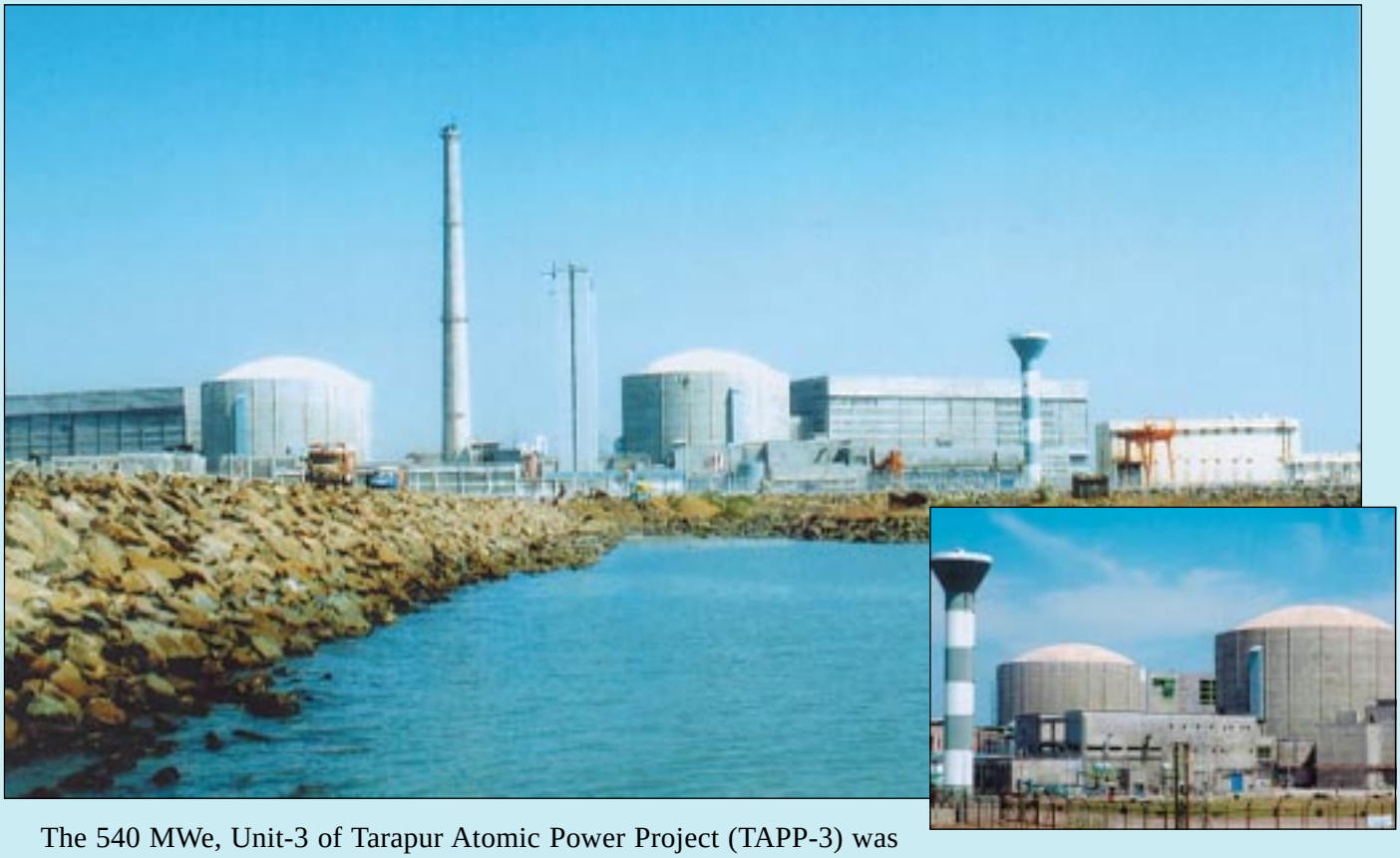
Website : http:// www.dae.gov.in

ISSN-09929-5523

Nuclear India

VOL. 40/NO.1-2/Jul.-Aug. 2006

540 MWe Unit-3 of Tarapur Atomic Power Project synchronized with the grid



The 540 MWe, Unit-3 of Tarapur Atomic Power Project (TAPP-3) was synchronized with the grid on June 15. Atomic Energy Regulatory Board (AERB) has authorised synchronisation of the unit and raising its power level

The 540 MWe Unit-3 of Tarapur Atomic Power Project (TAPP-3) attained criticality on May 21, 2006. This signifies the start of self-sustaining nuclear fission chain reaction in the reactor core. The criticality of Unit-3 came about two months ahead of schedule. Last year Unit-4 of this project, had achieved criticality on March 6.

Designed and built by the Nuclear Power Corporation of India Limited (NPCIL), a public sector undertaking under the Department of Atomic Energy (DAE), TAPP-3 is the 16 th nuclear power reactor in the country. Many DAE units have provided valuable research and development and material inputs. Indian industry too played a major role in the supply of critical equipment and in meeting highly crashed construction schedules.

Tarapur Atomic Power Project -3&4 (TAPP-3&4) comprises two Pressurised Heavy Water Reactor (PHWR) units of 540 MWe each. PHWRs use natural uranium fuel and heavy water both as moderator and coolant.

TAPP-3&4, India ‘s largest nuclear power plant has been built in the shortest time of any PHWR in India. This gestation period is comparable to international benchmarks.

All major milestones of TAPP-3 have been achieved ahead of schedule.

For Unit-3, the time taken between criticality and synchronisation is about one-fourth of the time taken for Unit-4, which was synchronised with the grid on June 4, 2005.

Presently TAPP-3 is in the process of conducting mandatory tests. This unit will supply electricity to the grid termed as "infirm power". The power of the unit will subsequently be increased to full power based on test results and authorization by AERB.

TAPP-3 is expected to be declared commercial in July 2006, six months ahead of schedule.

The two units of TAPP-3&4, of 540 MWe each, are India's largest and most advanced nuclear power units.

TAPP-3&4 belong to Pressurised Heavy Water Reactor (PHWR) family, which uses natural uranium as fuel and heavy water as moderator and coolant. The two units of Tarapur have been built and commissioned in the shortest time taken by any PHWR in the country. This gestation period is comparable to international benchmark.

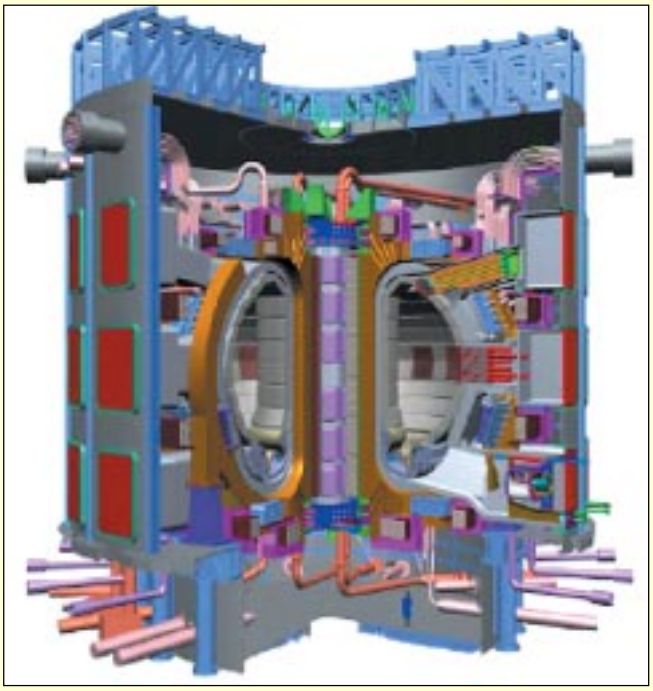
The experience gained from TAPP-3&4 is being utilized for uprating the unit size to 700 MWe. Four such units of 700 MWe each, two at Rawatbhata in Rajasthan and two at Kakrapar in Gujarat are proposed to be built.

At present, NPCIL operates 15 nuclear power units with an aggregate capacity of 3360 MWe. This will increase to 3900 MWe once the 16th unit, TAPP-3, is declared commercial. The installed nuclear power capacity will increase to 4,120 MWe by end of Tenth Five Year Plan (2002-2007) and 10,280 MWe by Eleventh Five Year Plan (2007-12). It is planned to achieve an installed nuclear power capacity of 20,000 MWe by year 2020.

NPCIL is unique in having built, under one roof, comprehensive capability in all facets of nuclear technology namely – site selection, design, construction, commissioning, operation, maintenance and life extension of nuclear power plants.

The International Thermonuclear Experimental Reactor (ITER), a project to demonstrate the potential of fusion as an energy source, is the world's biggest scientific collaboration of its kind and involves countries representing over half the world's population. The seven parties engaged in the project met in Brussels on 24 May 2006 to confirm the agreements negotiated over the past year, following the decision to select the site for the construction and operation of ITER in Europe at Cadarache in southern France. The Seven Parties to ITER are the European Union, Russia, Japan, China, India, South Korea and the United States.

The ITER project is an international collaborative research project which will reproduce the physical reaction - fusion - that occurs in the sun and stars. Fusion has several attractions as a large-scale energy source; its basic fuels are abundant and available everywhere; no greenhouse gas emissions; no transportation of radio-active materials; no possibility of meltdown or runaway reactions; no long-lasting radioactive waste to be passed on to future generations.



ITER signing ceremony at the European Commission in Brussels.

BRIT : Looking Ahead

Dr. A.K. Kohli
Chief Executive, Board of Radiation & Isotope Technology

In recent years, the Board of Radiation & Isotope Technology (BRIT) has been leading the resurgence of isotope applications and radiation technology across industry, healthcare, research and agricultural sectors. It is focused on bringing the benefits of India's vast resources available with the robust R & D efforts of Bhabha Atomic Research Centre and large irradiation capacities available with the Nuclear Power Corporation to create technologies, applications and services which cannot be replaced by conventional techniques. Harnessing the spin offs from the mainstream programmes of DAE, BRIT has independently created a separate visible area of contribution to the society.

To widen these activities and to enable the commercial exploitation of the results of R & D, BRIT was carved out of BARC as an independent constituent unit of the DAE in March 1989. The production of radioisotopes, which had begun with the research reactor APSARA, got a boost with the commissioning of research reactors CIRUS and DHRUVA. Later, production of cobalt-60 was initiated in the power reactors. The Rajasthan Atomic Power Project Cobalt Facility (RAPPCOF) located at Kota is the mainstay of the cobalt based programme of BRIT.

As a constituent unit of DAE, BRIT is unique in more than one way. It deals with radioactivity from microcurie to million curie levels. The complexities of the tasks involved in the day-to-day operations can be understood by a few examples like handling of huge casks with thousands of curies of cobalt to the laser welding of miniature steel capsules for making brachy-therapy sources. BRIT has a vast network of customers which ranges from major industrial units, ports, big hospital chains and sophisticated research laboratories to humble diagnostic laboratories. Consequently, BRIT has created expertise to cater to the exacting demands from such a diverse set of clientele.

Rajasthan Atomic Power Plant Cobalt Facility (RAPPCOF) , Kota, Rajasthan

Radiation Processing

A major impact of radiation technology has been in the field the sterilization of medical products, which over the years has gained tremendous popularity and acceptance in society due to its simplicity and reliability. Though the first radiation processing plant for the sterilization of medical products - ISOMED was commissioned in the country in the year 1974, the Radiation Processing Technology has established firm roots only now with the commissioning of four plants fully in the private sector. BRIT's other plant at Vashi, Navi Mumbai has also been performing very well and now has enabled the introduction of radiation processed food products for domestic , and more importantly, export markets. India being a large producer of agricultural commodities, strategies for food safety and security are of vital importance. Fully indigenous gamma radiation processing plants are going to play a very important role in this regard in the years to come. The recent acceptance of radiation processing as a mode of quarantine treatment for mangoes will enable Indian exporters to re-enter the large US market. Radiation processing of marine products is going to gain importance in the days to come. BRIT has already developed an all metal batch irradiator called Install & Operate irradiator which can undertake such jobs. It is planned to offer this design to private entrepreneurs in near future.

DAE has included the setting up

ISOMED Plant at Trombay, Mumbai

of Radiation Processing Plants in the country as one of its major missions. It is planned to set up more than 50 large irradiators by 2020 so that harmful fumigants used for sterilization and hygienization could be phased out from the country. BRIT is determined to achieve this mission for the welfare of the public, particularly farmers.

While the major thrust will be on the indigenous Cobalt-60 based technology, expansion of Electron Beam (EB) facilities is also underway. BRIT is managing the operation of a 2 MeV EB machine and will support this technology in a big way once the indigenous machines mature.

Radiation Processing Plant at Vashi, Navi Mumbai

Radiopharmaceuticals & Immunodiagnostic kits

Production of Radiopharmaceuticals, Immunoassay kits and Labeled Compounds constitute a significant part of the day-to-day activities of BRIT. Radiopharmaceuticals have revolutionized the medical field by their ability to provide static as well as dynamic images of internal organs in a non-invasive manner as well as by offering efficacious therapy for certain diseases. Growth in the quantity of consignments has been accompanied by the expansion in the range of products.

Radiopharmaceuticals based on technetium are used in over 80 per cent of nuclear medicine centres and form the workhorse of diagnostic nuclear medicine. BRIT, in conjunction with BARC, shoulders the responsibility of the development, production and supply of radiopharmaceuticals to about hundred nuclear medicine centres in

India and the number is growing. RIA and IRMA kits are supplied to about 400 laboratories in India. BRIT is routinely manufacturing about 25 radiopharmaceuticals and apart from catering to domestic requirements exporting to some of the neighbouring countries like Nepal, Sri Lanka etc.. BRIT has introduced Carbon-14 urea capsules used for diagnosis of helicobacter pylori infection which is mainly responsible for peptic ulcer and gastritis in human beings. BRIT is shortly going to introduce P-32 Samarium Phosphate colloid synovectomy injection for which multi-centric clinical trials are going on. Work is in progress for introducing therapeutic radiopharmaceuticals like I-131 MIBG and certain new cold kits for technetium labelling.

BRIT operates the 16.5 MeV Medical Cyclotron Facility in the Tata Memorial Hospital Building at Parel, Mumbai. This cyclotron produces special radiopharmaceuticals like ^{18}FDG for Positron Emission Tomography (PET) studies and supplies are already being made to major private hospitals in Mumbai. Another 30 MeV medical cyclotron is planned to be set up in Kolkata jointly with VECC to cater to the hospitals in the eastern region with wider range of isotopes. Introduction of PET-CT has already revolutionized medical imaging scene and demand for it is going to grow very fast.

Battle Against Cancer with Radiotherapy

BRIT contributes significantly to the battle against cancer by supplying Cobalt-60 teletherapy sources to cancer hospitals all over the country. BARC has recently introduced its indigenously developed teletherapy machine – Bhabhatron to enable its deployment in big way. BRIT will do its bit by manufacturing and supplying the Co-60 sources for the same. It also takes care of the needs of Platinum coated Iridium-192 wires for brachytherapy treatment in the country. Work has already been undertaken for development of state-of-the art HDR Remote Afterloading Equipment which will revolutionize cancer treatment activities in the country.

Furthering contribution to NDT Sector

A major contribution of BRIT to Indian industry is the development of gamma radiography cameras both with Iridium-192 and Cobalt-60 sources. The ROLI camera developed by BRIT today enjoys more than thirty per cent market share amongst industrial users for non-destructive testing (NDT) applications. BRIT is able to meet the demand of all the NDT Centres in the country for their requirement of Iridium-192 as well as Cobalt-60 radiography sources. There is a plan to enter the export market to the nearby countries. Servicing of radiography devices and source replenishment is carried out throughout the year on a regular basis by BRIT. Advanced models of radiography devices are under development to provide the domestic customers with improved features at economical rates.

Laboratory Irradiators

A much needed equipment for the medical users, Blood Irradiator, was launched a few years back and is used in specialty and cancer hospitals. Patients who are immuno-compromised cannot be given normal blood transfusion. A condition termed post-transfusion graft-versus-host disease occurs which can only be averted by eliminating the T-lymphocytes in the donor's blood. This can only be done by low dose irradiation. BRIT has developed the blood irradiator unit which can process blood bags. BRIT plans to lease out such Blood Irradiators so that these could be utilized in more effective manner.

Blood Irradiator

In order to facilitate laboratory scale research in diverse radiation related areas, BRIT has developed different models of compact self-shielded gamma chambers, which have been supplied to industries, research laboratories, and academic institutions around the country and quite a few units also have been exported to countries abroad. BRIT plans to come out with much more compact table top Cesium-137 based Laboratory Irradiators for similar purposes.

Custom Synthesis in Drug Discovery

The strengths nurtured over the years in BRIT with respect to radiolabelling technology and trained manpower has opened up interesting new business prospects. Labelled Compounds Laboratory, BRIT has entered the Compounds Synthesis Outsourcing business in Pharmaceuticals industry. Utilising the in-house strengths of highly experienced synthetic chemists and state-of the art infrastructure, BRIT offers development of novel routes and purification methods for clients interested in outsourcing part of their synthesis of new molecules. Rallis

India Ltd., Godrej Agrovet Ltd., Themis Medicare, Zydus Research Centre have already outsourced their tasks for radio-synthesis operations to BRIT.

BRIT, today, is gearing up to meet the challenges of the new millennium based on the experience of its past and expectant of the prospects of the future. BRIT would endeavour to consolidate its existing market for isotope applications and radiation technology while constantly opening up newer areas where the benefits of the atomic energy programme can reach all segments of our country's population.

Customer support

The Customer Support Services of BRIT handles the day-to-day needs of hundreds of customers and reachesto them specific isotopes for application in healthcare, industry, research and agriculture on a week-by-week basis. More than 45,000 consignments are dispatched to customers all over the country every year. A special Customer Relationship Cell functions at the Project House with all modern communication facilities. The website is deployed to assist the customers to get supply position of major sources and equipment on a 24x7 basis. Newer customer friendly services such as Retail Outlet to buy materials across the counter, advance intimation on booking of consign-ments on website etc. are introduced.

In the End …

BRIT today, is gearing up to meet the challenges of the new millennium based on the experience of its past and expectant of the prospects of the future. BRIT would endeavour to consolidate its existing market for isotope applications and radiation technology while constantly opening up newer areas where the benefits of the atomic energy programme can reach all segments of our country's population.

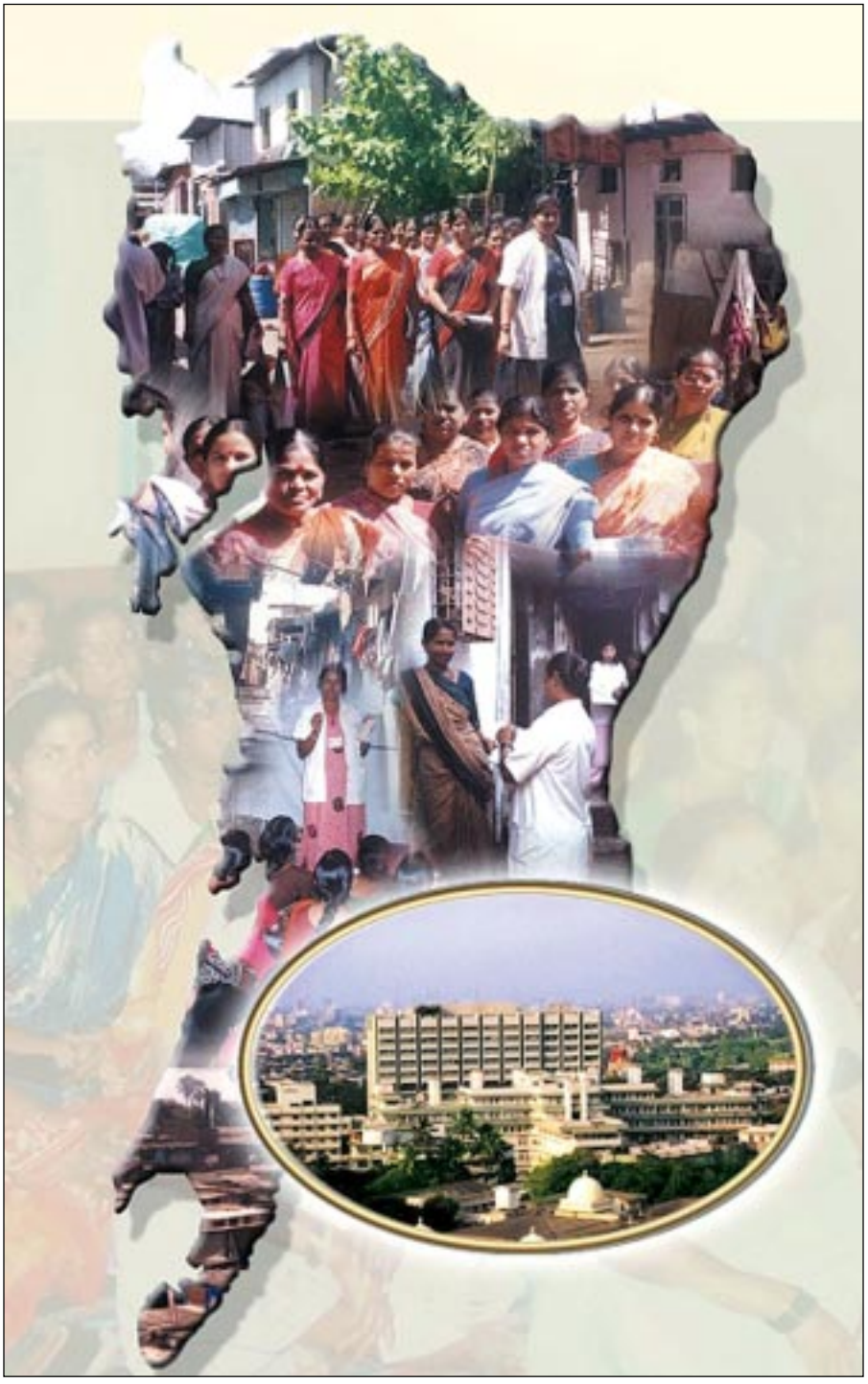
Shri R.N. Jayaraj has taken over as Chief Executive of Nuclear Fuel Complex (NFC) in place of Shri R. Kalidas, who has retired on attaining the age of superannuation. Shri Jayaraj was holding the post of Deputy Chief Executive (Nuclear Fuel Fabrication) at NFC. Shri Jayaraj has vast experience in the field of enriched and natural uranium nuclear fabrication which are used in Boiling Water Reactors (BWRs) at Tarapur (TAPS 1&2) and all Pressurised Heavy Water Reactors (PHWRs) in the country.

After obtaining Bachelor Degree in Mechanical Engineering in the year 1973 from Osmania University, Shri R.N. Jayaraj joined 17th Batch of Training School of Bhabha Atomic Research Centre (BARC), Mumbai, for one year re-orientation course in nuclear engineering. He then joined Atomic Fuels Division of BARC where he contributed in the production of metallic uranium fuel assemblies for CIRUS reactor and development of production processes for the manufacture of fuel assemblies for DHRUVA reactor.

After his transfer to Nuclear Fuel Complex, Hyderabad in the year 1978, he played a key role in establishing the assembly plant for the production of core sub-assemblies required for Fast Breeder Test Reactor (FBTR). He was instrumental in successfully fabricating and supplying all the core sub-assemblies for FBTR for the first time in India. In mid-80's, he was given the responsibility of production of natural uranium dioxide fuel bundles required for all the PHWRs, which he successfully executed in meeting the fuel requirements of Nuclear Power Corporation of India Limited. While carrying out regular production of fuel bundles for PHWRs, Shri Jayaraj immensely contributed in the indigenous development of various equipment for critical processes involving welding, machining centers and assembly stations. He also contemplated several process improvements in the uranium dioxide pellet production and fuel bundle fabrication resulting in substantial increase in the production recoveries. Shri Jayaraj played pioneering role in manufacturing fuel for the first 540 MWe reactor at Tarapur, first of its kind in the country, that was commissioned recently.

Early Detection of Common Cancers in Women in India (Tata Memorial Centre Urban Outreach Programme Project)

Dr A K Dinshaw, *Principal Investigator*
Dr S S Shastri, *Co- Investigator*
Dr Gauravi Mishra, *Project Co-ordinator*



The project Early Detection of Common Cancers in Women in India of the Tata Memorial Centre Urban Outreach Programme Project, has been funded by National Institute of Health, USA. Principal Investigator is Dr. K.A.Dinshaw, Director, Tata Memorial Centre and Dr. R.R.Shashi and Dr. Gauravi Mishra are the Co-investigator and project co-ordinator respectively.

It has been the mandate of the Tata Memorial Hospital, since its inception in the year 1941, to provide the best quality, comprehensive cancer care services, in the country. Over the last 65 years the hospital has provided succour to hundreds of thousands of cancer patients.

Unfortunately, the cancer burden in India continues to grow. Today there are around 2.5 million cancer cases. Every year 8 lakh new cases are added to this number, whereas 5.5 lakh cancer patients die each year. This large scale morbidity and mortality associated with cancer continues unabated due to the single most important fact that cancer prevention and early detection services are almost non-existent in the country leading to over 70% of the cases reporting for treatment in fairly advanced stages of the disease. This situation can be easily reversed if we could have, well planned cancer education and organized screening and early detection programmes.

Cancers of the cervix and breast account for 50% of cancers and 40% of all the deaths from cancers among women in India. A large proportion of these cancers present in advanced stages at the time of diagnosis, when cure is not possible. The standard methods and technologies used for screening of common cancers in the developed countries e.g. Pap smear for cervix cancer and mammography for breast cancer cannot be applied in developing countries like India because of resource constraints and absence of trained manpower.

The Tata Memorial Hospital over the last seven years has been devoting considerable time and resources towards the development of simple and cost effective methods for the early detection of cervical and breast cancers, among women. One such initiative is a programme entitled "Early Detection of Common Cancers in Women in India", which is testing the efficacy of a simple test called Visual Inspection of the cervix with Acetic Acid (VIA) for the early detection of cervix cancer and Clinical Breast Examination (CBE) for the early detection of breast cancer. Both these tests are provided by trained Primary Health Care Workers and the study is being carried out among 1.5 lakh women in the age group of 35 to 65 years, living in the slums of Mumbai. This study is conducted under the aegis of the Department of Preventive Oncology of TMC backed by the comprehensive cancer care facilities of the Tata Memorial Hospital.

Efficacy of mammography in young women is debatable. Our population structure has more than 60% of women below age of 50 (unlike in the west where 70% of population is above 50). Hence, a study demonstrating the efficacy of Clinical Breast Examination will be of a great benefit and relevance to almost all the developing countries like India. This study is the only scientific study anywhere in the world that will help establish the benefits of Clinical Breast Examination as a standalone method for early detection of breast cancer.

Detection of both breast and cervix cancers in the advanced stage of disease requires major mutilating surgeries e.g. mastectomy (Surgical removal of the affected breast) and hysterectomy (surgical removal of the affected cervix/uterus) resulting in serious physical and emotional loss of sexual identity for the woman. This is in addition to the enormous cost and serious side effects, chemotherapeutic medication (e.g. loss of body hair, increased risk to serious infections etc.).

Early detection through the TMCUOP results in down staging of the disease and subsequently gives the women the advantage of being able to avail of organ conserving treatment. (e.g. breast conservation surgery involves only surgical removal of cancerous lump and not removal of entire breast). Similarly, early stages of cervix cancer can be treated by simple excision biopsy like LEEP or Conization, thereby conserving the uterus and cervix.

This study investigates the effectiveness of well planned health education programme (HEP) along with low-cost screening methods e.g. clinical breast examination (CBE), and visual inspection of the cervix painted with 4% acetic acid (VIA), in down-staging and thereby reducing the incidence of cervix cancer and mortality due to breast and cervix cancers. The screened positive patients are referred to the Tata Memorial Hospital for further investigations and management. Also one of the secondary objectives of the study is to determine if such programmes can be integrated into routine public health care activities, in India.

The population of Mumbai is around 13 million (2001 census). A staggering 30% of the population of Mumbai lives in slums, which for all practical purposes can be considered a parallel city. Providing health care to the population living in slums is a highly challenging task. The early cancer detection service programme provides services to this socio-economically disadvantaged population living in the slums of Mumbai. This is a community based cluster randomized study involving 1.5 lakh women, from low socio-economic group between the ages of 35-64 years from the slums of Mumbai, staying in 10 geographically defined clusters that have been randomly allocated into an intervention arm and a control arm. Medical Social Workers carry out survey and invite the eligible women for examinations at the screening camp and trained female primary health workers conduct these examinations. The project provides a well planned health education programme along with breast and cervix cancer screening at 2 year intervals to 75,000 women from selected slum clusters in Mumbai. Another group of 75,000 women from other slum clusters are provided health education only.

The project envisages the provision of four rounds of screening followed by another eight years of observation for demonstrating a reduction in the incidence and mortality due to cervix and breast cancers among women who received the screening as compared to women who did not receive the screening. The actual field work was started in May 1998 and is expected to complete by December 2015. Till May, 2005, women from all the ten intervention-clusters (n=75955) received three rounds of intervention (average compliance rate 68%). Also women from first four intervention-clusters have received four rounds of intervention (average compliance rate 66%). Women from all 10 control clusters received on round of health education in the beginning (Compliance rate 91%). The present cycle consisting of 4th screen for clusters (5to10), is ongoing. 128 cases of breast cancer and 79 cases of cervix cancer were detected in the intervention arm and 61 cases of breast cancer and 44 cases of cervix cancer were detected in the control arm, till date.

This project, which was started in the year 1997, received funding from the National Institute of Health (NIH), USA during September 1997 to August 2003. It is presently run with

the intramural TMH grants.The intermediate results of this study are very encouraging showing that simple low cost technology carried out by highly trained Primary Health Workers is effective in downstaging breast and cervix cancers.

A total of 85 salaried project staff members were involved in the study which primarily include the medical social workers, primary health workers, project assistants and the Data Management Team. The investigators, consultants and co-ordinator from Tata Memorial Hospital plan and guide the project team.

This study which is the first of its kind from a developing country is expected to guide the future policies on cancer control programmes in India and other resource poor countries. This study is also the only Randomized Controlled Trial that compares Clinical Breast Examination with noscreening.

Anticipated benefits to the Developing Countries

This trial when completed will provide the basis for utilizing low-cost technology tools in down-staging, cervix and breast cancers in societies that have limited financial resources. This programme of 'Early Detection of Common Cancers in Women' can be used as a Model for the planning an implementation of National Health Programme for control of cancers. In the rural areas it can be implemented through the already existing network of field level staff consisting of health workers. In the cities the programme can be implemented by a chain of municipal corporation dispensaries and hospitals. This low-cost effective technology for cancer detection in women will prove to be highly beneficial for the developing countries.

Model Rural Cancer Control Programme

The Tata Memorial Centre commissioned a Model Rural Cancer Control Programme in Ratnagiri and Sindhudurg districts of Maharashtra under the DAE Xth plan projects, on August 17, 2003. These districts were chosen since they have a high incidence/prevalence of common cancers but have very poor access to cancer care and health care in general.

Six Mobile Education-cum-Screening Units (MESUs) have been established as part of this programme.

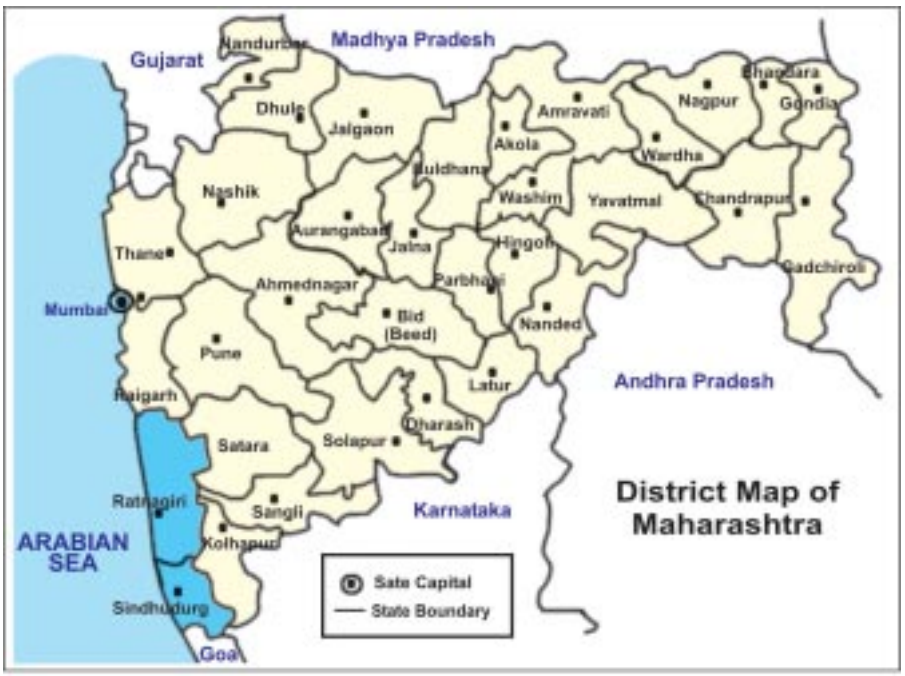
The programme creates awareness regarding tobacco related cancers, breast and cervix cancers in the local population and conducts screening camps for the early detection of cervix, breast and oral cancers among women and oral cancer among men through village camps. Trained primary health care workers and nurses carry out the primary screening. Diagnostic confirmation is also done at the village through mobile First Referral Level Units (FRLUs) by trained doctors. Persons detected positive for any of the above cancers are treated locally at the B.K.L. Walavalkar Hospital at Dervan, near

Chiplun, in Ratnagiri district, by consultants from Tata Memorial Hospital, who visit the site once a month.

Doctors from the BKL Walawalkar hospital are also trained during the project to enable them to treat cancer cases. Only patients requiring radiation therapy are required to travel to the Tata Memorial Hospital, Mumbai.

A proposal for setting up a Cobalt teletherapy unit at the BKL Walawalkar Hospital is under consideration. A cancer registry is also being set up to keep a track of the cancer morbidity and mortality in the region.

Around 5 lakh eligible men and women from the two districts are expected to participate in the screening programme. The screening will be completed by March 31, 2007.



Around 41,000 persons have been already screened till August 31, 2005 and 189 cancer cases have been detected and treated by the programme.

Another first in the area is the setting up of telemedicine services as integral part of the programme. Hardware, software and satellite communication for the telemedicine services are being provided free-of-cost by the Indian Space Research Organisation (ISRO)

Valuable benefits and outcomes of the Tata Memorial Centre Rural Outreach Programme are expected to be local capacity building and technology transfer, reduction of disease burden and economic gain. National human resource development for cancer control is another spin off from this programme. The first National Training Programme in Preventive Oncology organised by the Tata Memorial Centre Rural Outreach Programme during February 6-7, 2005, was attended by Medical Officers from Regional Cancer Centres across the country, who learnt the theory and practice of evidence-based screening for common cancers through rural community-based strategies.

The Tata Memorial Centre Rural Outreach Programme is expected to form the basis of future Cancer Control Programmes in the country.

This programme is being conducted by the 'Department of Preventive Oncology' of the Tata Memorial Centre in collaboration with the B.K.L.Walawalkar Hospital

Village women registering for cancer screening

Dr S.S.Shastri delivering the inaugural lecture at the National Conference for Regional Cancer Centres

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Hand Scan Biometric System

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Automated biometric systems consist of complex hardware and software designed to positively identify an individual or to verify his identity using measurements of the body. Such bodily measures have the appeal that they cannot be lost, forgotten or passed from one to another and they are very hard to forge. Biometric systems are based on fundamental features that are derived from unique physiological or behavioral characteristics of a person. These characteristics which include fingerprints, hand silhouette, iris pattern, blood vessel pattern on the retina, facial features, signature dynamics and voice pattern, have all been explored as biometric identifiers with varying levels of success.

BARC has researched the potential of using hand as a biometric identifier in a different way and importance was given for comfortable placement of hand i.e. with palm side resting on a base plate and the charge coupled device (CCD) camera seeing the nail side of hand from the top. A new image processing technique based on simultaneously matching the multiple and distinctive 2-D image patterns on fingers from nail side of the hand at predefined geometrical positions, has been developed for biometric verification.

A prototype system to demonstrate the technique has been developed as shown in Fig.1, and Fig.2 shows user verification in progress. Basically, it is a one-to-one system, in which a live sample provided by the user is compared to the pre-stored template according to pre-defined accuracy limits. This technique of verifying the identity of an individual involves following two major steps:

Registration : The system first captures from nail side of the hand image, multiple distinctive 2-D patterns on fingers. This is known as the registration process. These 2D patterns in the hand image of the individual along with their coordinate information are used to form a unique template which can be used for his/her subsequent verification against a live sample. A Personal Identification Number (PIN) is allotted to each person at the time of registration.

Verification : During verification the individual using the system is required to type his PIN to call up his record. A live sample provided by him/her is compared to the pre-stored template according to pre-defined accuracy limits. Based on this comparison, multiple parameters are computed. These parameters indicate degree of similarity of template patterns with respect to the corresponding patterns in verification image and also the geometrical

distance between some of these patterns. A Quality Degradation Factor (QDF) is computed based on the deviations observed in these parameters and user's claim for identity is accepted or rejected depending upon the threshold limit set for this factor in the template. Basically, it is a one-to-one system, which compares the biometric information presented by an individual with biometric information stored in the template corresponding to that individual.

Three systems based on the above technique have been installed at three different locations for evaluation. These systems are continuously in use and are working satisfactorily. In one of the systems where 130 persons were registered, analysis of the acquired data comprising of more than ten thousand Verification Attempts, revealed that the marginal cases of False Rejection were only due to improper placement of the hand. After training the persons using the Training Mode, False Rejection rate is reduced to a value below 2%. No case of False Acceptance has been reported so far during actual use on any of these systems. Hence, the False Acceptance rate as on today is zero.

A Face Verification System has also been developed for personal authentication and is under test. A plan is also taking shape to carry out fusion of face and hand biometrics to provide *layered biometric solution* for effective access control, especially for deployment at strategic locations.

Recovery of Uranium from Seawater by Harnessing Tidal Energy

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In the last century uranium has universally gained acceptance as primary energy source. Currently it caters to about 16% of the electricity generation globally. Uranium was projected as the main workhorse of future when the fossil energy reserves dwindle by the middle of this century. The terrestrial distribution of uranium ore occurrence is grossly uneven. With a large coastline, India, Japan, Korea and a few other nations have a larger stake in exploiting the 4.5 billion tones of uranium locked in seawater. The greatest of the scientific and technological challenges in extracting uranium from seawater are lying in finding a technology that gives a net positive energy balance in terms of electricity produced from the so recovered uranium and the other is the cost of production. This article deals with the Indian efforts on both these issues.

Basic adsorption mechanism

During seventies and eighties the Initial investigations on the possibilities of recovery of uranium from seawater were done using inorganic adsorbents. The inorganic adsorbents suffer limitations of adsorption rate and insufficient mechanical stability. Since early nineties extensive investigations are being carried out on organic adsorbents. Poly Acrylamid Oxime (PAO) was picked up as the best bet for studies since July 1999. It preferentially extracts heavy metal ions by chelating mechanism. A polypropylene fibre substrate is irradiated with electron beam to create grafting sites on the polymer chain and then treated with acrylonitrile to graft cyano groups on those sites. Then the cyano groups are reacted with hydroxylamine to convert them into amidoxime groups. These amidoxime groups trap the loosely bonded uranyl ion from the uranyl tricarbonate present in the ionic form i.e. $UO_2 (CO_3)_3^{4-}$ in seawater. For each pair of two molecules of PAO one uranium atom is captured. Stoichiometrically PAO should have an extraction capability of 3.6 kg U/ kg PAO.

Lab-scale experiments

During lab-scale experiments, many types of fiber cross-sections and geometries were evaluated for establishing efficacy of grafting. Polypropylene fibre of 1.5 Denier cross-sections as stem material in non-woven felt form was used. Electron Beam Radiation induced grafting of acrylonitrile was carried out with optimized parameters. The solution viscosity and temperature were also found to be important factors. Then the cyno group was converted to PAO.

The substrate was then reacted with alkaline solution to impart hydrophylicity and adsorption characteristics. The tokens of size 75x70x2 mm thick and 150x150x2 mm thick were used.

Corrosion, bio fouling and their combined effect on the adsorption kinetics and mechanical properties of the materials used in the suspension assembly and the substrate were studied and their compatibilities with seawater and process chemicals were

Continued on page 15

Research education linkage: IGCAR experience

The primary mandate of the Indira Gandhi Centre for Atomic Research (IGCAR) is to develop fast reactor technology for economic, safe and sustainable nuclear power. This requires introduction of innovative features to ensure increased bum-up of fuel, safety in design and operation, as well as effectively closed fuel cycle. Succeeding in this mission necessitates a multi-disciplinary R&D programme, which has been a hallmark for IGCAR. Synergism of expertise and facilities in IGCAR with Indian academia and research institutes is important for speeding up this challenging task. A conscious effort has been made over the decades to network a vibrant academia-research institute-industry interaction towards finding solutions for FBR technology. Apart from the contributions from eminent faculty members, the inputs provided by the dynamic and enthusiastic students have been commendable. Thus human resource development has been one of the areas of emphasis in the management philosophy of the Centre. Besides, it has also been realised that as a premier R & D centre with state-of-the art facilities, IGCAR is well placed to contribute to enhancement of science and technology education in India.

A variety of approaches to strengthen a vibrant interaction with academic and research institutes have been adopted by IGCAR. The various modes of interaction include participation of selected students to pursue postgraduate research at IGCAR, sponsored research projects, collaborative projects, and by organizing vocational training courses and workshops. Also, a few scientists from IGCAR have been invited as members of Board of Studies by academic institutional like Anna University, Annamalai University, Sathyabama deemed University and PSG College of Technology, to enhance their quality of education. Many scientists from IGCAR have also been benefited from interactions with academic institutions such as Indian Institute of Technology (IIT's), Indian Institute of Science (IISc.), Banaras Hindu University, Anna University, Madras University, etc., to acquire higher qualifications.

Project Students at IGCAR

Every year nearly 200 undergraduate and postgraduate students are selected to participate in the various on-going projects at IGCAR, encompassing various facets of materials development, chemistry, reprocessing, reactor design and safety. These opportunities are aimed at motivating the young minds and to groom them to become competent professionals. The benefits derived from such interactions are quicker R&D outputs, from eager and sharp, if not fully matured students, not to mention the expertise of the Institute guide. The DAE Graduate Fellowship Scheme (DGFS) recently started by DAE, is similar in spirit to identify talented students immediately after their undergraduate degree and nurturing them to contribute to Departmental mission programmes, by sponsoring their postgraduate study and enrolling them as employees of the Department. The benefits to IGCAR from this scheme have already been tangible both in terms of enhanced DAE-IIT linkage and quality of human resource addition.

Collaborative Research Projects

More than 80 sponsored projects have already been completed in

The 1.7 mega volt Tandetron Accelerator at the Materials Science Division, IGCAR.. This accelerator is being used for experiments on simulation of radiation damage using ion beams, synthesis of novel phases by irradiation and materials characterization using Rutherford backscattering, channeling and PIXE. The accelerator facilities at IGCAR are extensively used by the students under the UGC-DAE-CSR programme.

collaboration with 23 institutes, including many premier academic and R&D institutes. Many projects are sponsored by IGCAR, while some of the projects are sponsored by Board of Research on Nuclear Sciences (BRNS). Most projects are in areas vital to FBR and reprocessing programmes, be it support to robust design, detailed materials characterization, establishing and validating new technologies, or search for new and better processes. Majority of the projects with IIT Madras, in support of design involve development of models, and theoretical and computer code development. Some of the projects had also experimental components for which infrastructure available were used, or specifically built with the project fund. Examples are: buckling investigations of inner vessel and main vessel, dynamic experiments on core support structure, studies on thermal striping, structural integrity assessment of control plug and sodium piping, seismic qualification studies on Control Safety Rod Driver Mechanism, structural design of reactor vault, geo-technical characterization of 500 MWe Fast Breeder Reactor (FBR) site, mathematical model for sodium combustion in leak collection tray, and various thermal-hydraulics studies. Projects with IISc., Bangalore relating to various aspects of 500 MWe FBR design are equally important. These include review of Design Basis Earthquake for the site, seismic response of sodium pipelines, structural reliability analysis of core support structures, coalescence of drops in centrifugal contactors, and experimental and analytical study on the reinforced cement concrete beam column joints with/without fibers under cyclic loading.

The Metallurgy and Materials Programme of IGCAR has embarked on a range of collaborative research projects with various institutes. Projects in critical areas involving nondestructive evaluation (NDE) include: application of criticality refracted longitudinal (L_{CR}) ultrasonic waves for deformation and residual stress assessments in stainless steel plates and components of nuclear industry in collaboration with the Anna University; design and development of micro-electro-mechanical systems (MEMS) ultrasonic transducers for NDE applications in collaboration with the IISc, Bangalore; and development of ultrasonic phased array based techniques for rapid evaluation of end plug welds in fuel pin assembly in collaboration with the IIT Madras. Two other projects, in collaboration with IIT Madras may be mentioned here: transient infrared thermography based detection of blisters in pressure tubes of pressurized heavy water reactor, and eddy current based time domain electromagnetic survey system for remote sensing of uranium deposits. Facilities in IISc, Bangalore have been extensively utilized for generating the base line data necessary for identifying the safe processing windows of important reactor materials using Dynamic Material Modeling approach. IISc, Bangalore is also involved in a project on mitigation of bio-fouling of Ti surface in the coastal waters of Kalpakkam. A project on investigation of fretting wear and tribological behaviour of Modified 9Cr- I Mo/Aluminised IN 718 materials, has been sponsored to IIT Delhi. Another project on investigation of tribological behaviour of stainless steel 316LN, Colmonoy deposits on 316LN stainless steel,

Leak-Before-Break tests of 500 MWe FBR Steam Generator Shell Nozzle Junction at the Structural Engineering Research Centre, Chennai, Tamil Nadu.

CrN coating on 316LN stainless steel and ASTM A453 Grade 660 has been sponsored to IISc, Bangalore. These will generate important base line data, and will also mark the beginning of a new area of research in IGCAR, namely correlation between microstructure - tribology and fretting properties. In recent years, it has been increasingly recognized that welding and hardfacing technologies are crucial to the success of our fast breeder reactor and reprocessing programmes. A BRNS project on optimization of Colomonoy deposition process is in progress in collaboration with Annamalai University. A technologically important area in which IGCAR has developed expertise, is in dissimilar metal welding. This area has proved to be of crucial importance for the success of IGCAR's reprocessing programme. A multi-pronged approach has been undertaken, to generate a research base, which will eventually lead to the identification of the technologically viable method. Accordingly, projects that have been initiated are on Friction Welding of Ti to 304L SS in collaboration with IIT Madras; Diffusion Bonding of Ti to 304 L SS in collaboration with PSG College of Tech., Coimbatore; and Explosive Welding of Ti to 304L SS in collaboration with Annamalai University. Through these endeavours, IGCAR has been able to provide support for enhancing the infrastructural facilities at the academic institutes in addition to providing opportunities for the students to participate in areas of exciting science and challenging technologies.

The development of novel extractants and resins for reprocessing and waste management is a typical example of an area where strengths in academic and research institutes compliment those in DAE. A collaborative programme has been adopted involving National Chemical Laboratory (NCL), Pune, Thermax Limited, Pune, and IIT Madras. The development of chemical sensors is an important activity, the product of which would not only benefit the department but also lead to industrial applications in a large way. The development of sensors is a multidisciplinary activity involving not only chemistry, but also electronics, instrumentation and precise fabrication. IGCAR's interactions with Central Glass and Ceramic Research Institute (CGCRI) and IIT, Kharagpur are expected to catalyze this activity through the expertise available in these institutions in development of ceramics.

IGCAR is also an active participant in several other important BRNS sponsored projects. A first of its kind high temperature ultrasonic measurement facility has been established at MEPCO Schlenk Engineering College, Sivakasi, Tamil Nadu. In addition to dynamic detection of phase and structural transitions in alloys and oxide systems with scientific understanding on kinetic aspects, an important outcome is the realization of the fact that creep and/or fatigue damage can be detected with high sensitivity by measurement of ultrasonic parameters at higher temperatures. Synthesis and consolidation of oxide dispersion strengthened ferritic steels by powder metallurgical route, as well as development of titanium based coatings by molten salt route and boriding of austenitic stainless steels for applications in corrosive nitric acid environments are being developed in collaboration with PSG College of Technology, Coimbatore.

Collaboration under the UGC-DAE Scheme

Collaborative research under the Inter-University Consortium - Department of Atomic Energy Facilities (IUC-DAEF) Scheme was initiated at Kalpakkam in 1994, with the express purpose of enhancement of utilization of the accelerator facilities at IGCAR. Research scholars from various universities in India have made use of the low energy accelerators for pursuing research on ion beam modification of materials, and for characterization of materials using Rutherford back scattering, Particle-Induced X-ray Emission (PIXE) etc. In this scheme 13 students completed their Ph.D programmes, and it is satisfying to note that all of them are well placed in research laboratories both in India and abroad. With the recent enlargement of the scope of the collaboration in the form of University Grants Commission Department of Atomic Energy Consortium for Scientific Research (UGC-DAE-CSR) Scheme to encompass facilities other than accelerators, it is expected that the collaborative ventures will grow in strength. Many talented students from different universities would benefit from this opportunity of working with state-of-art and advanced techniques, many of which are available only in a few selected laboratories in the country. The impetus provided by these opportunities for young students to continue pursuing advanced research for their professional career is indeed heartening.

Memorandum of Understanding (MoU) with Educational Institutes

To formalise the linkages with the educational and research institutions, IGCAR has signed MoUs with many academic institutions. The list includes Anna University, IIT Madras, IISc, Bangalore, Loyola College, Velammal Engineering College & Management Institute, Vellore Institute of Technology, K.J. Hospital & Research Institute, Sathyabama Deemed University, Crescent Engineering College and St. Josephs college of Engineering. These MoUs

have provided opportunities not only for the research students and faculty from these institutes to interact with IGCAR scientists, but also provided opportunities to IGCAR scientists to participate in the educational process though seminars and joint discussions.

Vocational Training Programmes

IGCAR has been conducting a six week long annual Summer Training Programme for M.Sc (I Year) students in Physics and Chemistry. Starting from 1995, every year, 20 students are selected, in each discipline, from more than 200 applications. The students receive stipend during their stay. Initially, this programme was confined to students from Tamil Nadu and Pondicherry. However, in consideration of the overwhelming response, this programme has been extended to an all-India basis from 2005. In this very popular programme, running during May-July every year, the selected students undergo an intensive training comprising of lectures, project work and tutorials. Many of the students who attended these courses went on to pursue research careers at prestigious universities, and some of them have also joined DAE through the training school. This course has also created a fraternity of students, who helped to create an awareness of the research and development activities of the Department amongst the colleges and universities. IGCAR is associated with Chennai Mathematical Institute (CMI) in the conduct of the experimental programme for B.Sc. (Hons.) physics students. IGCAR scientists are also involved in giving lecture courses to the young and bright students at CMI. IGCAR has also been involved in the conduct of an Indian Academy of Sciences sponsored refresher course for college teachers. A DST sponsored Science & Engineering Research Council (SERC) school on Methods in Materials Characterisation for research scholars was organized at IGCAR in February 2004.

To summarize, outsourcing of R&D through collaborations with academic institutes has helped IGCAR in many ways. Critical inputs have been generated in relatively short period, which helped in early launching of the FBR programme. In the process, infrastructure has been developed at many centers of excellence. Most importantly, by harnessing the available multi-disciplinary expertise in the entire country, a level of technical achievement has been possible, which would be too difficult, if not impossible, to achieve for any single institution because of limitations of resources. IGCAR in turn has also significantly contributed to the development of science and technology education, both directly and through the academic institutions. Given the ambitious mandate of IGCAR, it can be confidently predicted that such collaborations between IGCAR and other premier institutes will continue to be strengthened in the years to come.

Continued from page 11

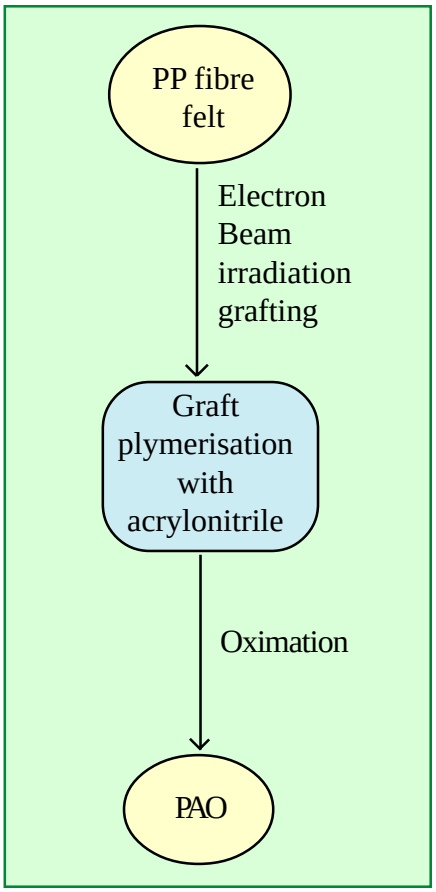
established.

Recovery of Uranium from Seawater ....

Based on initial success of extracting about 800 µg of uranium by harnessing the tidal wave using PAO adsorbent, a process flow sheet for a facility to extract 100gU/year was developed.

Conclusion

The specially developed organic adsorbent PAO has shown promising results for recovery of uranium from seawater. Pumped circulation schemes are inherently riddled with negative electricity gain, which means that the electricity producing potential of the recovered uranium is less than the electricity spent in its recovery.



Harnessing tidal waves has the advantage of positive electricity gain. The extent of energy gain ratio will depend much on the site selection. Feasibility studies on various sizes of pilot scales will help in optimization of process design parameters of adsorbent synthesis and improving the yield of recovered uranium. Various configurations of contactor array designs are being developed to facilitate the operational flexibility for the offshore unit of the plant and utilization of tidal energy/waves more efficiently.

Widened Horizon*

S. C. Hiremath
Chairman & Chief Executive, Heavy Water Board

... While pursuing the first phase of unique 3-phase Nuclear Power Programme starting with PHWRs, Heavy Water was identified as one of the key input. Under this back drop, the journey for Heavy Water Programme commenced. Given the country's priority for self-reliance, the first generation heavy water plants included setting up of Bithermal H_2S, H_2O exchange plant based on wholly indigenous effort while parallely constructing plants based on mono-thermal NH_3-H_2 exchange process with the assistance from foreign collaborators/suppliers. The technical competence generated from design, construction and commissioning of these plants, acquired skill of industrial operation and the urge for excellence paved the way for the consolidation phase. The second generation plants with higher plant capacity were taken up for construction using indigenous engineering capabilities. The plants at Heavy Water Plant, Manuguru based on H_2S-Water Exchange process and Heavy Water Plants at Thal and Hazira based on Ammonia - Hydrogen Exchange process were thus put into commercial operation.

Having set up more than 500 tons of heavy water production capacity and having stabilized the operation of all the plants, the emphasis shifted towards fine tuning of plants and improvement of performance. The exercise of self appraisal was undertaken in a mission mode at all heavy water plants. The result was phenomenal. Heavy water production in India exceeded its own requirement. Competitive cost of production gave India export opportunity for this high technology nuclear material. ....

In the new millennium, considering the trend of performance of all Heavy Water Plants, the primary mandate given to Heavy Water Board is successfully met. In the process, Heavy Water Board has created responsive high technology faculty which has the unique capability of taking product/process from Lab to industrial production with an ideal orientation towards industrial activities. With the onset of new millennium, meeting the requirement of certain key inputs for both the PHWR's of first phase and the FBR's of the second phase were seen as a challenge. At Heavy Water Plant, Talcher, development of process & product technologies on industrial scale production of various solvents having application in nuclear fuel cycle are undertaken. At Heavy Water Plant, Baroda, an alternate ammonia based process for heavy water production independent of fertilizer plants is developed. Heavy Water Board has thus exhibited the ability to convert the adversities in a specific plant location into the opportunities and used its human resource by diversifying into other activities.

Since separation of isotopes is the main strength for Heavy Water Board, the campaign was started with setting up of production of enriched

Manuguru Heavy Water Plant

Boron-10 required for Proto type Fast Breeder Reactors. Civil works for Boric acid enrichment plant through ion chromatographic route at Heavy Water Plant, Manuguru is completed and work on execution of EPC contract execution for the plant is in progress and is expected to be completed by June 2006. Resin testing procedures including its performance evaluation for isotope separation has been finalized in consultation with IGCAR. Test cell for Elemental Boron production has been erected.

Engineering of this production facility for Boron-10 with 90% isotopic purity used in neutron detectors is in advanced stage and likely to be ready for operation at HWP Talcher by middle of 2006 and this alternate route would augment the Boron availability for PFBR as well. Evaluation of commercially available mass transfer tower internals for various sizes of Exchange Distillation Columns has been completed and process design has been finalized for scaled up version of the plant for augmenting the enriched Boron production for meeting the PEBR's improved schedule for meeting the requirement of detector grade BF3-CaF2 complex for Neutron Detectors.

Heavy Water Board has also taken up process & technology development for other isotopes like O^{18}. O^{18} is one of the isotopes having application in nuclear medicine and

** Excerpts of the address on the occasion of the founder's day of the Heavy Water Board*

biochemical research. Doubly Labeled Water (DLW) having certain concentration of deuterium and O^{18} is used for measuring energy expenditure, total body water content, etc. O^{18} finds use in Positron Emission Tomography (PET) used for typically detection and staging malignancies. The isotope has demand in DAE and the Defence Research & Development Organisation (DRDO). HWB has embarked on distillation route for production of H_2O^{18} at 99.8% purity and engineering is in progress.

HWB has also taken up the assignment of supplying nuclear grade Sodium to be used as coolant for prototype Fast Breeder Reactor. The plant for production of nuclear grade metallic sodium is set up at HWP, Manuguru. The process involves molten salt electrolysis of sodium chloride followed by purification process to meet the desired quality of nuclear grade sodium. Technology for the plant, particularly the purification process has been obtained from IGCAR and the job of engineering, construction and subsequent operation will be carried out by HWB. Engineering and manufacturing trial operation of full Scale Fused Salt Test Cell has been accomplished. The first product drawl of Sodium metal from the Test cell has been accomplished on 15.01.2006 at HWP, Manuguru.

Solvents play a major role in various extraction processes used both in the 'front end' as well as 'back end' of the nuclear fuel cycle. Solvents, which have been identified for potential use, are TBP, D2EPHA, TOPO, TAPO, DNPPA, CMPO etc. HWB has already set up industrial scale production facility for TPB at Heavy Water Plant, Talcher. Pilot plant for production of D2EPHA has also been operated successfully. HWB is now engaged in identification of suitable process for production of other solvents on industrial scale. Work on synthesis of TOPO has been taken up at Heavy Water Plant, Tuticorin on a laboratory scale. The results obtained are highly encouraging and scaling up of the synthesis process is being taken up. In the next couple of years, HWB plan to set up industrial scale production facility for D2EPHA and TOPO as well as other solvents required for nuclear fuel cycle and FBR fuel cycle. D2EHPA and TBP being produced at Talcher facility are meeting the international quality standards and TBP Plant has met the requirement of NRG-BARC, UED-BARC and gearing up to meet the bulk requirement of NFC-DAE besides meeting the requirement of test facility at HWP (Talcher) itself.

DAE has initiated the programme for recovery of uranium from secondary sources. Phosphoric acid produced by fertilizer industries has been recognized as a suitable secondary source. Thanks to collaboration of last three decades with Gujarat State Fertilizer Corporation (GSFC), SPIC, Rashtriya Chemical Fertilizer (RCF), KRIBHCO, Heavy Water Board has excellent rapport with the fertilizer Industry. HWB possess the required management skills to set up uranium recovery plants coupled with phosphoric acid plants. Additionally, experience of production and handling of various solvents in its solvent test facilities has given added advantage to HWB for engineering solvent extraction facility for specific applications. A solvent test facility to check solvents' efficacy and stability has been set up at Heavy Water Plant, Talcher. Solvent extraction test, - using the solvents produced at Heavy Water Plant, Talcher - has indicated encouraging recovery efficiency. Apart from above, HWB has also taken up development of solvent extraction test facility for extraction of Uranium from phosphoric acid at HWP, Talcher. Separately action towards development of high efficiency solvent extraction equipment has also been taken up. The expertise available in other units of the Department such as NFC, BARC, IGCAR are being resource through well organised network for developing these equipment. HWB is setting up Technology Demonstration Plant for recovery of Uranium from secondary sources especially from phosphoric acid manufactured using rock phosphate, which contains 60-150 ppm Uranium at the RCF, Trombay.

In order to achieve further reduction in internal dosage of occupational workers of Nuclear Power Station, a prototype Heavy Water clean up facility has been developed and engineered. Utilizing the experience of Hydrogen isotope separation and also the experience of operation of cryogenic plant at Heavy Water Plant, Nangal, HWB is setting up a Heavy Water Clean Up Facility at RAPS/HWP (Kota). Project execution is taken up simultaneously while concurrent development and engineering is in progress. ...

Taking note of the large potential for non-nuclear applications of deuterium in the fields of Medical, life science. Communication and microelectronics, HWB has initiated actions for development of alternate applications of deuterium / heavy water. Deuterium substituted polymers have shown outstanding signal transmission characteristics with reduced loss of intensity and better transmission efficiency when deuterium gas is used in the optical fibers. As required by one of the leading Optical Fibre manufacturers, HWB has generated deuterium gas of required quality and supplied gas samples of 3% deuterium for experimental purpose. The results are very much encouraging and the manufacturer has come forward for entering into an MOU with HWB for regular supply of 3% bone dry

deuterium gas (15 cylinders/month) for a period of one year. Discussions on use of heavy water in various applications in veterinary fields have been also initiated with Indian Veterinary Research Institute, lzat Nagar.

HWB have already supplied small quantities of heavy water to Bombay Veterinary College for R&D purpose i.e. for studying the effect of heavy water on some specific living cell(s) and for viral vaccine studies in eggs and tissue culture.

Experience in design, construction and operation of cryogenic system will provide HWB the engineering back up for separation of Helium from its natural sources. HWB has also identified a unique but difficult to deal with, source for recovery of helium using cryogenic process. The re-cycled synthesis gas of ammonia synthesis loop of large scale natural gas based ammonia plants - provides a feed material which is pre-enriched by around ten times compared to the helium content of the feed natural gas. HWB is in the process of firming up of unit operation and their sequence as a part of process technology development and to explore the techno-economic feasibility of the above process.

HWB has decided to utilize the infra-structure facilities available at Heavy Water Plant, Talcher for setting up of an In-House R&D Centre as it is of importance for any industrial unit for keeping pace with the modernization and front end technologies for developing new process towards isotope separation, developing synthesis route for potential solvents, development of catalysts and its performance evaluation, testing of solvents and 'solvent extraction equipment' for its performance etc.

New cost effective and eco-friendly heavy water production process HWB intends to develop other innovative heavy water production process which can bring in a significant change in the cost of production as well as environment impact. One such process has been identified as Water - Hydrogen (H,0-H,) Exchange process for which the process as well as the catalyst development has been taken as a R&D activity.

HWPs have maintained their Excellent Safety Performance and have achieved accident free continuous run of all the operating plants during the period April - December 2005. HWP, Tuticorin & HWP, Kota have bagged the prestigious Shreshtha Suraksha Puraskar for the year 2004 from National Safety Council of India and in particular HWP, Tuticorin has bagged it consecutively for the fourth year. HWP, Hazira has crossed 2877 days of accident free running as on 31.12.2005 without any reportable disabling injury. HWP, Hazira has won the Winner Award from Gujarat Safety Council for the year 2004. Heavy Water Plant, Kota is the first among all the Heavy Water Plants and DAE units to get IS-18001, Occupational Health & Safety Management System (OHSMS) certification from Bureau of Indian Standards. HWPs at Thal and Tuticorin have also been certified for IS-18001. HWB (Central Office) also has been certified for IS:9001-2000 in January 2005 with respect to development of process products, design and engineering of plants, production and supply of heavy water, specialty chemicals and other nuclear materials. No technology can be considered as successful if it has not addressed the environmental aspect completely.

The technology of development of Heavy Water Plants in India is a case in consideration where the technology was developed from concept to commissioning and, there are very few parallels in the Indian scenario.

Three decades of operation and maintenance of heavy water plants has developed about 4000 strong trained and experienced personnel in addition to development of suppliers who are tuned to all aspects of high tech industrial activity. This manpower has been responsive to the community around the plant, has developed an unparalleled safety culture, and has shown utmost concern for the management of environment including conservation of natural resources. Such an experienced and trained manpower is an invaluable asset. HWB takes pride in having such proactive manpower and wishes to develop them by further enhancing their knowledge base and skill sets. Human resource development and knowledge management is, therefore, taken as an important area of activity of HWB.

As on date. Heavy Water Board has widened its horizon. While the production of heavy water still remains its major activity, diversification in other fields will provide growth opportunity to the Board. Heavy Water Board is determined to utilize its expertise in various areas in supporting nuclear power programme. The odyssey of excellence continues in the present year as the performance of Heavy Water Board surges ahead of its own record of previous best which was created last year. The credit goes to every member of the HWB and Heavy Water Plants and HWPs/HWB will raise the bar and set newer bench mark every year.

R.No. 9002/62

18TH ALL INDIA ESSAY CONTEST IN NUCLEAR SCIENCE & TECHNOLOGY

DAE invites essays as per following details written in any official Indian language or in English from regular full time students studying for graduation in India (after 10+2), in any discipline, in an Indian university or an institute deemed to be a university.

Topics

The introduction should highlight the multifarious achievements of DAE in basic sciences and nuclear technology development and how these have helped in overall societal development in the country. This introductory portion should not exceed *500 words* and should be followed by a detailed essay not exceeding *1500 words* in any one of the following topics:

(1) **Energy scenario in India: emerging technologies in nuclear power generation for safe and sustainable growth.**

(2) **Achievements and future prospect of radioisotopes and radiation technology in India.**

(3) **Emerging applications of beam technologies: present status and future prospects in India.**

Howto send the Essay

The essay should be sent to the address given below directly by the contestant, along with bonafide studentship certificate from the principal of his/her College/Institute. No essay will be accepted if sent by E-mail or Telefax. The participant shall write his/her name, College/ Institute and address on a separate detachable sheet only. Name or address should not be written elsewhere on the text of the essay.

Mode of Selection

After initial screening and evaluation, a maximum of thirty six essays will be selected and their authors will be invited to Mumbai in the last week of October 2006 for an oral presentation of the essays. Final selection will be made on the basis of combined performance in oral presentation and quality of the essay. **Only the candidates short-listed for oral presentation will be informed.** Those called for oral presentation in Mumbai shall be eligible for:

a) To and fro AC 3-Tier rail fare by the shortest route. Claim for reimbursement of rail fare for journey performed by Rajdhani/August Kranti/Shatabdi Express will be restricted to AC 3-Tier by ordinary Express/Mail train.

b) Boarding and lodging in the Guest House of BARC at Anushaktinagar, Mumbai during the authorized period of stay.

Prizes

First Prize (3 nos.)	: Rs.7,500/-
Second Prize (3 nos.)	: Rs.5,000/-
Third Prize (3 nos.)	: Rs.3,000/-
*Consolation Prizes	: Rs.1,500/-

** To all those who make oral presentation but do not secure first, second, or third prize.*

The prizes will be distributed on the Founder's Day (October 30, 2006), which is the birth anniversary of late Dr. Homi J. Bhabha.

The last date for receipt of essay is September 1, 2006

For further details please write to:

Administrative Officer,
Public Awareness Division,
Department of Atomic Energy,
Government of India, Anushakti Bhavan, CSM Marg,
Mumbai 400 001.

This information is also available on ***www.dae.gov.in***