cooling flow and the top of the assembly for this condition are 770 W and 550 W respectively. This flow rate has been proposed in the cooling jackets of IFTM during normal operation of the reactor.

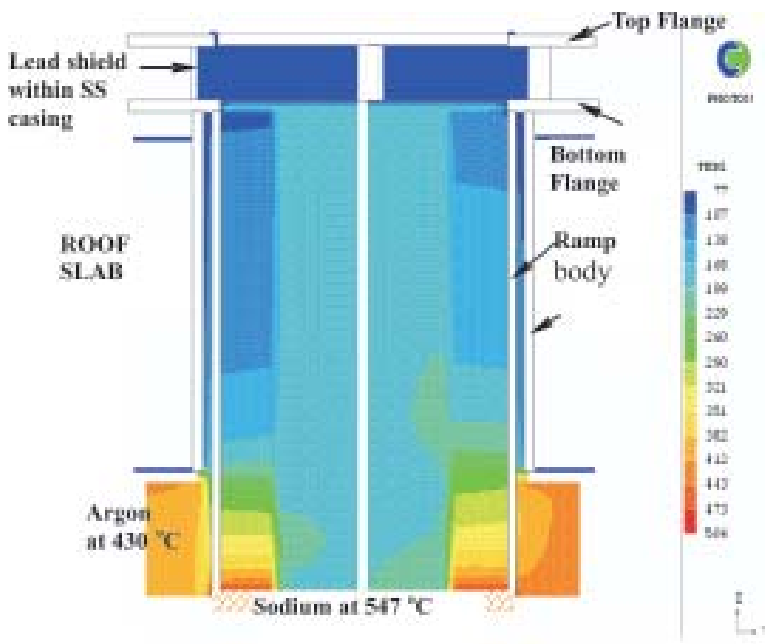


Fig. 3: Temperature distribution in IFTM at Roof Slab

Conference/Symposium Highlights

Technical Meeting (Third Research Co-ordination Meeting) of the CRP on Studies of Advanced Reactor Technology Options for Effective Incineration of Radioactive Waste

IAEA has been piloting a Coordinated Research Project (CRP), within the framework of *Technical Working Group on Fast Reactors (TWG-FR)*, in carrying out R&D towards demonstrating the transmutation and incineration of long-lived minor actinides (MA) using reactors with fast neutron spectrum and accelerator driven systems (ADS). The CRP concentrates on the assessment of the transient behaviour of various transmutation systems. For a sound assessment of the transient and accident behaviour, neutron kinetics and dynamics methods and codes have to be qualified, even more so as the margins for the safety relevant neutronics parameters are becoming small in transmutation systems, especially in transmuters with fertile-free fuels. The 1st and 2nd Research Coordination Meeting (RCM) were held at Forschungszentrum Karlsruhe, Germany, 5-8 November 2002 and Institute of Plasma Physics, Chinese Academy of Sciences, Hefei, Anhui, China 22-26 November, 2004 respectively. A Consultancy meeting was held at IAEA Headquarters, Vienna, Austria, during 28 – 30 November, 2005.

The 3rd RCM for this CRP was hosted by IGCAR, at Chennai during 15-19 January 2007. The meeting was attended by 21 participants from IAEA, OECD/NEA, JRC, Petten, EU, SCK•CEN, Belgium, Nuclear Research Institute (NRI) Rêzplc Czech Republik, Academia SINICA-IPP, CIAE, INET, China, CEA, France, FZK, FZR, Germany, BARC & IGCAR, India, Politecnico di Torino, Italy, Kyushu University, Japan, KFKI, Budapest University of Technology and Economics, Hungary, KAERI, Republic of Korea, NRG, Netherlands, Academy of Mining and Metallurgy, Cracow, Poland, IPPE, RRC-KI Russia. Apart from the participants, there were 14 observers from IGCAR and BARC. The main objectives were to review ongoing work, define further work plans and drafting the final report.

This CRP has eight domains with different advanced reactor technology concepts for radioactive waste incineration. In particular, critical reactors and sub-critical (hybrid) systems driven by an external neutron source were considered. The comparative investigations cover burner reactors and transmuters both containing fertile and fertile-free fuels. The neutron spectra of the reactors extend from thermal to fusion energy levels. Further, systems with solid fuels and molten salt fuels are compared. The solid fuel systems investigated cover also the impact of various coolants from sodium to heavy liquid metals and gas. Specifically, the systems investigated are allocated to eight different domains, which comprise in detail:

(i) Critical transmuters with fertile fuel
(ii) Critical transmuters with fertile-free fuel
(iii) Hybrid systems (ADS) with fertile fuel
(iv) Hybrid systems (ADS) with fertile-free fuels
(v) Molten salt systems with fertile fuel
(vi) Molten salt systems with fertile-free fuels
(vii) Gas cooled systems (ADS)
(viii) Hybrid Fusion/Fission systems

During the meeting, each domain discussed about their reactor models, static and dynamic analysis and methods used for calculations and efficiency of transmutation. Our centre's work comes under Domain I for designing a fast critical transmuter with fissile-fertile fuel. At IGCAR, an FBR model has been designed, having features similar to PFBR, with modifications done as necessitated (a) inclusion of 5 % MA in the fresh fuel, and (b) radial blanket made of ThO_2. The initial composition of MA corresponds to that of the Indian PHWR discharged fuel. This FBR model shows a potential to incinerate nearly 10 % of the MA, during one equilibrium cycle, with satisfactory safety parameters. In the present (3rd) CRP meeting, IGCAR presented results for the FBR model, with ThO_2 replacing UO_2 in all the blanket regions and on the spread of the predicted reactor parameters due to spread in MA nuclear data.

Under Domain I, IGCAR has done static and transient analyses of the FBR model as planned. Works under most Domains are nearly completed and presented in the meeting excepting the following. In Domain I, KAERI has discontinued its participation after the 1st RCM where static analysis of its Pb cooled FR model was presented. In Domain II, IPPE contributed their static analysis and sodium void reactivity effects for their reactor model, but did not complete transient analysis. Commitments under Domain V have also not been met fully, excepting substantial contribution from NRI of Czech Republik.

The final goal of the CRP is to deepen the understanding of the dynamics of transmutation systems, to qualify the available methods, specify their range of validity, and formulate requirements for future theoretical developments and transient experiments, rather than the technical comparison between different systems. Besides the safety and transients related work the transmutation capability of the various systems is confirmed and questions of the fuel cycle were dealt with. Finally a material database has been developed within this CRP providing valuable input for other projects. The studies and conclusions of the CRP will be published by IAEA as a technical (TEC DOC) report.

(Reported by G. Pandikumar and P. Mohanakrishnan,Reactor Physics Division, REG)

DAE Anu Week Celebrations-2007

VIT University, Vellore, February 13-17, 2007

Public Relations Activities Implementation Committee (PRAIC) of IGCAR organized the DAE's prestigious 'Anu Week Celebrations 2007' on the theme "Unleashing the energy of nuclei for a sustainable future" in collaboration with the VIT University, Vellore during February13-17, 2007 in the University campus. The programme included a 5-day DAE Exhibition, a two-day Workshop for secondary school science educators and target specific Essay, Quiz, Elocution & Cartoon Contests in English and Tamil for students of various classes from schools and colleges situated in and around Vellore district.

Dr.Baldev Raj, Distinguished Scientist and Director IGCAR inaugurated the Celebrations, and Shri.Prabhat Kumar, Project Director BHAVINI declared the exhibition open. Theme address was delivered by Dr. S.K.Malhotra, Head, Public Awareness Division, DAE, Mumbai. Shri G Viswanathan, Hon'ble Chancellor, VIT University presided over the inaugural ceremony, along with other dignitaries of VIT. Shri. P.V.Ramalingam, Director, ROMG, IGCAR proposed the vote of thanks. Resource persons from IGCAR, MAPS, BARC & DAE covered the multifaceted applications of radiation and radioisotopes for the benefit of mankind, during the teachers' workshop. Informal contests were conducted for the participants. Field visits were organized on the third day for the teachers to the Christian Medical College (CMC), Vellore and BHEL, Ranipet and the use of radioisotopes in the healthcare and industry were demonstrated to them. During the valedictory function on February 17, 2007, the Chief Guest Shri S.Krishnamurthy, Station Director, MAPS distributed certificates and prizes in the form of gift exchange vouchers for books for a total value of Rs.60,000/- to the winners and runners of various contests.

The academia and the general public in this semi-urban part of Tamil Nadu were excited and benefited by participating in the Celebrations, which had helped to spread the awareness about the activities of the Department of Atomic Energy.

(Reported by J. Daniel Chellappa and P.V.Ramalingam, PRAI Committee)

Forthcoming/Symposium Conferences

Recent Advanced in Information Science & Technology (READIT-2007)

July 12-13, 2007

MAdras **L**ibrary **A**ssociation – **K**alpakkam **C**hapter is planning to conduct a two day National Conference on REcent Advances in Information Science & Technology" (READIT-2007) during July 12-13 2007. MALA-KC and Scientific Information Resource Division (SIRD), IGCAR have been conducting a series of conferences on "Recent Advances in Information Science & Technology" from 1995. The proposed conference will have invited talks by experts in the field and contributed paper presentations from Researchers. A pre-conference tutorial on *"Web Tools and IT Enabled Services"* is also being arranged for the benefit of Information Professionals on **July 11 2007.**

Call for Papers

The conference will consist of invited talks and contributed papers. Contributed papers, on any of the following theme sub-topics are welcome.

Theme:

Information to Knowledge: Technology and Professionals

Sub-topics

- Library as Knowledge Centers
- Digital Infrastructure and Technology Integration
- Document Management and Resource Generation
- Digital Preservation Issues
- Information Security
- Knowledge Environment and Professionals
- Knowledge – A Commodity

Important Dates

Pre-registration (with abstract)	: May 23, 2007
Intimation of acceptance	: May 30, 2007
Receipt of completed papers	: June 22, 2007
Last date for registration	: June 29, 2007

Address for Correspondence:

Shri M. Somasekharan
Convener, READIT-2007
Head, Scientific Information Resource Division (SIRD)
IGCAR - Kalpakkam - 603 102
Phone 044 27480281; Fax 044 274 80096
e-mail: soma@igcar.gov.in
http://www.malakc.org

Visits of Foreign Dignitaries

Joint Meeting of the Indian Nuclear Society and American Nuclear Society

A Delegation of the American Nuclear Society (ANS) visited Kalpakkam during January 19-20, 2007. The ANS delegation was led by Dr. Harold McFarlane, President, ANS and the INS delegation was led by Dr. Placid Rodriguez, President, INS. The ANS delegation consisted of Dr. Harold Finley McFarlane, President, American Nuclear Society; D-ALD, INL, Dr. James Lake, Past President, ANS; Battelle Executive, Dr. Alireza Haghighat, Chairman, NEDHO; Chair NE Dept. University of Florida, Dr. Arvind Kumar, Chair NE Dept. University of Missouri, Mr. Arthur DiGiovine, Vice-President, Studsvik ScandPower, Inc., Dr. Atambhir Singh Rao, Int'l Committee, ANS; Nuclear Energy Directorate, IAEA, Dr. Samit Bhattacharyya, President, RENMAR and Dr. Dennis Berry, Director, Nuclear Programs, Sandia. The INS delegation consisted of Dr. Placid Rodriguez, President, Indian Nuclear Society, Mumbai, Shri S.C. Chetal, Director, Reactor Engineering Group, IGCAR, Shri P. Swaminathan, Shri G.D. Mittal, Secretary, Indian Nuclear Society, Mumbai, Dr. V. Ganesan, Treasurer, Indian Nuclear Society, Kalpakkam Branch, Dr. M.L. Jhoshi, Head, Health Physics Division, BARC, Dr. R.R. Puri, Head, Human Resources Development Division, BARC and Dr. M. Sai Baba, Head, Strategic & Human Resources Planning Section, IGCAR. The ANS delegates visited some of the facilities at IGCAR, MAPS, BHAVINI, BARCF and SRI at Kalpakkam on January 19, 2007. On January 20, 2007, a joint workshop of the two societies on the theme "Preparing for the Nuclear Renaissance: Strategies for Human Resources Development and Nuclear Knowledge Management" was held with opening remarks by Dr. Placid Rodriguez, President, INS. A number of presentations were made by members of INS and ANS delegations on the theme.

Visit of delegates from Japan Atomic Industrial Forum, Japan

Members of the Japan Atomic Industrial Forum, Mr. Masao Saigo, Senior Project Manager; Mr.Masaki Uotani, Associate Vice-President, Central Research Institute of Electric Power Industry & Deputy Director, Nuclear Technology Research Laboratory; Mr.Fumitaka Ito, Deputy GM, Mitsui & Co. Ltd., Electric Power Project Division, Tokyo, Japan and Shri. Ogoti Krishna Kishore, Mitsui & Co. India Pvt. Ltd., visited the Centre during January 20-22, 2007. The delegation had discussions with the Director and senior colleagues of the Centre and also visited various Laboratories of IGCAR.

Dr.Hirofumi Haghihara and Dr.Masaki Nakagawa from Japan Energy Safety Organisation, Japan with Dr.P.R.Vasudeva Rao, Director, CMMG and Dr. M.Sai Baba Head, S&HRP, IGCAR

Visit by scientists from National Institute of Materials Science (NIMS), Japan

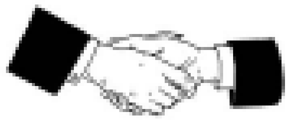
Dr. M. Kitagawa, Vice President National Institute of Materials Science (NIMS), Japan, Dr. C. Nishimura, Managing Director, Fuel Cell Research Center, Dr. E. Akiyama, Corrosion scientist and international liaison officer and Dr. A.Vinu, Senior Scientist, NIMS visited various laboratories in the centre on February 26, 2007 and had discussions with the Director, IGCAR and senior scientists of the Centre.

Visit of delegates from the Japan Energy Safety Organisation, Japan

Dr.Hirofumi Haghihara, Associate Vice-president and In-charge of International Cooperation and Dr.Masaki Nakagawa, Senior Officer, International Affairs Group, Safety Information Research Division from the Japan Energy Safety Organisation visited the Centre on March 1, 2007 and held discussions with the Director, and senior scientists at IGCAR on safety related issues of Fast Reactors. Presentations on behalf of IGCAR were made by scientists of the Centre and the visitors also gave a presentation of their mission. The delegates visited various laboratories of the Centre.

(Reported by M. Sai Baba, S&HRP)

MoU between IGCAR and UGC-DAE CSR

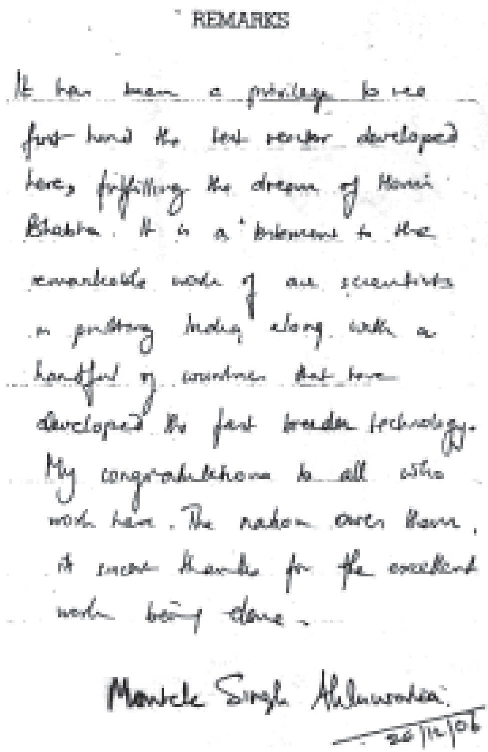


Dr. Baldev Raj, Director, IGCAR and Dr. Praveen Chaddah, Director, UGC- DAE DSR following the signing of MoU between IGCAR and UGC-DAE CSR..

A Memorandum of Understanding between IGCAR and UGC-DAE CSR was signed on January 16, 2007, at Kalpakkam. Under this agreement, IGCAR will open its medium sized, but high technology facilities for University researchers to promote collaborative research in the area of Physical, Chemical and Engineering Sciences. This MoU envisages the creation of a UGC- DAE CSR Node at Kalpkkam, that will house high-end research facilities that would be open to University researchers. The Node would help to foster an active collaboration between DAE and the academic institutions through the involvement of young research scholars.

(Reported by C. S. Sundar)

Visit of Deputy Chairman, Planning Commission


REMARKS

It has been a privilege to see first hand the test reactor developed here, fulfilling the dream of Homi Bhabha. It is a tribute to the remarkable work of our scientists in putting India along with a handful of countries that have developed the fast breeder technology. My congratulations to all who work here. The nation owes them a sincere thanks for the excellent work being done.

Montek Singh Ahluwalia
20/12/06

Shri Montek Singh Ahluwalia, Deputy Chairman, Planning Commission, Government of India along with Dr. Baldev Raj, Director during his visit to IGCAR. Remarks of Shri Ahluwalia in FBTR visitors book are reproduced.

AWARDS AND HONOURS

His Excellency President of India, Dr. A.P.J. Abdul Kalam honouring Dr. Baldev Raj, Director, IGCAR with PADMA SHRI Award on April 5, 2007

- **Dr. Baldev Raj** has been honored with the prestigious Padmashri Award by Government of India. He has also received the Meritorious Contribution Award for 2006 from NACE International India Section.
- **Dr. U. Kamachi Mudali,** Corrosion Science & Technology Division has been elected as a Fellow of the Indian Institute of Metals.
- **Dr. P. Chellapandi,** Reactor Engineering Group has been awarded "Mechanical Engineering Design Award – 2006" by The Institution of Engineers, India.
- **Mrs. B. Sasi,** Non-destructive Evaluation Division has been awarded *R.Chandrasekhar Memorial Prize* for Best Industry-oriented research work during National Seminar on Physics & Technology of Sensors(NSPTS-12) held during March 2007 at Mumbai.

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