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INSIDE

From the Director's Desk

History of Engineering Services Group

The Engineering Services Group (ESG) has a very important mandate of infrastructure development for all units of the Department of Atomic Energy located at Kalpakkam. It spans from Planning, Design, Engineering, Execution, Testing and Commissioning of Civil, Electrical, Mechanical, Air-conditioning and Ventilation works for the Laboratories, Township including Housing, Schools, Hospitals, Hostels, Roadways and various Public utilities and facilities. This Group is also responsible for commissioning, operation and maintenance of various services for the Atomic Energy installations at Kalpakkam.

The history of this group can be traced back to the 1960s, when the Department of Atomic Energy decided to establish a centre dedicated to the comprehensive development of fast reactors with closed fuel cycle technologies. In 1969, when the then Reactor Research Centre (RRC) was born at Kalpakkam, expert teams identified to carry out this significant mission were functioning at BARC, Mumbai. The responsibility of developing the infrastructure for the construction of RRC and a part of the township was steered by veteran Shri C.R. Ramamurthy, Chief Engineer (C), and his team functioning at the Madras Atomic Power Plant (MAPP). The team consisted of Shri T.V. Prabhakaran, Chief Architect, Shri C.R. Nagaraj, heading the construction, and Shri N.M. Ramaswamy, heading the design activities. Shri P.S. Sukumaran, Shri N.K. Murthy and Shri R. Ranjithakrishnan were entrusted with the responsibility of supporting with respect to power requirements for the construction and other activities.

Around this time, several teams were identified at BARC who would work towards supplementing the infrastructural needs at RRC. Shri B.S.Iyengar, Project Engineer (Co-ordination) conceived the Central Workshop while Electrical, Air-conditioning, Ventilation and Communication needs were addressed by Shri S.N. Narasinga Rao with support from Shri K. Venkataraman, Shri A.K. Gupta and other colleagues from Technical Services Division, BARC. Shri A. Soosainathan was identified to provide the architectural support. With the relocation of Shri K. Venkataraman and Shri N.S. Sreenivasan, who took charge of Electrical and Air-conditioning works in 1972 at Kalpakkam the activities at the site gained momentum. The group was strengthened with the addition of several young engineers (from BARC training school and recruited directly), supervisors and tradesmen. The teams led by Shri C.R. Nagaraj and Shri B.S. Iyengar together with Shri K. Venkataraman were well set to take up the challenges of providing the complete infrastructure to the projects at Kalpakkam. It was a familiar sight to all when the daily rounds of Shri K. Venkataraman and Shri P.S. Sukumaran to the site were intercepted with the ones by Shri N. Srinivasan, Director, RRC and Shri C.R. Nagaraj. A day was never complete without the independent visit of Shri C.R. Ramamurthy,

Chief Engineer (C) to all the construction sites - MAPP, Fast Breeder Test Reactor(FBTR), the laboratories of RRC and the township. He provided invaluable guidance during the daily briefing to the site teams to proceed with the activities.

Dr. Vikram Sarabhai with Shri C.R. Ramamurthy (extreme right) and senior colleagues during one of his visits to Kalpakkam

Shri C.R. Ramamurthy was a man of few words. His disciplined and thorough approach, were instrumental in delivering the civil engineering targets relating to MAPP, RRC and township effectively and comprehensively.

Over the years, the activities of Air-conditioning & Ventilation Systems Division, Central Workshop Division, Electrical Services Division, Quality Assurance Division at IGCAR as well as the Technical Coordination and Quality Control Section at Mumbai have evolved with the objective of supporting the Centre's mandate to develop Fast Reactor and associated closed fuel cycle technologies. I wish to highlight in this article the achievements and contributions of each of these activities of the Engineering Services Group presently being steered by Shri Y.C. Manjunatha.

A) Civil Engineering Division

Civil engineering team commenced its activities in full swing at Kalpakkam during 1969-70 in MAPS, with an impetus to establish RRC. A group of experienced engineers from the State Public Works Department were already functioning since 1966. The civil requirements of RRC were in addition to the ongoing works at MAPS, which included the construction of reactor buildings, turbine and service buildings, indoor switchyard, submarine tunnels, approach jetty, etc. It is noteworthy to mention here that the indoor switchyard is the first of its kind in Asia and the submarine tunnel, first of its kind in India. The civil team since inception has deserved accolades for its ability to conceive, design (architectural and structural), construct and maintain a variety of civil structures. The participation from external agencies and consultants was limited to design of nuclear and power islands of integrated reactor systems, which was scrutinized by the experts in the Department. Our experts were also responsible for obtaining approvals and clearances from regulatory bodies like AERB, Ministry of Environment & Forests, etc.

A dynamic team consisting of Shri N.M. Ramaswamy and Shri C.R. Nagaraj under the able leadership of Shri C.R. Ramamurthy took up several civil works of RRC,

HALL-3 building of FRTG

including the FBTR, which was a major challenge. Construction of several laboratories, buildings and services beginning with the conceptual design to construction was the primary mandate for the team. The team has successfully dealt with several difficult assignments like building engineering halls with slender columns, radioactive cells with special concrete, tall stacks (upto 100 metre), folded plate roofs, the Sarabhai Auditorium in Homi Bhabha Building with steel trusses, pre-cast slabs, etc. The twin column approach to construction of the forty four

Kalpakkam Township

Water tank with a capacity of one lakh gallon

metre Engineering Hall No. 3 with a large useful floor area for engineering facilities is a significant achievement. It is one of the tallest single bay structures in the country.

The one lakh gallon water tank built at IGCAR has been the prototype for other nuclear installations. Support systems involving roads, water supply, drainage, sewerage treatment, etc. established by the pioneers are indeed effective, and have been validated by years of good service. This Group has developed special concretes to meet the specific requirements of DAE units and computer codes to solve complex problems. The team had introduced several innovations in their design which were also cost effective.

The establishment of modern townships with all amenities at Kalpakkam and Anupuram is a major milestone in the history of the civil engineering activities. The role of Shri B. Chinnappa and contribution from other colleagues from civil engineering is commendable and outstanding in this context.

The Civil Engineering Division, apart from handling various services required for the Centre, has also provided support on infrastructural development for BARC facilities at Kalpakkam, Rare Materials Plant, Mysore, Magneto Hydro Dynamics Project - Bharat Heavy Electricals Limited, Trichy, Indian Rare Earth projects at Alwaye & Manavalakurichi,

A Panoramic view of the Township

Society for Applied Microwave Electronic Engineering and Research, Chennai, Institute of Mathematical Science, Chennai, Harishchandra Research Institute, Allahabad and National Centre for Biological Sciences at the Tata Institute of Fundamental Research (TIFR), Bangalore. The team, at present is extending the consultancy service support to the proposed India Neutrino Observatory project of TIFR.

Successive Chief Engineers from Shri C.R. Ramamurthy, Shri C.R. Nagaraj, Shri V. Krishnamurthy to Shri P.C. Koteswara Rao have left behind a legacy of significant achievements. The mandate of the present team is to sustain the present infrastructure, augment it during XI plan, approval of documents and coordination of PFBR related civil works and establishment of civil infrastructure of the FRFCF along with development of the associated township. The townships from now on would redefine a new skyline as multistoried buildings occupying the landscape of Kalpakkam and Anupuram. The Group has major plans of providing an aesthetic and sustainable green environment at the project site and the townships. It also intends to introduce water management schemes to ensure uniform quality of water in all seasons through the years. The tasks are being steered by a team of senior civil engineers. I take this opportunity to wish my civil engineering colleagues all success in their future endeavors and look forward to record many more success stories from them.

B) Electrical Services Division

A significant policy decision of MAPS / Power Projects Engineering Division, is to take into account the power requirements of FBTR, R&D and process plants of RRC and Township and include the same as in-house requirement of MAPS laid a firm foundation to the Group in developing strategies to meet the demands on electrical power and infrastructure at Kalpakkam. This facilitated a unique tariff structure incorporated in the Power Purchase Agreement of MAPS at an appropriate stage. Apart from considerable savings in the energy charges, the decision also helped in providing adequate, high quality reliable and uninterrupted power through a well designed network, to the Kalpakkam community. In tandem with civil works, the Division has contributed significantly towards meeting the

Central Switching Station

electrical infrastructural needs for several projects of the DAE. The significant features of the power system include network of underground cable feeders, adequate main and standby feeders/ equipment, sufficient Diesel Generator backed system with Auto Mains Failure feature accompanied by state of the art, control, protective and indication schemes.

A major milestone in the electrical power system activity was the commissioning of 33 kV Central Switching Station during January 1977. Till 1980, the total power requirement was met by the 33 kV and 11 kV supply provided by Tamil Nadu Electricity Board. The Central Water Chilling Plant, the 33 kV Central Switching Station, 11 kV / 415 V sub-stations at RDL, Central Workshop and MDL were the first to be built. With the commissioning of 33 kV Central Switching Station, load transfer from 11 kV Tamil Nadu Electricity Board to 11 kV from 33 kV Central Switching Station was effected in a phased manner. The 33 kV Central Switching Station was networked with 220 kV indoor switchyard of MAPS in 1980, retaining the source of Tamil Nadu Electricity Board as a standby. Since then, the station has been successfully providing the OFF site power to FBTR as per the technical specifications. The electrical system at FBTR and RML was designed and executed by an independent team comprising of Shri K. Raghavan, Shri T.K. Shanmugam and Shri R. Jeevanandham. Shri R. Jeevanandham and his team also played a significant role in commissioning of the 33 kV Central Switching Station.

A major value addition to the system was replacement of the standby 33 kV Tamil Nadu Electricity Board source with the full power standby 33 kV source from 230 kV MAPS switchyard. It is an engineering achievement wherein an energized 230 kV indoor switchyard was expanded without effecting major shut down. This was possible due to the timely recommendation of Shri C.V. Sundaram the then Director of RRC and acceptance by Dr. M.R. Srinivasan the then Director, Power Projects Engineering Division. The spin off benefit of this action is the availability of tie feeder to PFBR switchyard that is now under construction.

A significant development during nineties was the replacement of the outdoor electrical system with overhead line network at the habitated Township with an indoor system networked with underground cables and provision of Earth Leakage Circuit Breakers to all the houses. This has enhanced the reliability and safety of the system. Shri K. Venkataraman harnessed the required financial support for upgradation of the Township electrical system, by appropriate discussions with DAE. Shri N.S. Sreenivasan and Shri Y.C. Manjunatha (often referred to as Lav & Kush in inner circles), under the directive from Shri K. Venkataraman have contributed substantially towards establishment, augmentation and sustenance of the system.

A significant step in enhancing the communication facilities was the establishment and sustenance of state of the art reliable inter-communication system consisting of several exchanges and associated networks. Introduction of special features and link to Bharat Sanchar Nigam Limited network is laudable.

Another major facility effected during the IX & X plan periods was the introduction of contingency power distribution arrangements, one at 6.6 kV bus of Steam Generator Test Facility and the other at 6.6 kV bus of Nuclear Desalination Development Project, so as to meet the minimum essential power requirement during emergencies.

Thanks to the foresight of the earlier planners, MAPS has been providing adequate, safe, reliable and quality power to IGCAR, BARC Facilities and GSO till date. Starting from an operating load of about 1.5 MVA during 1977, the load on the power system has grown to a level of 22 MVA. The projections indicate that the load would grow to about 35 MVA by 2012 and to about 60 MVA by 2017. The present team is well set to take on the challenges pertaining to sustenance, augmentation and establishment of power systems at

new projects of IGCAR, GSO and FRFCF. With a proactive approach all along, the group has initiated several augmentation measures at source end, receiving end and associated networks. A 230 kV/33 kV/11 kV, 50 MVA, third power source, being built as a part of the PFBR switchyard, is expected to be operational by December 2008. The electrical power system of FRFCF is conceived to meet the power requirements for the present phase as well as the envisaged expansion in the future. Considering the steps that are being initiated, the Division is confident of meeting the projected power requirements and is moving ahead with an objective to sustain the path of excellence.

C) Air-conditioning & Ventilation Systems Division

The role of the Air-conditioning and Ventilation Systems Division (AC&VSD) goes hand in hand with the progress of civil and electrical works at the Centre. Since its inception in 1973, the Division has made significant contribution in establishment, augmentation and sustenance of air-conditioning and ventilation activities to meet the ever increasing needs of the Centre. Shri G.V. Krishnamurthy, Shri A.S. Raghu and Shri K. Venkatesan under the expert guidance of Shri K. Venkataraman and later Shri S. Keshavamurthy Rao have played crucial role in achieving the targets. The Central Water Chilling Plant with six numbers (4 W + 2S) of 550 TR chiller units along with associated cooling towers, underground piping networks has been in operation since 1980. The plant has been refurbished with the state of the art, energy efficient and eco-friendly chillers and cooling towers during IX and X plans.

This Division also meets the air-conditioning requirements of all the groups of IGCAR. While the operation and maintenance of radiological labs, FBTR and systems in FRTG rests with the respective groups, the back up resource for all the divisions is the mandate of the AC&VSD. Additional responsibilities of the Division include establishment and sustenance of diesel generator sets, material handling system – electrical overhead traveling and Hand operated overhead traveling cranes and clean rooms. In tandem with civil works, the Division has also contributed significantly towards air-conditioning, ventilation and material handling activities for various projects of DAE.

Array of compressors to "chill" the water

Since the air-conditioning and ventilation systems are known to consume a good share of the energy in any R&D establishment, this Division has initiated several energy conservation measures during XI plan. The present team has initiated many activities so as to provide state of the art, energy efficient, reliable and eco-friendly air conditioning and ventilation systems.

D) Central Workshop Division

The need for dedicated workshop facilities was felt right during the days of conceptual formation of RRC. Shri B.S. Iyengar who held a senior position at Central Workshop, BARC, was entrusted with the responsibility of planning and execution of the Central Workshop facilities at RRC. He was also heading the electrical and air-conditioning divisions during the early days of RRC. The Zonal Workshop at Hall 1, was established first to meet the immediate requirements. It continues to maintain its high standards even today. The pleasant interactions with Shri S. Aravamudhan, then In-Charge, Zonal Workshop, are being recollected by the old timers even today.

Central Workshop with the then state of the art machines became operational in 1975. It is equipped with plant and machinery for machine shop, fabrication shop, carpentry and smithy facilities. Lathe with special features, milling machines, planning machine, plasma cutting facilities, shearing machine, etc. are some of the facilities that have been recently added.

Under the able guidance of Shri B.S. Iyengar and later from Shri K. Venkataraman, Shri R. Deivasigamani, Shri A.S. Raghu, Shri K.S. Krishnamurthy, Shri N. Gunasekaran and a very motivated work force, Central Workshop has contributed enormously with innovation and precision in meeting the fabrication requirements of FBTR, R&D laboratories of IGCAR and other units of DAE.

Inaugural Function of Workshop on 27 April1974

Major FBTR components manufactured at Central Workshop include steel vessel, Control Rod Drive Mechanism (CRDM) guide tube, spare CRDM components, argon storage tank, material air lock, CDF gripper body and fingers. It may be recalled that Shri Adimoolam of Central Workshop was the first to qualify in welding as per FBTR standards which is of a special category.

CNC machines and metrology tools were introduced during 1982-1987 along with a nuclear clean room. The leadership of Shri M.K. Ramamurthy, then Director, Technical Engineering and Management Services Group and Shri K. Balachander gave a new direction to the team at Central Workshop. Quality Circle concepts were introduced and sustained in a structured manner. In fact, the colleagues at Central Workshop are veterans amongst DAE employees in sustaining and propagating the Quality Circle movement. They have won several awards in the state and national level competitions. Central Workshop continues to extend support to R&D and technology development activities of PFBR systems. Achievements continued to pour in during the stewardship of Shri R.D. Kale and Shri M.A.K. Iyer, who were instrumental for development and introduction of computerized work management system for production, planning and control of work orders and formation of outsourcing cell.

The present team under a dynamic leader is gearing up to take up challenging manufacturing activities including design and development. The shop is being augmented with many new machines and facilities during XI plan. An optimal manpower mix with a reasonable outsourcing content is being planned. I am also happy to record the additional contributions by Central Workshop to other units of DAE viz. NPCIL – MAPS, NAPS, BARC Facilities (Augmented Upgradation Facility) and VECC, Kolkata. The role of the Division in delivering services from Autoshop to

Shri R. Deivasigamani describing the details of fabrication

IGCAR, BARC Facilities and GSO is widely appreciated.

The Division has maintained a high reputation in the production of quality products meeting stringent requirements of various codes. The contributions in areas where the jobs could not be outsourced (due to demanding requirements, small quantity of jobs etc.) deserve special merit. Over the years of successful performance, successive Heads of Division and the team have left many meritorious foot marks, worth emulation.

E) Quality Assurance Division

Thanks to the vision of the founders, the need for a functionally independent quality assurance activity was realized during 1974. The Quality Control and Inspection Wing became functional under the leadership of Shri G. Mallikarjun reporting to Shri N.L. Char, Project Engineer, RRC. Necessary tools and equipment for Non-Destructive Evaluation, pressure testing and optical equipment along with dedicated and motivated manpower were positioned. Important achievements include establishment of nuclear clean environment for fabrication, welding of austenitic stainless steel, radiographic examination of double envelope piping, etc.

The dedicated work on Quality Assurance is the hall mark of the team. Amongst many achievements of FBTR, a typical case to mention is zero sodium leakage incident in the fabricated portion of FBTR structures. The wing was renamed as Quality Engineering Section during 1986. From 1998, the Quality Engineering Section under the leadership of Shri Chandramohan was elevated to Quality Assurance Division (QAD) when it became a part of Technical Engineering and Management Services Group with Shri M.K. Ramamurthy as the Director. Around 1988, the entire experiences of QAD on FBTR were recorded in the book "Over a decade of nuclear inspection and testing experience in Fast Breeder Test Reactor".

The dedicated team under the successive leadership of Shri B.S.C. Rao, Shri M. Palaniappan and Shri K. Shanmugam continued to contribute to Quality Assurance activities of technology development of PFBR, by active participation at all stages starting from conceptual design to inspection at manufacturer's works. Reactor vessel, safety vessel, inner vessel, control and safety rod driving mechanism, Failed fuel locating module, transfer arms, roof slab, etc. are a few amongst many a components wherein QAD has played a key role. The role of Shri K. Shanmugam in obtaining ISO 9000 certificate to PFBR design activities is noteworthy.

The Division is the forerunner amongst the various divisions of Engineering Services Group to get ISO 9001 certification. As an additional activity, the Division has ambitious plans to take up several directed research & developmental activities in the areas of NDE pertaining to development of FBR technologies and asset management. The Division has rendered its expertise to other DAE units and strategic sectors like Defence and Space.

F) Technical Coordination and Quality Control Section (TC&QCS), Mumbai

As the need for Quality Assurance and Inspection activities of IGCAR at Mumbai was felt, Shri Khandelwal was posted at Mumbai. Subsequent to the relocation of Shri D.P. Dedhiya, Head, TC&QCS, during 1984, a team with a few senior colleagues was positioned at an identified office at Hall 3, BARC at Mumbai. The team has contributed a lot towards technical coordination activities at BARC, DPS (major high value purchases of IGCAR were effected through DPS, Mumbai, until 2002), DAE head quarters and Quality Assurance activities with industries in the western region. Shri D.P. Dedhiya and his small team contributed significantly to the collaboration between BARC and IGCAR to expedite and implement the programmes of the Centre.

Inspection of Control and Safety Rod Drive Mechanism by QAD personnel at the factory premises

The contribution from TC&QCS spans all the activities of IGCAR – from FBTR, J-Rod campaign, FRTG works, R&D and technology development activities for PFBR systems right upto In Service Inspection of devices.

The present team is all set to take up future challenges associated with development of FBRs and associated closed fuel cycle. With the support from Directorate of Construction Services & Estate Management, a separate FBTR Coordination Centre is being established at Vikram Bhavan, Anushaktinagar, Mumbai. The role by this small team, filling the gaps in a chain of activities, is very vital and is highly appreciated by all the colleagues at the Centre.

Inspection of Steam Generator for SGTF by TC&QAS at L&T Mumbai

To sum up, the Engineering Services Group of today is a combination of three former groups namely, Engineering Services Group prior to 1999, Technical Engineering and Management Services Group prior to 1999 and Civil Engineering Group prior to 2002. It is one of the largest groups having special mandates to meet variety of demanding deliverables to IGCAR and GSO. In view of decline in the number of experienced manpower, several steps are being initiated to outsource the works for optimal utilisation of manpower. With the excellent team spirit and the prevailing matrix organizational structure, I am confident that the group will deliver the goods to a level par excellence, as has been the tradition within the Group. I take this opportunity to wish my Engineering Services colleagues all success in their future endeavors and look forward to record many more success stories from them.

(Baldev Raj)
Director, IGCAR

Infrared Spectroscopy Study of PFBR Concrete Degradation on Exposure to Sodium Fire

Sodium-concrete reactions are a class of reactions that have been extensively studied in the context of Fast Breeder Reactor safety. It is well known that when hot liquid sodium comes in contact with structural concrete, an interaction takes place due to both the thermal loading of the concrete and the chemical reactivity of the liquid metal with the constituents of concrete.

In spite of adequate safety measures taken during design, fabrication and operation stages of liquid metal cooled fast breeder reactors there is still a possibility of leakage of hot liquid sodium from primary and secondary heat transport circuits of the reactor during operation. If this spillage were to happen in the air filled enclosures as in the steam generator buildings then one would have added complications due to the occurrence of sodium fires which would raise the liquid sodium to very high temperatures resulting in severe degradation of the structural concrete flooring. Among the several measures taken to limit/eliminate such interactions, the use of limestone aggregate concrete as a protective sacrificial mortar layer over the structural concrete flooring is being preferred due to its higher resistance to sodium attack. Hence, limestone aggregate concrete needs to be further qualified and its performance checked by exposing them to conditions conforming to a typical accidental hot sodium leak that could occur in the steam generator building of Prototype Fast Breeder Reactor (PFBR). This work also forms a part of the study to check the feasibility of whether a 50 mm thick protective sacrificial layer of limestone aggregate concrete would suffice to protect the structural concrete flooring of the steam generator building of PFBR.

In the current experiments conducted at Safety Engineering Division, hot liquid sodium maintained at ~550°C was transferred on to the central cavity of limestone aggregate concrete test block (Fig.1.) and allowed to interact for a typical period of 30 minutes, thus simulating a typical accident scenario. Both temperature profiles and weight changes were monitored during sodium exposures. Samples were removed from various locations on the concrete surface for various depths to check for degradation (Fig.1.). Although the extent of mechanical damage has been estimated through several pre/post test measurements, in this work we have used infrared spectroscopy for the first time to follow the extent of thermochemical degradation of concrete on account of the hot sodium attack and hence generate a depth profile of the degradative effects. The results of this study would have implications on the design of the protective sacrificial layers to be used in the steam generator building of PFBR.

It is well known that setting/ degradation in cements involves conversion of water from the free state to a bound state or vice versa and since infrared spectroscopy is a very valuable tool to probe the hydration state of water, the samples were subjected to a mid infrared spectroscopic analysis. Definite signatures of thermochemical degradation indicating dehydration

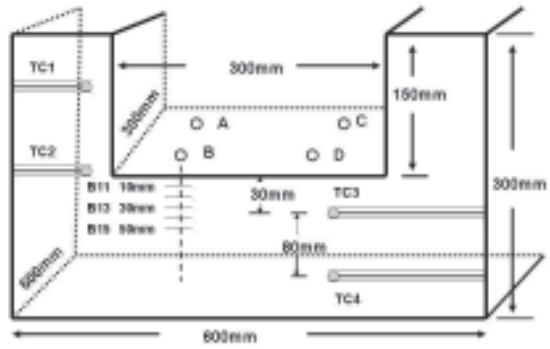


Fig.1. Schematic of concrete test block along with location of thermocouples and details of samples drawn from different depths.

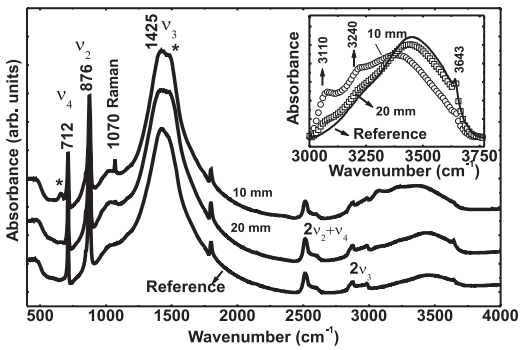


Fig.2. Room temperature mid-infrared spectrum of the limestone aggregate reference concrete along with the spectra of sodium exposed samples from various depths. The inset clearly points to a dramatic softening of the modes of water associated with increased intensity of low frequency mode

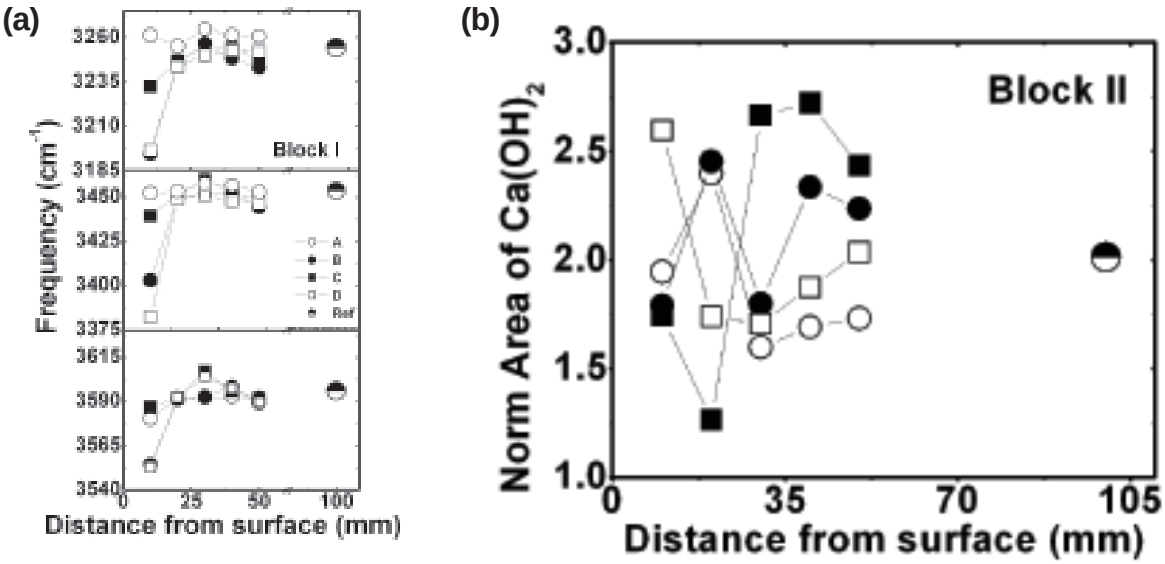


Fig. 3(a). Variation of vibrational frequencies as a function of distance from affected surface. **(b)** shows the variation of normalized area of $Ca(OH)_2$. which indicates dehydration in the samples. A,B,C and D indicate the locations on the test block from which the samples have been drawn (refer Fig.1.). The half shaded circles indicate reference values.

and structural modification of the limestone concrete have been obtained for the first time using this technique. Control runs were carried out to delineate the thermal effects of sodium fires from that of the chemical interaction effects. Measurements on limestone aggregate samples treated with fused NaOH provided direct evidence of the exact mechanism of the sodium attack on concrete. The observed degradative effects were correlated to the mechanical strength of the concrete blocks and to the intensity of the sodium fires.

Figure 2 shows the room temperature mid-infrared spectrum of the limestone aggregate reference concrete along with the spectra of sodium exposed samples as a function of depth. The spectrum of the reference sample revealed vibrational features corresponding to the major constituent -limestone ($CaCO_3$) in the sample. The broad absorption feature centered around 3500 cm^{-1} is attributed to stretching mode of bound water in concrete. In particular the sharp feature at 3643 cm^{-1} riding on the broad water background is said to arise due to the O-H stretching of $Ca(OH)_2$ - the major hydration product of Portland cement. Estimating the area under this peak at 3643 cm^{-1} could follow the extent of setting/dehydration of cement. It is clearly evident from the Figure that the spectrum of the sodium exposed sample removed from 10 mm from the affected surface shows appreciable changes as compared to that of the reference sample. The stretching modes of water in the affected sample reveals a significant softening associated with a dramatic increase in the intensity of the low frequency components as compared to that of the reference sample Fig. 3(a). The intensity of the 3643 cm^{-1} peak corresponding to O-H stretching mode of $Ca(OH)_2$ is also seen to significantly decrease. These changes are understood as arising due to the loss of both free and bound water from the concrete on account of sodium exposure, thus degrading the concrete. The appearance of a new mode at 1070 cm^{-1} and the splitting of the doubly degenerate ν_3 and ν_4 modes indicate a structural transformation of the limestone aggregates.

In order to generate the depth profile of the degradative effects which could have implications on the design of sacrificial protective layers, the vibrational frequencies and the normalized area of $Ca(OH)_2$ are plotted as a function of depth from the affected surface (Fig.3(a) and 3(b) respectively). While effects of thermochemical degradation are evident for depths up to 30 mm from the affected surface (Fig.3(a)), mild effects of dehydration are seen even for depths up to 50mm from the affected surface (Fig.3(b)).

Although the degradative effects are evident upto depths of 50 mm, the effects are still very mild and hence we infer that under the present set of reaction conditions, a 50 mm thick protective sacrificial layer of limestone aggregate concrete will suffice to protect the structural concrete flooring in PFBR. Thus, infrared spectroscopy has helped provide an insight into the changes occurring at the molecular level, enabling a simple and reliable route to monitor this important class of reaction.

(Reported by M. Premila, K. Sivasubramanian, G. Amarendra and C. S. Sundar, Materials Science Division and *Safety Engineering Division)*

Replacement of Flexible Metal Tube in Turbo Expander of Helium Plant

Background

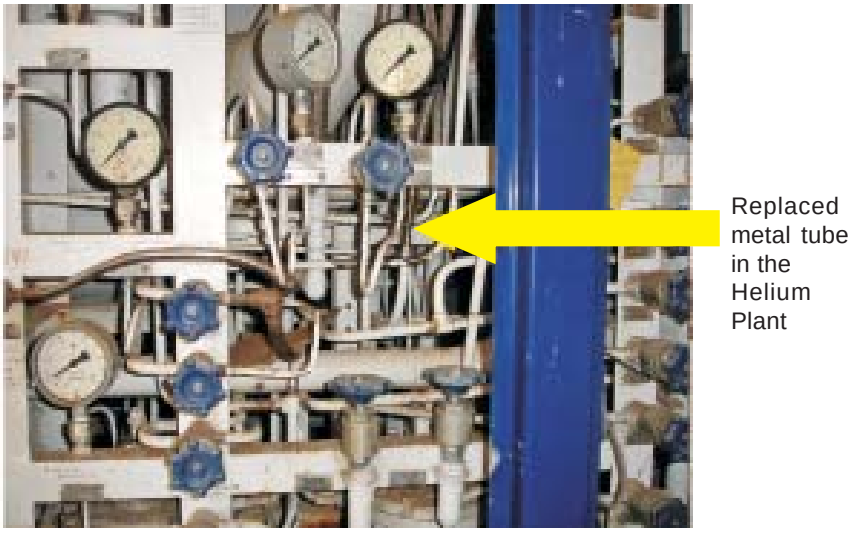
Helium utility plant to support the main heat transportation system is a part of some of the nuclear facilities and these plants are equipped with turbo expanders. Recently, in one of the helium plants, the instrument lines used for checking the differential pressure between inlet and outlet side of the turbo expander developed a leak in the flexible metal tube joint region. The instrument line is a high pressure line and was located in the midst of a number of pipelines. Accessibility was very restricted and thus repair of this leak joint was a challenge. The defective tube joint was observed to be 200 mm inside the panel of the turbo expander and several system lines were found to be in the vicinity of the defective joint. After detailed deliberations taking into account, the possibility of *in situ* repair etc., it was decided that the joint region would be cut and then welded with a new tube.

The campaign

It was decided to introduce an intermediate tube of length 50 mm and outer diameter to 12.1 mm match the existing connections. The objective of introducing the intermediate tube was to compensate the short fall in length of the existing line due to cutting and also to convert the positional weld joint from 2G butt joint to 2F fillet weld. This change in the weld configuration was also to ensure adequate penetration since the joints were critical and Non Destructive Testing techniques such as radiography or ultrasonic examination could not be carried out due to problems of accessibility. This implied that the welding had to be carried out with utmost caution and with skill. Before proceeding to the site, preparatory works were completed at Central Workshop Division. One end of the intermediate tube was welded with metal tube and other end of the tube was welded with an existing elbow by Gas Tungsten Arc Welding (GTAW) process. These prefabricated joints were subjected to dye penetrant testing carried out as per the requirements of ASME Sec V and found to be satisfactory.

The pre-fabricated tube was then taken to site and then positioned appropriately. Using a portable gas tungsten welding machine and a miniature welding head and necessary tool kit, welding was attempted. A major challenge during welding was the visibility of the backside of the tube. The team used a novel approach of using an angled mirror and the welder then skillfully and meticulously carried out the welding in 2 F position successfully. Visual inspection using the mirror was then carried out to ensure that the weld was satisfactory. The line was then subjected to helium leak testing and the joints were found to be satisfactory. The work received appreciation from the plant personnel for the innovative and timely repair.

(Reported by P.Sivaraman, M. Krishnamurthy and A.S.L.K.Rao, Central Workshop Division)



Helium Utility Plant

Forum for Young Officers

Computational Prediction of Decay Heat Removal Capability of Steam Generator Casing in FBTR

Shri M. Rajendra Kumar, graduated from Coimbatore Institute of Technology with Chemical Engineering as major in 2003. He then did his Masters degree in Thermal Engineering from Indian Institute of Technology, Madras. He is from the 3rd DGFS batch of BARC Training School. He is working in the Thermal Hydraulics Section, Mechanics & Hydraulics Division, Nuclear Engineering Group of Reactor Engineering Group from January, 2007.

Currently, FBTR is operating at 17 MWt power with four steam generator (SG) modules. The current operating temperatures are low as the reactor is designed for 40 MWt power and hence the corresponding heat transfer surface areas are large. In order to increase the operating temperature as much as possible with the present small core, it is planned to reduce the surface area in the SG modules. To achieve this, it is planned to remove two SG modules and operate the reactor with the other two SG modules (i.e. one module per loop). It may be highlighted that the four SG modules are placed inside an insulated rectangular casing as shown in Fig. 1. The decay heat in the reactor is removed by opening the trap doors of the SG casing. With two modules not in service, the decay heat removal capability will be less. However, the decay power also would be less, as the reactor operating power is less. It needs to be established that the decay heat removal capability (with two modules alone in service) is adequate. Establishment of decay heat removal with only two SG modules calls for comprehensive 3-D Computational Fluid Dynamic (CFD) studies, considering the flow by-pass effects. Moreover, it is also essential to identify the two modules which should be removed out of four modules, so that the decay heat removal capability will be the maximum for the selected configuration. This is the basis for the current study.

Mathematical Model

A 3-D CFD model of the casing along with the SG modules has been developed for the investigations. The outlet from the SG casing is vented to the ambient through a ten meter long insulated duct. As the shape of the duct is very complex and there is no established correlation for the specification of the pressure drop for flow through this duct, the duct with insulation is modeled completely. High Reynolds number k-e turbulence model has been used for modeling the turbulence. Natural convection of air inside the casing is simulated using the ideal gas law. About 2.5 lakhs structured hexahedral mesh (Fig. 2) have been used for the calculation. Natural convection of air inside the casing, radiation heat exchange between the casing wall and the SG walls, heat conduction through the insulation have been considered simultaneously as a conjugate problem.

Validation of CFD Model

It is essential to validate the predictive capability of the CFD model. Towards this, the commissioning tests conducted in the plant have been utilized. It may be indicated that commissioning experiments have been carried out in the SG casing of FBTR to estimate the heat removal capacity by natural convection of air.

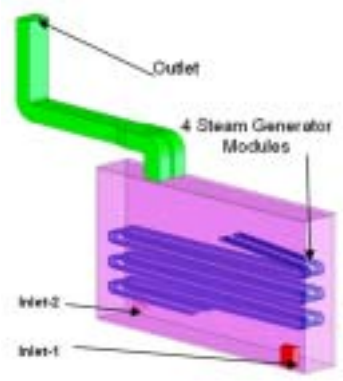


Fig. 1. Steam generator casing of FBTR with all the four modules

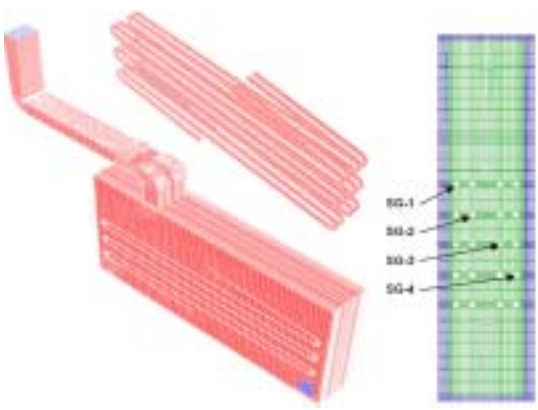


Fig. 2. Computational mesh

Experimental data are available for two values of SG temperatures viz., 215°C and 350°C. These data are for the condition that all the four SGs are in service. In order to validate the present CFD model, simulation has been carried out with four SG modules with these temperature conditions. The predicted mass flow rates of air through the inlets (viz. Inlet-1 and Inlet-2), the air outlet temperatures and the power removed by air are compared with the measured data. For SG, a wall temperature of 215°C, the predicted power removal by the induced air flow is 330.1 kW and is only 1.24 % less than the measured value. Similar comparison for a 350°C SG wall temperature indicates that the predicted power removal is 695 kW and is 3.34% less than the measured value of 719 kW. Thus, through this study the validity of the CFD model has been established.

With all the four SG Modules

Based on whole plant thermal analysis, it has been estimated that when two modules are not in service, the temperature of the remaining modules is 420°C during decay heat removal condition. Hence, all the CFD calculations have been performed for this value of SG wall temperature. Fig. 3. shows the predicted natural convective velocity pattern of air inside the casing. Lateral entry of air into the casing, its upward movement over the SG walls as well as over the casing walls and its final exit from the casing at the top are very well predicted by the code. The air velocity at the entry to the casing is ~ 2 m/s and the velocity over the SG walls is of the order of 1 m/s. The bulk temperature of air increases gradually from 40°C at the bottom of the casing to 270°C at the top of the casing, as seen in Fig. 4. The walls of the casing are heated by the radiation heat transfer from the SG modules and natural convection currents are set up along the casing walls. The temperature of the vertical walls is higher than that of the horizontal ones, as they are closer to the SG modules to offer a larger view factor for radiation heat transfer. The mean temperature of the vertical walls is about 275°C, while the SG walls are at 420°C. The mass flow rates of air through inlet-1 and inlet-2 are estimated to be 1.99 and 2.10 kg/s. The temperature of air at the outlet is predicted to be 235°C. Thus, the power removal by natural convection is 905 kW. This is base value for the comparison of two SG cases.

With two SG Modules

Fig.5. depicts the temperature distribution on a vertical section for four different cases studied along with the reference case. The temperature distribution depicts that the casing walls receive heat from the SG walls and dissipates the same to the air, thus actively participating in heat transfer due to their large surface area. Among cases1-4, the temperature profiles are nearly identical, with case-2 having marginally higher air temperature. A comparison is made for the induced air flow rates, air outlet temperature and heat removal for all the four cases. It is seen that the air temperature rise in the reference case (i.e. with four SGs present) is 235.6 °C while in all the other cases (i.e. with only two SGs present), the temperature rise is ~ 190 °C, which is about 75 % of the reference value. The heat removed by air in the reference configuration is 905 kW. For the two SG cases, the heat removal varies in the range of 660 kW to 700 kW, with the maximum for case-2, wherein the middle two SG are removed (Fig. 6). Thus, it is clear that the decay heat removal capability of SG casing with two modules in service is nearly 75 %

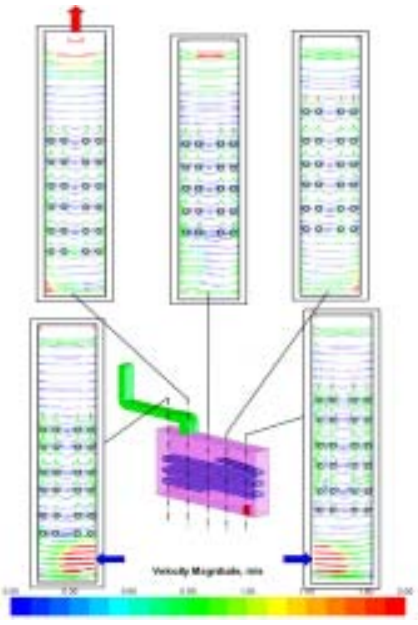


Fig. 3. Natural convective velocity field of air inside the casing with four modules

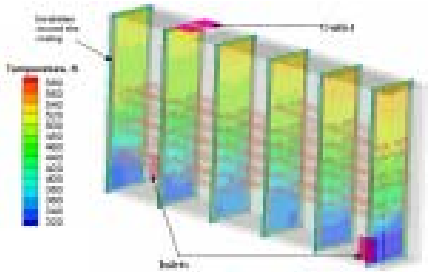


Fig. 4. Temperature field in air as well as in insulation at various planes

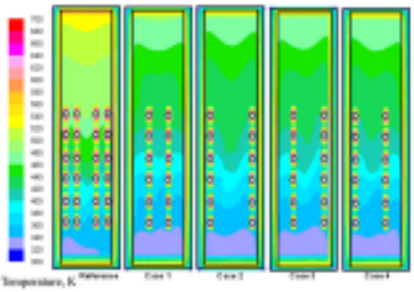


Fig. 5. Temperature contours in a vertical plane for all the four cases

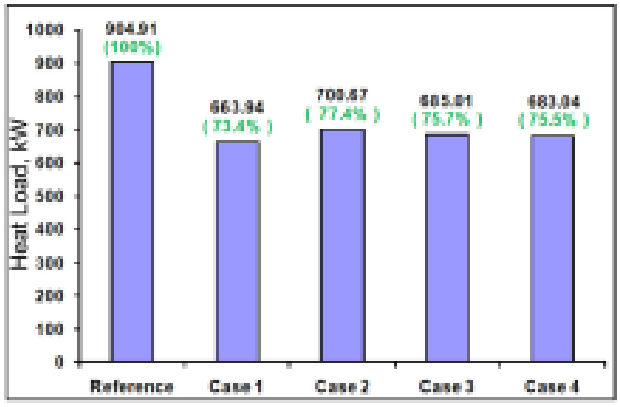


Fig. 6 Comparison of heat removal for all the four cases along with the reference case

of that with four modules, demonstrating that this option of enhancing the primary sodium temperature is feasible. It is also seen that this value is nearly independent of the configuration. However, the heat removal capability for the case 2 (Fig. 5) where the middle two SGs are removed is marginally high. Hence, it is recommended to remove the middle two SGs.

(M. Rajendra Kumar and his colleagues, Mechanics & Hydraulics Division, Reactor Engineering Group)

Conference/ Meeting Highlights

Industrial Safety Workshop - ISW-2007

November 29-30, 2007

Shri. S.C.Chetal, Director, REG, delivering the inaugural address

A two-day Industrial Safety Workshop (ISW-2007) was organized by IGCAR in association with Indian Institute of Chemical Engineers, Kalpakkam Chapter during November 29–30, 2007 at Sarabhai Auditorium, IGCAR. Shri M. Rajan, Director, Safety Group welcomed the gathering. The workshop was inaugurated by Shri S.C. Chetal, Director, Reactor Engineering Group. Prof. (Smt.) Kalpana Balakrishnan, Head, Department of Environmental Health Engineering, Director, WHO Collaborating Centre for Occupational Health, Shri Ramachandra Medical College & Research Institute, Chennai delivered the key note lecture on Emerging Principles in Integrated Occupational Health and Safety Management. Shri S.C. Chetal released the souvenir and soft copy of the proceedings. Prof . (Smt.) Kalpana Balakrishnan received the first copy. About two hundred delegates from IGCAR, BARC(F), MAPS and BHAVINI participated in the workshop. Fourteen experts from DAE and other institutes delivered invited lectures. The workshop covered expert lectures on safety in material handing including AERB guidelines, Ergonomics emphasizing its need in work place for safe, comfortable and effective human use, Safety requirement during chemical processing and the Atomic Energy factory rules and its importance in enforcing safety in work place. Dr. K.K. Satpathy delivered vote of thanks.

(Reported by K.K. Satpathy, Environmental & Industrial Safety Section, Safety Group)

Sustaining Global Pressures: Women in Science and Engineering Next Generation Challenges and Opportunities - SGPW-2008

January 3-5, 2008

Dr. Baldev Raj, delivering the presidential address

The international symposium on "Sustaining Global Pressures – Women in Science and Engineering" (SGPW 2008), organized at Kalpakkam by Indian Women Scientists' Association (IWSA) Kalpakkam Branch, was inaugurated by Dr.Kaiser Jamil, President, Third World Organisation for Women in Science (TWOWS). Dr.Junko Ogawa, Global President, Women in Nuclear (WIN), Japan, delivered the keynote address. Dr.Baldev Raj, Director, IGCAR presided over the function. Smt. Uma Seshadri, Head, Planning Division and Chairperson, SGPW 2008 welcomed the gathering, Dr.S.S.Raj, Co-Chairperson, gave a brief summary of the activities of IWSA in Kalpakkam over the years. Dr.R.Sandhya, Convenor, SGPW 2008 proposed the vote of thanks. There were eight sessions which included Women Scientists in Developed and Developing Countries, Women as Decision Makers, Next Generation Challenges and Opportunities, Women's Legislation, Motivating the Girl Child to a Career in Science and Technology, Women and Environment, Women Entrepreneurship and Women's Role in Rural Development, with each session dwelling on the challenges, opportunities and pitfalls in each of the themes. All the themes were dealt upon by specialists in the respective fields including eminent personalities like Dr.(Smt.)Y.G.Parthasarathy and Dr. Reena Ramachandran. The symposium concluded with a panel discussion which came out with a set of resolutions to be forwarded to the Department of Science and Technology for scrutiny.

(Reported by R .Sandhya and Mary N.Mohankumar, Organising Committee, SGPW-2008)

DAE Anu Week-2008

February 15-19, 2008

Dr.M.R.Srinivasan, Member-AEC and Dr.W.Selvamurthy, Chief Controller-R&D, DRDO with Dr.Baldev Raj, Director, IGCAR, Shri P.V.Ramalingam, Director, ROMG and PSG authorities during the inauguration

The Public Relations Activities Implementation Committee (PRAIC) of IGCAR organized the regional annual event of DAE viz. 'Anu Week Celebrations' this year at PSG College of Technology, Coimbatore during February 15-19, 2008 on the theme 'Nuclear Energy for Global Edge'. The week-long celebrations included the DAE's 5-day participatory exhibition and 3-day workshop for school science educators, besides bilingual elocution, essay and quiz competitions and cartoon contest. The workshop was inaugurated by Dr.W.Selvamurthy, Chief Controller of R & D, DRDO. Dr. Baldev Raj, Director, IGCAR gave a special address. Dr.M.R.Srinivasan, Member-AEC, Dr.K.S.Parthasarathy, former Secretary, AERB and Raja Ramanna Fellow, DAE and Dr. S.K.Malhotra, Head, PAD, DAE delivered the plenary lectures at the teachers' Workshop. The multifaceted applications of radiation and radioisotopes in power and non-power sectors like healthcare, agriculture, industry and food processing were covered by the resource persons from IGCAR, SRI, BARC and DAE. The participants were taken to the PSG Hospitals for first-hand knowledge on the uses of radiation in human health care and diagnosis. Dr.H.S.Kushwaha, Director, Health, Safety and Environment Groups, BARC delivered the valedictory address and distributed the prizes.

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

Theme meeting on "Small Specimen Mechanical Testing"

February 25, 2008

A one day theme meeting on "Small Specimen Mechanical Testing" was held on February 25, 2008 at IGCAR under the auspices of the Indian Institute of Metals, Kalpakkam Chapter. The main aim of the theme meeting was to disseminate the knowledge and trends in the current practices in this emerging field of mechanical testing. A total of seven lectures were delivered by speakers from IGCAR, BARC, Mumbai and IIT, Chennai. Beginning with introductory remarks by Dr P R Vasudeva Rao, Director of Metallurgy and Materials Group, the first lecture was on the historical evolution of the small specimen mechanical testing which was delivered by Shri K V Kasiviswanathan. He presented a broad perspective of various test techniques and their genesis, the progresses and the recent developments in each of the test techniques. The next talk on the specifics of Small punch technique and the experiences on the use of Small punch for fracture toughness evaluation was delivered by Dr. S. Chatterjee, BARC. The third talk was on the use of novel methods for evaluating the fatigue properties presented by Dr Raghu Prakash of IIT, Chennai, wherein the use of cyclic ball-indentation for fatigue property evaluation was discussed in detail. The afternoon session was deliberated by four speakers with more focus on ball-indentation technique and recent developments in SP Creep testing. Shri E Ramadasan highlighted the small specimen testing activities at BARC while Dr MD Mathew shared his experiences on the unique applications of ball-indentation techniques. The last talk was delivered by Shri V Karthik on the experimental programmes and the results of small specimens test activities at IGCAR. In the course of the meeting, there were discussions on the experimental approaches and analysis techniques used by different groups, and on the need for developing a common code of practice for such novel test techniques. The theme meeting was finally summed up by Shri K V Kasiviswanathan, where he stressed on importance of carrying out various round robin exercises between the different working groups within the country for arriving at an accepted code of practice.

(Reported by V. Karthik, PIED)

BRNS sponsored Workshop on "Physics and Mechanics of Advanced Structural Materials" (PMASM-2008)

March 27-29, 2008

A three day BRNS sponsored workshop on "Physics and Mechanics of Advanced Structural Materials" was held during March 27-29, 2008 at Convention Centre, Anupuram, organized by UGC-DAE CSR, Anupuram and IGCAR. The purpose of the workshop is to familiarize the academic faculty from various universities and academic institutes with the on-going research work on advanced structural materials at IGCAR and to identify common themes of research programmes for collaborative research. About forty senior faculties from various eminent institutes such as Indian Institutes of Technology, Indian Institute of Science, National Institutes of Technology, Indian Statistical Institute, Anna University, PSG College of Technology participated. Shri S.C. Chetal, Director, Reactor Engineering Group, IGCAR inaugurated the workshop and delivered the inaugural lecture on "Design and Materials Challenges for Fast Reactor Programme". An overview of the programmes of UGC-DAE CSR was given by Dr. P. Chaddah, Director, UGC-DAE CSR. The technical sessions commenced with two overview talks by Dr. P. R. Vasudeva Rao, Director, Chemistry, Metallurgy & Materials Group and Dr. Ajay Gupta, Centre Director, UGC-DAE CSR, Indore Centre. Dr. Baldev Raj, Director, IGCAR, addressed the gathering on "Synergy between UGC-DAE CSR and IGCAR". There were nine technical sessions dealing with Advanced Structural Materials, Structural Mechanics & High Temperature Design, Mechanical Properties, Microstructure, Corrosion & Coatings, Robotics, Modeling & Deformation Processes, Welding Science & Technology and Non-destructive Evaluation. In each of these technical sessions, there were talks by experts from academic institutes as well as from IGCAR, highlighting expertise and facilities available and current trends in the research. A visit to various laboratories in IGCAR was also organized for the participants. In the concluding session, various programmes that could be considered for collaborative research under the aegis of UGC-DAE CSR were identified.

(Reported by T. Jayakumar, Convenor, PMASM-2008*)*

Delegates of PMASM workshop from various academic institutes and IGCAR.

Inauguration of UGC-DAE CSR Node at Anupuram

IGCAR and UGC-DAE Consortium for Scientific Research, Indore (UGC-DAE-CSR) had signed an MOU on January 16, 2007 to collaborate in the areas of Physical, Chemical and Engineering Sciences (IGC News Letter, Vol. **72**, April 2007). This collaborative venture was taken to the next level with the inauguration

Dr. Baldev Raj, inaugurating the UGC-DAE CSR, Anupuram Node

of the premises of UGC-DAE CSR, Anupuram Node by Dr. Baldev Raj, Director, IGCAR on March 27, 2008, in the presence of Dr. P. Chaddah, Director, UGC-DAE CSR and other senior colleagues from IGCAR and faculty members from various academic institutes. This will house sophisticated experimental and

Dr. Baldev Raj, Director, IGCAR, Dr. P. Chaddah, Director, UGC-DAE CSR along with (L to R) Dr. G. Amarendra, Dr. P. R. Vasudeva Rao, Director, Chemistry, Metallurgy & Materials Group,Dr. T. Jayakumar, Head , NDED Shri Y.C. Manjunatha, Director, Engineering Services Group, Dr. C.S. Sundar, Head, MSD

computational facilities that will provide access to University researchers across the country through collaborative research mode as well as one-time users. The inauguration coincided with the organization of a BRNS sponsored workshop on "Physics and Mechanics of Advanced Structural Materials" during March 27-29, 2008 organized by UGC-DAE CSR, Anupuram and IGCAR, Kalpakkam.

(Reported by G. Amarendra, MSD)

Forthcoming Symposia and Conferences

5th International Conference on Creep, Fatigue and Creep-Fatigue Interaction

September 24-26, 2008

The 5th international conference on Creep, Fatigue and Creep-Fatigue Interaction (CF-5) will be held at Indira Gandhi Centre for Atomic Research, Kalpakkam, during September 24-26, 2008. CF-5 is being organised jointly by The Indian Institute of Metals (IIM), Kalpakkam Chapter and Metal Sciences Division. It is being sponsored by the Board of Research in Nuclear Sciences (BRNS), co-sponsored by The Japan Society of Mechanical Engineers (JSME) and The Society of Materials Science, Japan (JSMS). The conference aims to provide a forum for interaction among scientists and engineers from national institutes, R&D laboratories and academic institutions working in the areas of creep, fatigue and creep-fatigue interaction behaviour of materials. The conference would have several technical sessions in which contributed papers as well as invited talks by leading specialists from various countries will be presented.

For more information, please contact

Dr. M.D. Mathew, Convenor, CF-5
Head, Creep Studies Section, Mechanical Metallurgy Division
Indira Gandhi Centre for Atomic Research
Kalpakkam - 603 102
Email: cf5@igcar.gov.in
http://www.igcar.gov.in/seminars/cf5
http://www.cf5.co.in

Theme Meeting on Recent Advances in Post-Irradiation Examination (PIE) "RAP-2008"

May 22-24, 2008

The theme meeting will cover all the aspects from fuel design, fuel fabrication, pre-irradiation characterization, post-irradiation examinations on fuel and structural material and advances in PIE techniques and design of in-cell equipments etc. The proposed theme meeting on "Recent Advances in PIE" is expected to bring together several experts in the department working in the above areas. This meeting will serve as a forum to review the current understanding in their respective field, identify the challenges ahead and draw a road map for future work.

For more information please contact

Shri N.G. Muralidharan, Convenor - RAP-2008
Post-Irradiation Examination Division
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http://www.igcar.gov.in/seminars/rap2008.pdf

NEWS & EVENTS

Visits of Important Dignitaries

Dr. M.R.Srinivasan, Member-AEC, with Dr. Baldev Raj, Director, IGCAR during the discussion meeting

Dr. M.R.Srinivasan, Member-AEC and Former Chairman, AEC visited the Centre during 25-26 January, 2008 and held discussions with Senior colleagues of the Centre. He also interacted with the Trainee Scientific Officers and Junior Research Fellows in the Training School Hostel Premises.

Prof. Rajan Gupta, *Group Leader, Elementary Particles and Field theory at Los Alamos National Laboratory, USA* visited the Centre during 31 January and 1 February, 2008. He briefed the senior member of IGCAR on the R&D activities at LANL and visited the laboratories in Materials Sciences Division, Safety Group, Chemistry Group and BHAVINI. He held discussions with Scientists and Engineers on Global Energy Issues. Prof. Rajan Gupta also gave a lecture on "Global Energy Systems- Opportunities and Challenges".

Prof. Rajan Gupta, LANL and Dr. Baldev Raj, Director, IGCAR sharing a point during discussion

Dr. Zaleski, Executive Director, Centre for Geopolitics of Energy and Raw Materials, University Paris Dauphine, France and Mrs.Zaleski with Shri S.C.Chetal, Director, REG

Dr. Casimir Pierre Zaleski, *Executive Director, Centre for Geopolitics of Energy and Raw Materials, University Paris Dauphine, France* and Mrs. Ann Zaleski visited the Centre during 14 -15 February, 2008. Dr. Zaleski held discussions with various senior colleagues of the Centre and visited the Facilities in Fast Breeder Test Reactor, BHAVINI, Safety Group and Fast Reactor Technology Group. Dr. Zaleski spoke on "Fast Neutron Reactor: Past, Present and Future".

A delegation from United States Nuclear Regulatory Commission (USNRC) *led by Dr.James Edward Lyons* visited Kalpakkam during 3-4 March, 2008. This visit was a part of periodic bilateral exchange of visits between USNRC and AERB. The team was interested to know about project management and safe work culture while executing major nuclear reactor projects and expressed their appreciation of our approach in managing the BHAVINI project.

Team members of the USNRC delegation with Shri S.C.Chetal, Director, REG

Senior scientists from IGCAR holding discussions with the visiting Norwegian-Swedish Delegation

A Norwegian- Swedish delegation visited Kalpakkam during 28-29 March, 2008. During the visits there were presentations by the visiting team on Thorium Utilisation by Dr.Anders Hermansson, Swedish Waste Management Programme by Dr.Tomas Lefvert Vattenfal and Titanium Production by Dr.Bard Sæthre. From the Indian Side, Shri S.C.Chetal, Director, Reactor Engineering Group gave an overview of status of FBRs in the country and Dr.P. Mohanakrishnan, Head, Reactor Physics Division, REG elaborated on the Thorium utilization in Fast Breeder Reactors. The delegation visited Fast Breeder Test Reactor, BHAVINI, Safety Group and Fast Reactor Technology Group. The delegation has indicated that an ambitious plan of utilizing the thorium resources is being pursued.

Dr. Gordon Jarvinen, Dr.Baldev Raj, Director, IGCAR, Dr. Chaim Braun, Prof. Siegfried Hecker, Dr. P.R.Vasudeva Rao, Director, CG & MMG, Dr.C.S.Sundar, Head, MSD and Dr.M.Sai Baba, Head, SIRD and S&HRPS during the presentations at Ramanna Auditorium

Prof. Siegfried Hecker, Co-Director, Centre for International Security and Cooperation, Stanford University, Dr.Gordon Jarvinen, Deputy Director, Seaborg Institute, Los Alamos National Laboratory and Dr. Chaim Braun, Science fellow, Stanford University visited the Centre during 20-21 March 2008 and held discussions with senior scientists and made presentations on Fundamental Physics and Metallurgy of Plutonium and Plutonium Alloys (Prof. Hecker), Fundamental Chemistry of Separations and bonding (Dr.Jarvinen) and Advanced Reactor Programmes from Industry Perspective (Dr. Braun). The delegates also visited various facilities at the Centre.

Students visit

23 Research Scholars from University Institute of Chemical Technology, Mumbai visited IGCAR during March 3-7, 2008 to hold discussions with senior scientists and to explore areas for undertaking collaborative projects relevant to the programmes and mission of the Centre.

A Group of 20 budding Mechanical Engineers from the Society of Mechanical Engineering, Chennai, visited the Centre on March 7, 2008.

Students from Indian Institute of Technology Madras doing their Masters degree in various engineering disciplines visited the Centre on March 28, 2008.

UICT students interacting with Dr. Baldev Raj, Director, IGCAR

Awards & Honours

- Dr. Baldev Raj has been **Elected as Member of German National Academy of Sciences.** He has been awarded the **Distinguished Alumni Award** for sustained excellence in Science & Technology by the Indian Institute of Science, Bengaluru. He has been elected as **Vice President, Materials Research Society of India** (2008-2011).
- Dr. Baldev Raj has been appointed as **Adjunct Professor** of PSG College of Technology, Coimbatore and University Institute of Chemical Technology, University of Mumbai.
- Dr. P.R. Vasudeva Rao, has been appointed as **Adjunct Professor** of University Institute of Chemical Technology, University of Mumbai.

The following members were appointed as **Adjunct Professors** of PSG College of Technology, Coimbatore

- Dr. P.R. Vasudeva Rao, Chemistry and Metallurgy & Materials Group
- Dr. P. Chellapandi Reactor Engineering Group
- Dr. T. Jayakumar Non-Destructive Evaluation Division
- Shri. S.A.V. Satya Murty Computer Division
- Dr. K.S. Viswanathan Materials Chemistry Division
- Dr. B. Venkataraman Quality Assurance Division
- Dr. U. Kamachi Mudali Corrosion Science and Technology Division
- Dr. G. Amarendra, Materials Science Divsion
- Dr. P. Shankar, Materials Science Division
- Dr. M. Sai Baba, Strategic and Human Resources Planning Section

The editorial responsibility of the IGC Newsletter has been entrusted to a new committee. The committee under the chairmanship of Dr. P.R. Vasudeva Rao, has worked relentlessly in bringing out the news letter in time and with improved quality for each of the issues. The contributions of the members of the editorial committee: Dr.G. Amarendra, Shri M. Ganapathy, Dr.K.V.G.Kutty, Dr. Mary Mohankumar, Shri G. Padma Kumar, Shri Shekar Kumar, Shri M. Somasekharan, Shri R. Srinivasan, Shri R.V. Subba Rao and Shri K.V. Suresh Kumar is greatly acknowledged.

The new committee with the following members is taking over the responsibility from the next issue:

Dr. M. Sai Baba, Convenor, Editorial Committee Members: Shri Utpal Borah, Dr. K. Ananthasivan, Dr. K.K. Satpathy, Shri N. Desigan, Shri S. Varadharajan, Dr. Vidya Sundararajan, Shri C. Jayakumar and Shri J. Daniel Chellappa.

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