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Tarapur Atomic Power Station-3&4 : A Saga of Success

On March 6 this year, DAE reached a momentous milestone when efforts of its organizations, mainly the Nuclear Power Corporation of India Ltd. (NPCIL) and Bhabha Atomic Research Centre (BARC), came to fruition with the successful attainment of criticality of a 540MWe pressurized heavy water reactor at Tarapur.

Comprising twin-reactor units of PHWR type each of 540 MWe capacity, TAPP-3&4 has been built adjacent to Tarapur Atomic Power Station -1&2, on the shores of the Arabian Sea, in Thane district of Maharashtra. These reactors are based on natural uranium as fuel, and heavy water as moderator and coolant.

The first concrete (high strength Grade M-60 concrete developed indigenously), was poured on March 8, 2000 and it has taken less than 5 years for TAPP-4 unit to attain criticality. Earlier, on January 22, 2005, this unit had taken a major stride when all the systems of the reactor were integrated successfully, and after the clearance of the Project Design Safety Committee of AERB, its fuel loading had commenced.

The commissioning of TAPP-4 nuclear reactor, about eight months ahead of the schedule and achieving drastic reduction in the gestation period that compares well with international benchmark, has established technological and managerial prowess of NPCIL. An automatic computer controlled batching plant was established and concrete was pumped to the place of concreting. Permanent cranes and hoists were installed and commissioned well in advance, so that they could be made available for erection jobs inside the buildings. With the help of a heavy-duty crawler crane, the lowering of steam generator into position was completed in just three hours as against more than a month in earlier projects. The overall plant execution was done by contracting out mega-packages of activities rather than single activities. This approach simplified coordination, and increased speed of execution of various works. This technological and project management experience will be useful for future high-tech programme.

The design of TAPP-3&4 reactors incorporates all the basic features of the existing PHWRs. The safety features in the existing 220 MWe units, such as fast acting diverse independent shutdown systems, high pressure emergency core cooling systems, double containment, supplementary control room along with the safety objectives like redundancy diversity, avoidance of common cause failure, are incorporated in these units.

Since the 540 PHWR is a large reactor, some systems are much different from those used in the 220 MWe reactor of standardized design and a number of new systems are also needed in these large reactors. This necessitated research and development in several areas. Also, driven with the objective of maintaining and improving the indigenisation of nuclear power plant components, additional design innovations were carried out. Certain pieces of equipment were redesigned so that their manufacturing is within the capability of Indian industry.

AERB has authorised synchronization and operation of the unit upto 90% power level.

Maharashtra will receive 36 percent of electricity generated from TAPP-3&4, Gujarat's share will be 19 percent and Madhaya Pradesh's 17 percent, and rest of the power will be supplied to Goa, Union Territories of Daman, Diu and Nagar Haveli, and to deficient states.

The second reactor TAPP-3 of the project will be commissioned shortly.

NPCIL, that is responsible for the design, construction and operation of nuclear power reactors in India, now operates 15 reactors (2 boiling water reactors and 13 pressurised heavy water reactors). With the commissioning of TAPP-4 reactor, the total capacity stands at 3310 MWe. Five PHWRs and two light water reactors of NPCIL are under construction. After the completion of these reactors, the total installed nuclear power generation capacity will be 6730 MWe.

Successful commissioning of TAPP-4 has tremendously boosted the confidence of the Indian nuclear engineers and scientists. With this, India has entered the era of electricity generation from large size nuclear reactors. The achievement of high capacity factor and low gestation period of the Indian nuclear reactors have made them competitive with other types of electricity generating units. With a view to further bring down the per unit price of electricity, a larger reactor of 700 MWe capacity is being developed by NPCIL.

During the 51 years of its formation, the Department of Atomic Energy (DAE) has taken impressive strides from fundamental scientific research to development and commercial applications of nuclear energy. The Department has mastered all the aspects of nuclear fuel cycle technology that ranges from exploration of nuclear minerals, mining and ore processing, fuel fabrication, power generation, reprocessing of spent fuel and nuclear waste management. It has also achieved high standards in safety and environment management. The nuclear technology developed in DAE's research centres is being widely used in industry, health, agriculture, food preservation, urban waste management and desalination.

The Department has been pursuing a 3-stage Nuclear Power Programme that is focused on utilization of uranium and abundantly available thorium resources of the country for power generation. The programme comprises setting up of pressurised heavy water reactors (PHWRs) and associated fuel cycle facilities; fast breeder reactors (FBRs) backed by reprocessing plants and plutonium-based fuel fabrication plants, and thorium based reactors.

Preparing For The Future : Challenges And Opportunities

Anil Kakodkar

Programmes of Department of Atomic Energy are described by different people in different ways. We talk about research with all its open-ended connotations. We also talk about research with a mission focus. We talk about converting the knowledge that one derives out of research done by somebody else, done by our own people, the research done in the past or research that is taking place currently. Our attempt is to convert available knowledge into something useful for our society and for our country. For this purpose our work covers the entire Research-Development-Demonstration and Deployment (RD^3) chain. We don't stop at developing something and showing that it works in the laboratory. Our programme goes all the way to demonstrating that we can make the new development work in the market place or in the society overcoming not just the technological challenges but also other non-scientific and non-technical impediments. We now have experience of fifty years or more in the pursuit of the programme and we have, I must say, several successes. For example, if I talk about nuclear energy and I do so because that's where I can talk with confidence, we have a wonderful blueprint given to us by Dr. Bhabha, the famous Three-Stage Nuclear Power Programme. It is quite unique. Nowhere in the world, a programme has been defined in this sequence and in terms of its contents particularly in the later stages. This programme is visualised to be different than what would happen in the rest of the world and that is simply because the pattern of Indian resource profile is quite different from the rest of the world. Thanks to the tremendous and sustained efforts put in by thousands of our colleagues, we have been eminently successful in the first stage. We have been able to demonstrate commercial excellence with indigenously developed technology both with respect to operating power reactors as well as with reactor projects under construction. In terms of deployment, we have nearly reached the half-way mark in terms of whatever was visualised for the first stage of the programme. First stage was visualised to be a 10,000 MWe programme. The Pressurised Heavy Water Reactors (PHWRs) both under operation and under construction together account for something like 4500 MWe. This capacity would be fully operational in around 2 – 2-1/2 years from now. On the second stage, which would be a series of Fast Breeder Reactors (FBRs), we have completed the necessary research and development work through R&D is an ongoing activity and we have begun the commercial deployment phase. The first 500 MWe Prototype Fast Breeder Reactor (PFBR) is now under construction. On the third stage which visualises thorium utilisation for energy production, I would say we are well into the Research & Development phase and are very close to a demonstration stage where we can show a large commercial power reactor as a technology demonstrator. So, as you can see, we have translated research into development, development into demonstration and demonstration into deployment, quite successfully and the three stages of our programme would follow successively one after the other.

Rajasthan Atomic Power Station-1to4

While around 70,000 tons of uranium that we currently know we have in our soil would support just 10,000 MWe of PHWR programme, the fast reactor technology would allow us to go to as high as 500,000 MWe using the same uranium once cycled through PHWRs. The thorium technology would allow us to sustain the power generation capacity at such high levels for a very long time. The Accelerator Driven Systems

Technology would allow us to sustain respectable growth even with thorium systems which otherwise is not possible. The High Temperature Reactor Systems which is another direction of research that we have to pursue would allow us to use nuclear energy not just for production of electricity but also for production of hydrogen which is going to be an important energy carrier in addition to electricity in future. Finally, the fusion systems would probably open up the door for unlimited access to energy to sustain development of our civilisation.

Our challenge is to master the new technologies in time to sustain the growth of the progamme in tune with the needs of economic development. For some technologies we can carry out development on lines similar to the developments that have taken place elsewhere. This is what we have done in the context of PHWRs and FBRs. For the development of thorium reactors, we have to be more innovative because I do not see any other country moving in any significant way on this path simply because they do not need to. For us, it is an absolute must. The strength that we now have in terms of R&D capabilities provides us the confidence that we can achieve success on this path on our own. Our energy requirements are however growing very fast, thanks to rapid economic development that is taking place. We had therefore, also visualised the possibilities of external additionalities both in terms of uranium as well as in terms of nuclear power plants. It is a matter of some satisfaction that there is now a recognition of India being a responsible country with advanced nuclear technology and that we should be treated on par with other countries with advanced nuclear technology such as the United States for international trade in civilian nuclear energy. Thus, I expect to see a more rapid augmentation of nuclear power generation capacity addition without any compromise on our autonomous decision making capability in terms of pursuit of domestic programme in nuclear area.

This is the horizon as I see in the context of nuclear energy. How should we organise ourselves to realise the goals? Self-reliance has been our motto right from day one. In the early phases of the programme self-reliance meant to do things yourself. This has contributed to our technological empowerment despite the technology denial regime. Later, we modified our approach. We now don't mind acquiring things from outside so that we can grow faster. But then in doing so, we must ensure that we don't become vulnerable in terms of our technological capabilities in any manner. Now we should pick-up sufficient confidence and prepare ourselves to move on unchartered territories without bothering about whether somebody has walked that path or not as long as we are convinced that it is the right thing for us to do. Self-reliance should now mean that we are able to do things that are relevant and appropriate for us without having to look for a parallel blueprint anywhere else. I know that this is easily said than done. But it looks to me that this is definitely possible. If we derive strength from each other, I think we can realise this new form of self-reliance. As I mentioned, particularly in the context of utilising thorium and to some extent in the context of other technologies, it is inevitable that we take the initiative and move ahead on our own. I think it is important that we graduate ourselves to that mode in as many areas as we possibly can.

To bring about completely new technologies at a rapid pace, it is obvious that there have to be greater linkages between basic research and technology development. Presently, it seems to me sometimes that our basic research and our technology development activities are two virtually parallel tracks. The connections between these activities within the country are far weaker than our connections abroad wherever they exist. Considering the strength of our R&D community, one can build up tremendous national strength if we make the domestic connections stronger.

When it comes to the linkages between education and research, the situation is even more precarious. It is important that students during their higher education programme are exposed to latest knowledge available in the area of interest through teaching programme, to skills and training to implement programmes of relevance through research projects and be associated with debates/discussion related to issues before our society or industry or nation as a whole, where the education the student is undergoing could be of help. Unfortunately, the larger part of our academic, research and industrial implementation activities in the country have very little interaction between them. We seem to have nurtured a system which preferentially facilitates export of our knowledge and related attainments to the detriment of benefits that we can derive in terms of its translation to new and innovative technologies within the country.

It is in this background that we have taken several initiatives in the recent past. We now have a number of centres for pursuing R&D in different academic institutions. Apart from carrying forward necessary R&D in areas of interest, these centres provide opportunity to students to work in frontline areas of national relevance. We also have a programme of selective induction of Ph.Ds through Dr. K.S. Krishnan Research Associateship.

The DAE Graduate Fellowship Scheme enables us to promote similar research-education linkages at M.Tech. level with most of the IITs.

All students under this scheme are absorbed in relevant DAE programmes after they complete the fellowship programme.

The recently established Homi Bhabha National Institute will nurture both research-education as well as research-technology linkages. Under the Fellowship Scheme, applicable here, a student would work on areas at the interface between research and technology under two guides covering research side as well as the technology side and would eventually be absorbed in a technology oriented institution. We are now working towards enhancing the student strength in all our R&D institutions.

I feel these initiatives would strengthen our self-reliance in pursuing new technologies. The challenge of meeting national energy requirements through new technologies of relevance to India is in my view a great opportunity to work on areas no one has worked before and thus scale up to global leadership. With large human resource available with us, I think this challenge is within our reach.

Sometimes, I wonder that the varnashram that has crept in very deep in our psyche has also crept in our scientific system. We must dismantle it because without working together spanning the entire RD^3 chain, realisation of challenging technologies is not possible. The education system, the R&D system and the society or industry need to work together in a manner where a student right from the primary level all the way upto the professional career is put through our enjoyable experience of learning, exploring and contributing to our society. If we are able to do this, I am sure we can empower the nation through nuclear energy much more comprehensively than we have done so far.

Homi Bhabha National Institute

R.B. Grover
Director, Homi Bhabha National Institute

On June 4, 2005, Prime Minister Manmohan Singh visited Bhabha Atomic Research Centre and announced the approval of the government for setting up of Homi Bhabha National Institute (HBNI) under the aegis of DAE, with the status of a 'deemed to be university' under the UGC Act. This landmark announcement will help in accelerating the pace of basic research as well translation of basic research into technology development. HBNI will have the following as its Constituent Institutions (CIs).

R&D Centres

1. Bhabha Atomic Research Centre (BARC), Mumbai, Maharashtra
2. Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam, Tamil Nadu
3. Centre for Advanced Research (CAT), Indore, Madhya Pradesh
4. Variable Energy Cyclotron Centre (VECC), Kolkata, West Bengal

Grant-in-aid Institutions

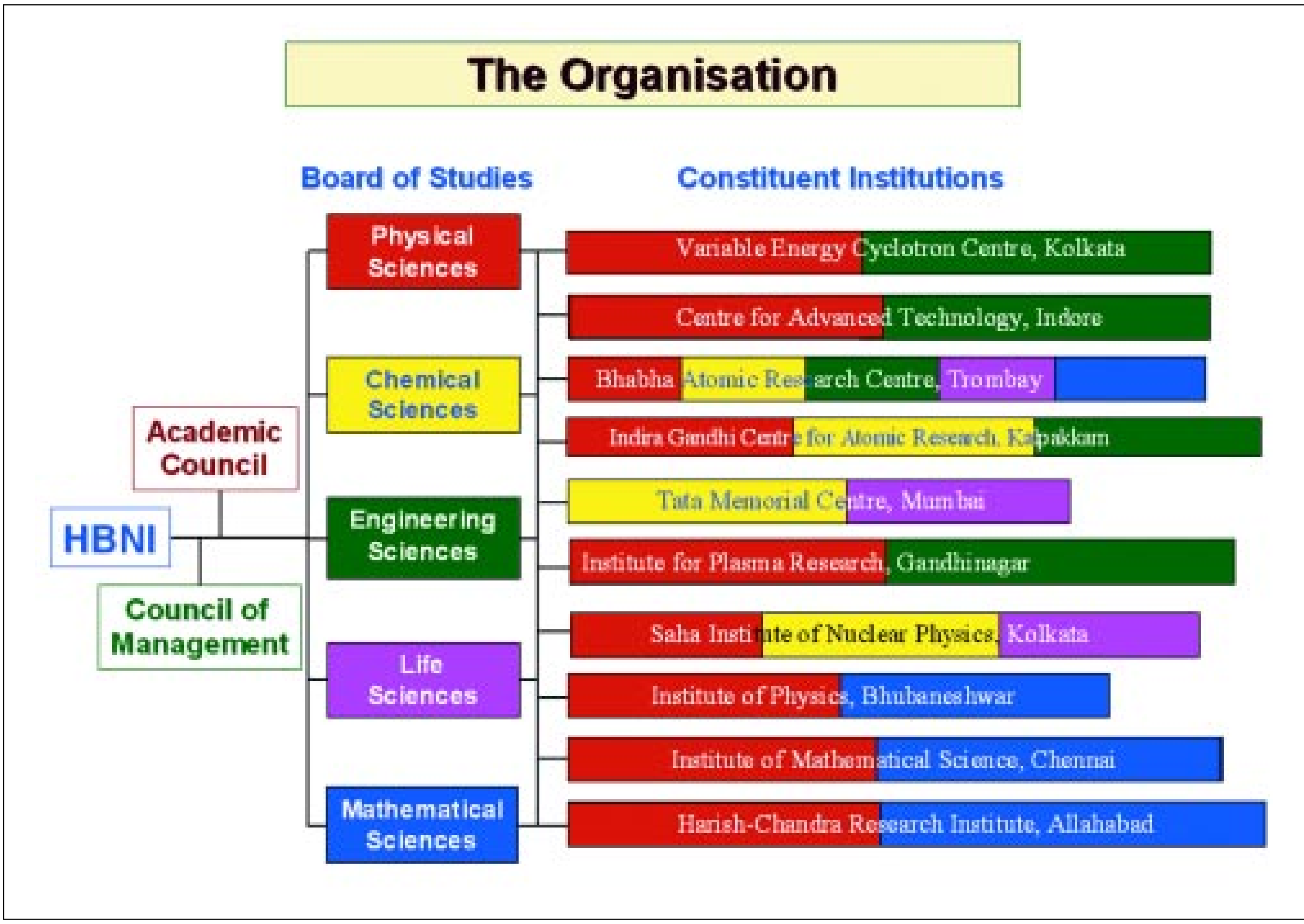
1. Saha Institute of Nuclear Physics (SINP), Kolkata, West Bengal
2. Institute of Plasma Research (IPR), Ahmedabad, Gujarat
3. Institute of Physics (IOP), Bhubaneshwar, Orissa
4. Harish-Chandra Research Institute (HRI), Allahabad, Uttar Pradesh
5. Tata Memorial Centre (TMC), Mumbai, Maharashtra
6. Institute of Mathematical Science (IMSc), Chennai, Tamil Nadu

Tata Institute of Fundamental Research (TIFR), Mumbai is also a grant-in-aid institution of DAE. It is not included as a part of HBNI as it is a deemed university by itself.

Officers of the institute such as Director, Dean and others have been appointed. Authorities like council of management, academic council, boards of studies have also been constituted. All the officers of HBNI will hold office concurrently with their positions in the CIs and thus are adjunct appointments. Framework for initiating academic programmes is being evolved in a manner that aims at maintaining excellent academic standards and at the same time provides for flexibility in implementation.

Right from its inception in 1954, the Department of Atomic Energy has laid strong emphasis on human resource development and this emphasis has been a very important contributor towards the success of the programmes pursued by the Department. A key element of the success achieved in the human resource development is the visionary initiative of Dr. Homi Bhabha who set up the prestigious Training School BARC in the year 1957, just within three years of setting up of the department. This has helped the department in pursuing basic research as well as technology development with equal rigour. Over the years, a robust institutional framework has been put in place. Today, apart from the industrial units, DAE runs 4 major research centres and 7 grant-in-aid institutions.

While in the research centers, the focus is more sharply on technology and product development, the grant-in-aid institutions concentrate relatively more on basic research. In the process, the research centres and



the grant-in-aid institutions have together provided high calibre technologists as well as scientists to the Department but for which India's spectacular strides in the field of nuclear sciences and their applications would not have been possible.

Subsequent to the setting up of the Training School at Trombay, over the years, Training Schools have been set up at other places as affiliates of BARC Training School. The BARC Training School and its affiliates have been running a remarkably successful Orientation Course for Engineering graduates and Science post-graduates (OCES). The grant-in-aid institutions, apart from carrying out research, have been running pre-doctoral and doctoral programmes, which have helped in producing high quality scientific research personnel. It is in this respect of an in-house human resource development programme that the DAE has been unique.

The DAE has not only trained manpower for running its own programmes, it has also made significant contributions to the national scene. It has strengthened the research programmes at universities by providing grants for well defined projects. All grants are channelised through the Board of Research in Nuclear Sciences (BRNS), which has the distinction of being the first agency in the country for funding extra-mural research. In the recent years, funding through BRNS has been significantly stepped up and the Department is planning to further expand its activities.

Yet another visionary and uniquely DAE centred initiative is the institutional arrangement whereby advanced and major research facilities such as research reactors and accelerators of the Department are made available to the academic institutions. This is the strongest link, which the University Grants Commission and the DAE have established and nurtured for over a decade. There is no parallel for such an arrangement in the country. This successful arrangement hitherto called the Inter-University Consortium for DAE facilities (IUC-DAEF), was refashioned and expanded under a new Memorandum of Understanding (MoU) signed on December 10, 2003 and has been renamed as 'UGC-DAE Consortium for Scientific Research'.

Students from universities come to the research centres of the Department for training and for their thesis work in significant numbers. BARC also conducts year-long training courses for equipping science post-graduates to work as medical physicists and radiological safety officers, doctors to practice nuclear medicine and science graduates to work as technologists in nuclear medicine centres. TMC is another unique centre in the country and conducts several educational programmes for training medical doctors in the treatment of cancer.

Along with massive in-house basic research and technology development programme as well as support to such programmes in academic institutions and other national laboratories, the Department has thus been exceptional in having variously contributed to human resource development. Self-reliance of DAE's atomic energy programme and world-class excellence realized in commercial performance of the indigenously built nuclear plants testify to the soundness of the approach.

India is a populous country, but is not endowed with plentiful energy resources. Energy is the engine for economic growth and when the country moves ahead on the growth path, it is necessary to exploit every energy resource available in the country. The strategy developed to meet the growing energy demand calls for setting up of fast reactors as a follow up to the successful Pressurized Heavy Water Reactor programme. The first fast reactor is already under construction at Kalpakkam and will be followed by four similar units. Research and development programme for future fast reactors which aims at rapid multiplication of fissile material has been drawn and is being pursued. The fast reactors will be followed by thorium reactors on a long-term horizon. This programme is unique in the world and places arduous demands for self-reliance on the DAE. In this scenario, the country and, in particular, DAE have to necessarily take innovative steps to consolidate the gains achieved so far and take fresh initiatives for enhancing the capabilities to meet the imminent and future challenges.

It has, therefore, become imperative that DAE conceives of novel ways through which in-depth capabilities in nuclear science and nuclear engineering are unabatedly nurtured within our institutions. It is in this context that the idea of establishing the Homi Bhabha National Institute (HBNI) with a deemed to be university status was proposed. The concept underlying the HBNI is to promote advanced degrees, viz., Masters and Ph.D degrees, largely with the help of the research centres and grant-in-aid institutions of the DAE. At present, the research centres and the grant-in-aid institutions of DAE, with the exception of TIFR, have to seek recognition for their researchers to be awarded degrees by one or the other Indian universities. Instead, the HBNI would offer a uniform scheme for such activities in education and research. It is envisaged that such a scheme will concomitantly result in strengthening linkages between the grant-in-aid institutions and the research centres for the benefit of advancing the pace of research in nuclear sciences on the one hand and, on the other, accelerate the process of translating R&D into technology products and their applications. Internationally, initiatives are being taken by enlightened organizations and academic institutes to promote interdisciplinary research in challenging areas of technological significance, with varied successes. HBNI, in view of the available excellence in the Constituent Institutions and of the inherent interdisciplinary nature of nuclear science and technology, offers a unique opportunity to succeed.

Dr. Grover has been appointed Director of the Homi Bhabha National Institute (HBNI). He graduated in mechanical engineering from Delhi College of Engineering, Delhi, studied nuclear engineering at the BARC Training School as a Trainee of the 14th batch and received his Ph.D. in Mechanical Engineering from the Indian Institute of Science, Bangalore. He is a Fellow of the Indian National Academy of Engineering and is working as Director, Knowledge Management Group, Bhabha Atomic Research Centre and Director, Strategic Planning Group, Department of Atomic Energy. He will function as Director, HBNI concurrently with his present assignments.

Dr.R.R. Puri, Head, Human Resource Development Division, BARC, has been appointed as Dean of HBNI. Holding a post-graduation in physics and a doctorate in mathematics, Dr. Puri graduated from the 17th batch of the BARC Training School in physics discipline. He has been working actively in the areas of theoretical quantum optics, foundations of quantum mechanics and quantum chaos.

He has been a visiting scientist to the University of Rochester, USA, visiting professor to the University of Manchester Institute of Science and Technology, UK and Humboldt Fellow in the University of Essen, Germany.

His current research interests include quantum computing and information processing, and the motion of charged particles in electro-magnetic fields in cavities.

It is well recognised that there is no greater motivation to a bright young student than the prospect of a higher degree, especially when it is achieved through work in an advanced subject of relevance to technology. The DAE offers an excellent environment of challenging projects and world class facilities. Furthermore, the attractiveness of the advanced degree is accentuated by the good prospect of an assured employment and career in one of the finest scientific agencies in the country.

The setting up of HBNI as a deemed to be University aims, therefore, to provide a platform for accelerated pace of research and development. While the advanced degree for those already employed or a promise of such employment while obtaining an advanced degree, provide the attraction to those who would enroll, the gains for the department are envisaged in terms of strong links between the research centres and the grant-in-aid institutions through the medium of the new generation of researchers and research problems. Moreover, it is expected that the volume, quality and relevance of research and development will all simultaneously see an upward and more rapid growth. It is only through accelerated research that India can hope to achieve a leadership position in some of the emerging areas of science and technology.

The education and training has to be a lifelong process and only then one can ensure lifelong employability of scientific personnel. To nurture lifelong education, institutions of the Department have always laid emphasis on conferences and special lectures and colloquia. Under the auspices of HBNI, by starting summer and winter schools, it will be possible to provide a formal framework for such activities.

A scheme called DAE Graduate Fellowship Scheme for Indian Institutes of Technology (DGFS-IITs) with the twin objectives of human resource development and collaborative research through the medium of M.Tech. students was launched by the BRNS in the year 2002. The scheme provides for selection of M.Tech. students admitted to one of the 6 select IITs for working on a project of interest to DAE under the guidance of faculty from IITs and DAE. Such students receive enhanced financial support from DAE while pursuing M.Tech. and on completion of which are ensured employment within the DAE system.

A programme similar to DGFS-IITs, to be called DAE Graduate Scheme for HBNI (DGFS-HBNI), has been approved for launching by the Department. This scheme aims at selecting students for Ph.D. programmes and they will research on topics which lie at the interface of basic research and technology development under the joint guidance of two thesis supervisors – one having strength in basic research and the other in technology development, preferably across CIs. This 'integrated' Ph.D. programme will run parallel to the 'distributed' programme, which will be pursued at each CI in a conventional manner. The students pursuing the integrated programme will get higher fellowship.

Institutions in India have become proactive in setting up linkages with institutions abroad. HBNI would like similar linkages to be set up within the institutions in India and have already initiated dialogue to meet this objective. The linkages could include transfer of credits and joint supervision of research by students.

It is expected that setting up of HBNI will help to further raise the standard of research in the area of nuclear science and engineering in the institutions of the DAE and India by creating additional avenues for human resource development.

Statement by Prime Minister Dr Manmohan Singh made in Parliament on his visit to the United States of America (29-July-2005)

"I am pleased to present to this House a statement on my recent visit to the United States. President Bush invited me to pay an official visit and my wife and we were received by President Bush and the First Lady Mrs. Laura Bush with great warmth and with full ceremonial honours. My talks with the President covered a wide range of bilateral and global issues. The Vice President and senior Cabinet members of the US Administration such as Secretary of State, Dr. Condoleezza Rice, Defence Secretary, Mr. Rumsfeld and Treasury Secretary, Mr. Snow also called on me during my stay. I had the honour to be invited to address the Joint Session of the US Congress. I believe that the visit was a success in furthering our foreign policy interests and in terms of its substantive outcome. It was evident that the United States wished to signal that we are embarking on a transformation of our ties so as to realise their inherent potential. A copy of the Joint Statement issued during my visit is placed on the Table of the House.

The purpose of my visit was to sensitise the US Government about the full extent of the changes that have taken place in India since 1991. These changes have given us a stronger capability to work with the United States on more equal terms as we address common concerns and challenges. I also sought to emphasise that the Indian economy is stronger than it has ever been and we hope to participate in and benefit from the economic processes of globalisation. We are determined to be a competitive destination for investment, including foreign investment and the US business community could contribute to development in India through greater investment and trade. We are uniquely placed to enter into such mutually beneficial interaction drawing on the strength of our knowledge sector. Hence another important goal was to underline to the US that the emergence of India as a centre of knowledge based industries and services would provide a good basis for long-term collaboration between our economies. The expansion of the Indian economy and acceleration of our growth rates is crucial not just for our own people but would be beneficial to global economic progress and stability.

My discussions in Washington with President Bush and members of his Administration were productive and helped advance these national goals. Both sides agreed that our relationship was based on shared values and shared interests that included the strengthening of democratic capacities where desired and without coercion, and in combating terrorism without selective or segmentation. The conclusion of the UN Comprehensive Convention on International Terrorism proposed by India, at an early date, was deemed a priority by both countries. On the economic side, we welcomed the launching of a CEOs Forum that has brought together the best business minds of both countries. We discussed the urgent need for modernisation of India's infrastructure and our quest for greater investments in this sector, in view of its centrality for the continued growth of the Indian economy. Recognising the importance of the rural economy, we also agreed on an agricultural initiative aimed at facilitating a new generation of research and agricultural practices to build on the Green Revolution.

Appreciating the importance of technology to India's economic and social development we also discussed measures that would ensure more liberal and predictable access to US technology. We will endeavour to build closer ties in frontier areas such as space exploration, satellite navigation and launch, and related commercial activities that would greatly benefit our space industry, which is now recognised as a global leader. A Science and Technology Framework Agreement has been agreed during my visit that provides for expanded joint research and training. Underlining the intent of working at a new level of cooperation, the United States announced the removal of five Indian organisations from its Entity List, three from the space sector and two from atomic energy and indicated further review in this matter.

India's quest for energy security as an essential component of our vision for our development was a significant theme of my talks. I elaborated the imperative need for India to have unhindered access to all sources of energy, including nuclear energy, if we are to maintain and accelerate our rate of economic growth. I am pleased to state that the US understood our position in regard to our securing adequate and affordable energy supplies, from all sources. This approach, I underlined, would enable us to reduce our dependence on fossil fuels. This would have concomitant advantages for all in terms of reduced pressure on oil prices and environmental sustainability. It was in this context that we affirmed the importance of cooperation in the civilian nuclear energy sector.

Accordingly, a central element of my interaction with President Bush was the resumption of bilateral civilian nuclear cooperation between India and the United States, which has been frozen for decades. President Bush and I agreed that we would work towards promoting nuclear energy as a means for India to achieve energy security. The US side undertook to adjust its laws and policies domestically and to work with its friends and allies to adjust relevant international regimes. Full civilian nuclear energy cooperation would include, but not limit itself, to the expeditious consideration of fuel supplies for Tarapur. The US will also encourage other partners to consider similar requests favourably. We also obtained consideration of our desire to participate as full partners in the International Thermo Nuclear research Project and the Generation IV International Forum. These programmes in frontier areas of science and technology have considerable potential for our country's and indeed global energy security in the future. The US agreed to consult other participants with a view towards India's inclusion. This is a testimony not only to the enormous international stature and respect achieved by our nuclear scientists but recognition of their attainments.

Our nuclear programme in many ways, is unique. It encompasses the complete range of activities that characterise an advanced nuclear power including generation of electricity, advanced research and development and our strategic programme. Our scientists have mastered the complete nuclear fuel cycle. The manner of the development of our programme which has been envisaged is predicated on our modest uranium resources and vast reserves of thorium. While the energy potential available in these resources is immense, we remain committed to the three-stage nuclear power programme, consisting of Pressurised Heavy Water Reactors (PHWRs) in the first stage, fast breeder reactors in the second stage and thorium reactors in the third stage. These would need sequential implementation in an integrated manner. Our scientists have done excellent work and we are progressing well on this programme as per the original vision outlined by Pandit Jawaharlal Nehru and Dr. Homi Bhabha. We will build on this precious heritage.

Energy is a crucial input to propel our economic growth. We have assessed our long-term energy resources and it is clear that nuclear power has to play an increasing role in our electricity generation plans. While our Indigenous nuclear power programme based on domestic resources and national technological capabilities would continue to grow, there is clearly an urgent necessity for us to enhance nuclear power production rapidly. Our desire is to attain energy security to enable us to leapfrog stages of economic development obtained at the least possible cost. For this purpose, it would be very useful if we can access nuclear fuel as well as nuclear reactors from the international market. Presently, this is not possible because of the nuclear technology restrictive regimes that operate around us. What we have now agreed with the United States should open up the possibility of our being able to access nuclear fuel and nuclear power reactors and other technologies from outside to supplement our domestic efforts. There is also considerable concern with regard to global climate change arising out of CO_2 emissions. Thus, we need to pursue clean energy technologies. Nuclear power is very important in this context as well.

The Joint Statement recognises that as a responsible State with advanced nuclear technology, India should acquire the same benefits and advantages as other such States which have advanced nuclear technology. As a result we expect that the resumption of India's nuclear trade and commerce with the US and globally, is an achieveable goal, involving the dismantling of the technology denial regimes which have hitherto targeted India.

Predicated on our obtaining the same benefits and advantages as other nuclear powers, is the understanding that we shall undertake the same responsibilities and obligations as such countries, including the United States. Concomitantly, we expect the same rights and benefits. Thus we have ensured the principle of non-discrimination. I would like to make it very clear that our commitments would be conditional upon, and reciprocal to, the US fulfilling its side of this understanding. The Joint Statement refers to our identifying, and separating civilian and military nuclear facilities in a phased manner and taking a decision to place voluntarily civilian nuclear facilities under IAEA safeguards. India will never accept discrimination. There is nothing in this Joint Statement that amounts to limiting or inhibiting our strategic nuclear weapons programme over which we will retain unrestricted, complete and autonomous control. I repeat there is nothing in this Joint Statement that amounts to limiting or inhibiting our strategi nuclear weapons programme over which we will retain unrestricted, complete and autonomous control.

Reciprocity is key to the implementation of all the steps enumerated in the Joint Statement. We expect a close co-relation between the actions to be taken by the United States and by India. Indian actions will be contingent at every stage on actions taken by the other side. Should we not be satisfied that our interests are fully secured, we shall not feel pressed to move ahead in a pre-determined manner.

Hence phased action, in terms of identification and separation of civilian nuclear facilities based solely on our own duly calibrated national decisions will be taken at appropriate points in time, consistent with our national security interests. Before voluntarily placing our civilian facilities under IAEA safeguards, we will ensure that all restrictions on India have been lifted. Our autonomy of decision-making will not be circumscribed in any manner whatsoever.

I wish to emphasise to this House that the basis for this understanding was a clear recognition that India is a responsible nuclear power with an impeccable record on nuclear non-proliferation. Our strategic policies and assets are a source of national security and will continue to be so, and will remain outside the scope of our discussions with any external interlocutors. I should like to take this opportunity to assure Hon'ble Members that the Government will not allow any fissile material shortages or any other material limitations on our strategic programmes in order to meet current or future requirements. The defence and security interests of our country are our highest priority and will continue to remain so.

Our policies and actions have earned us global recognition and widespread esteem, which I am sure, the House recognises and welcomes. This allows us not only to make a credible case for an end to three decades of technology denial but also to find a central and growing place in international organisations.

I used the occasion of my visit to the US to spell out the basis on which India has made a compelling case for expansion of the UN Security Council and for our admission as a Permanent Member. The US has a different position on this matter and has not found it possible to endorse India's position. It is my hope that over time the US will recognize the validity of what we say. In fact, the Joint Statement itself reflects growing US recognition of this position. It states "international institutions must fully reflect changes in the global scenario that have taken place since 1945." The US President also reiterated that international institutions are going to have to adapt to reflect India's central and growing role. In this regard, global initiatives that we have initiated with the United States, which include disaster relief, HIV/AIDS and strengthening democratic capacities in societies that seek such assistance testify to the greater recognition of our strengths and capabilities.

I therefore believe my visit to the United States has led to greater understanding and appreciation of our concerns and interests. It has contributed to significant initiatives that have important economic and developmental implications for India. I have made a strong case on behalf of the Indian people that our voice be heard when decisions that affect us are made in global councils. I am confident that this House would welcome these developments.

I would like to conclude by stating that we can feel justly proud that our achievements are being recognized globally. This is a tribute to our scientists, engineers, teachers, workers, farmers, entrepreneurs and professionals. We are now a nation of over one billion people. We are the world's fourth largest economy, with the second highest rate of GDP growth today. The manner in which we have achieved this progress within the framework of a democratic dispensation is the subject of admiration and respect. Increasingly, India is seen as a benchmark for the rest of the world. I therefore believe our strength lies in the essential correctness of the path we have chosen, and in the creativity and enterprise of our people. This has enabled India to stand tall in the comity of nations.

I realise that there would be criticism in some quarters regarding aspects of the Joint Statement. Constructive criticism is part of the Parliamentary tradition, and I welcome it. This adds clarity to our debates and vibrancy to the institution of our democracy. I can however assure this August House, and through it, our nation, that my visit to the United States was undertaken solely with the purpose of enhancing relations with one of the world's pre-eminent powers, so as to widen our developmental options. It was my endeavour to expand our access to energy supplies to fuel our growth, while protecting our strategic interests. I believe our effort to undo some of the long-standing restrictive nuclear regimes will enable us to secure access to the significantly greater quantities of energy that we will need to spur massive growth in our industrialisation programme. Once secured, cheap and affordable energy will enable India to leapfrog its current pace of economic growth, to secure the future for generations to come.

All of us gathered together in this August House recognize that inspired by our freedom struggle, we have inherited a proud and patriotic tradition. Our commitment to work for universal nuclear disarmament, so passionately espoused by Prime Minister Rajiv Gandhi, in the long run will remain our core concern. At the same time, I can assure the House that we have never made, nor will we ever make, any compromises insofar as our fundamental and strategic needs are concerned. Our inheritance gives us confidence, our experience gives us courage, and our belief gives us conviction to assert today that our nation stands on the threshold of an even better future. I therefore venture to think that my visit to the USA has opened up new opportunities and possibilities for promoting our energy security and pathways to accelerated social and economic development. We must all work together as a united nation to realise these opportunities to make India a major powerhouse of the evolving global economy."

India - USA Joint Statement

The following is the text of Indo-US Joint statement issued after the delegation-level meeting between the Prime Minister, Dr. Manmohan Singh and the US President Mr. George W. Bush, in Washington DC on July 18, 2005.

"Prime Minister Manmohan Singh and President Bush today declare their resolve to transform the relationship between their countries and establish a global partnership. As leaders of nations committed to the values of human freedom, democracy and rule of law, the new relationship between India and the United States will promote stability, democracy, prosperity and peace throughout the world. It will enhance our ability to work together to provide global leadership in areas of mutual concern and interest.

Building on their common values and interests, the two leaders resolve:

To create an international environment conducive to promotion of democratic values, and to strengthen democratic practices in societies which wish to become more open and pluralistic.

To combat terrorism relentlessly. They applaud the active and vigorous counterterrorism cooperation between the two countries and support more international efforts in this direction. Terrorism is a global scourge and the one we will fight everywhere. The two leaders strongly affirm their commitment to the conclusion by September of a UN comprehensive convention against international terrorism.

The Prime Minister's visit coincides with the completion of the Next Steps in Strategic Partnership (NSSP) initiative, launched in January 2004. The two leaders agree that this provides the basis for expanding bilateral activities and commerce in space, civil nuclear energy and dual-use technology.

Drawing on their mutual vision for the U.S.-India relationship, and our

joint objectives as strong long-standing democracies, the two leaders agree on the following:

For the Economy

Revitalize the U.S.-India Economic Dialogue and launch a CEO Forum to harness private sector energy and ideas to deepen the bilateral economic relationship.

Support and accelerate economic growth in both countries through greater trade, investment, and technology collaboration.

Promote modernization of India's infrastructure as a prerequisite for the continued growth of the Indian economy. As India enhances its investment climate, opportunities for investment will increase.

Launch a U.S.-India Knowledge Initiative on Agriculture focused on promoting teaching, research, service and commercial linkages.

For Energy and The Environment

Strengthen energy security and promote the development of stable and efficient energy markets in India with a view to ensuring adequate, affordable energy supplies and conscious of the need for sustainable development. These issues will be addressed through the U.S.-India Energy Dialogue.

Agree on the need to promote the imperatives of development and safeguarding the environment, commit to developing and deploying cleaner, more efficient, affordable, and diversified energy technologies.

For Democracy and Development

Develop and support, through the new U.S.-India Global Democracy Initiative in countries that seek such assistance, institutions and resources that strengthen the foundations that make democracies credible and effective. India and the U.S. will work together to strengthen democratic practices and capacities and contribute to the new U.N. Democracy Fund.

Commit to strengthen cooperation and combat HIV/AIDs at a global level through an initiative that mobilizes private sector and government resources, knowledge, and expertise.

For Non-Proliferation and Security

Express satisfaction at the New Framework for the U.S.-India Defense Relationship as a basis for future cooperation, including in the field of defense technology.

Commit to play a leading role in international efforts to prevent the proliferation of Weapons of Mass Destruction. The U.S. welcomed the adoption by India of legislation on WMD (Prevention of Unlawful Activities Bill).

Launch a new U.S.-India Disaster Relief Initiative that builds on the experience of the Tsunami Core Group, to strengthen cooperation to prepare for and conduct disaster relief operations.

For High-Technology and Space

Sign a Science and Technology Framework Agreement, building on the U.S.–India High-Technology Cooperation Group (HTCG), to provide for joint research and training, and the establishment of public-private partnerships.

Build closer ties in space exploration, satellite navigation and launch, and in the commercial space arena through mechanisms such as the U.S.-India Working Group on Civil Space Cooperation.

Building on the strengthened nonproliferation commitments undertaken in the NSSP, to remove certain Indian organizations from the Department of Commerce's Entity List.

Recognizing the significance of civilian nuclear energy for meeting growing global energy demands in a cleaner and more efficient manner, the two leaders discussed India's plans to develop its civilian nuclear energy program.

President Bush conveyed his appreciation to the Prime Minister over India's strong commitment to preventing WMD proliferation and stated that as a responsible state with advanced nuclear technology, India should acquire the same benefits and advantages as other such states. The President told the Prime Minister that he will work to achieve full civil nuclear energy cooperation with India as it realizes its goals of promoting nuclear power and achieving energy security. The President would also seek agreement from Congress to adjust U.S. laws and policies, and the United States will work with friends and allies to adjust international regimes to enable full civil nuclear energy cooperation and trade with India, including but not limited to expeditious consideration of fuel supplies for safeguarded nuclear reactors at Tarapur. In the meantime, the United States will encourage its partners to also consider this request expeditiously. India has expressed its interest in ITER and a willingness to contribute. The United States will consult with its partners considering India's participation. The United States will consult with the other participants in the Generation IV International Forum with a view toward India's inclusion.

The Prime Minister conveyed that for his part, India would reciprocally agree that it would be ready to assume the same responsibilities and practices and acquire the same benefits and advantages as other leading countries with advanced nuclear technology, such as the United States. These responsibilities and practices consist of identifying and separating civilian and military nuclear facilities and programs in a phased manner and filing a declaration regarding its civilians facilities with the International Atomic Energy Agency (IAEA); taking a decision to place voluntarily its civilian nuclear facilities under IAEA safeguards; signing and adhering to an Additional Protocol with respect to civilian nuclear facilities; continuing India's unilateral moratorium on nuclear testing; working with the United States for the conclusion of a multilateral Fissile Material Cut Off Treaty; refraining from transfer of enrichment and reprocessing technologies to states that do not have them and supporting international efforts to limit their spread; and ensuring that the necessary steps have been taken to secure nuclear materials and technology through comprehensive export control legislation and through harmonization and adherence to Missile Technology Control Regime (MTCR) and Nuclear Suppliers Group (NSG) guidelines.

The President welcomed the Prime Minister's assurance. The two leaders agreed to establish a working group to undertake on a phased basis in the months ahead the necessary actions mentioned above to fulfill these commitments. The President and Prime Minister also agreed that they would review this progress when the President visits India in 2006.

The two leaders also reiterated their commitment that their countries would play a leading role in international efforts to prevent the proliferation of weapons of mass destruction, including nuclear, chemical, biological and radiological weapons.

In light of this closer relationship, and the recognition of India's growing role in enhancing regional and global security, the Prime Minister and the President agree that international institutions must fully reflect changes in the global scenario that have taken place since 1945. The President reiterated his view that international institutions are going to have to adapt to reflect India's central and growing role. The two leaders state their expectations that India and the United States will strengthen their cooperation in global forums.

Prime Minister Manmohan Singh thanks President Bush for the warmth of his reception and the generosity of his hospitality. He extends an invitation to President Bush to visit India at his convenience and the President accepts that invitation."

50th Symposium on Nuclear Physics, DAE/BRNS, India

Date: 12-16 December 2005

Place: Bhabha Atomic Research Centre, Mumbai
Topics: Nuclear structure, Low and medium energy nuclear re actions, Physics with radioactive ion beams, Intermediate energy nuclear physics, Relativistic nuclear collisions and QGP, Nuclear matter and nuclear astrophysics, Instrumentation and accelerators for nuclear physics.
Format: The scientific programme would constitute invited talks, contributionsin the form of poster presentation and theses presentations.
Contributions: Contributions and thesis summary are invited.
Updates on Website: Detail information on the symposium website.
(Website: "http://www.barc.ernet.in/webpages/symposium snp2005/")

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Eighth Biennial Trombay Symposium on Radiation & Photochemistry (TSRP-2006)

January 5-9, 2006
Bhabha Atomic Research Centre, Mumbai- 400 085, India

Topics To Be Covered
- Fast & Ultra fast processes
- Inorganic, organic & polymer radiation and photochemistry
- Gas phase photochemistry & dynamics
- Charge, electron & energy transfer processes
- Radiation & photochemistry for environmental protection
- Radiation & photochemistry of drugs and antioxidants
- Industrial applications of radiation & photochemistry
- Radiation and photochemistry in biology & medicine
- Radiation and photochemistry of advanced materials
- Role of Radiation and Photochemistry in nanosciences

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Hydrogel Dressing : A Radiation Processing Technology to Heal Wounds

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ISOMED, Radiation Technology Development Section,
Bhabha Atomic Research Centre

Hydrogels are three dimensional network structure of hydrophilic polymers holding large amount of water. These have been observed to be highly effective in healing almost all types of external wounds. Extensive clinical studies have established their safety and shown that they are not only an excellent first aid for burns but also cure other difficult-to-heal wounds like diabetic foot ulcers, leprosy ulcers, animal bites etc.

Hydrogel Dressings are now available in the market under the brand name 'HI-ZEL'. Dr. Reddy's Laboratories, Hyderabad , a multinational pharmaceutical company has recently signed an memorandum of understanding (MoU) for technology transfer to produce and market this product throughout India. This would increase the availability of the product for the benefits of large number of patients. With growing awareness, more applications of this hydrogel would add to the existing list. The use of such dressings as well as other hydrogel products are established abroad but so far their local use was restricted due either to nonavailability or high cost of the imported products. Radiation processing technology developed at BARC produces high quality hydrogel dressings at fraction of the market cost of imported material. The availability of such products are expected to induce research and development of such products by local pharmaceutical companies bringing new gel products into the market for treating diseases.

Generally, hydro(water) gels contain 30 -90% of water entrapped in a three dimensional network structure of a hydrophilic polymer. The large water content makes them highly biocompatible and therefore preferred for use as biomaterials.

The basic property which is required to be incorporated in a polymer to produce a usable hydrogel is to form cross links between different polymers chains, resulting in a three dimensional network structure. One of the most convenient ways to produce cross links is to irradiate aqueous solution of the polymers by gamma rays or electron beam. This method allows to control the degree and nature of cross links, which influence swelling capacity, mechanical properties and pore size of the gel. On irradiating dilute polymer solution the major fraction of the radiation energy is absorbed by water forming radicals and molecular products as shown below :

H_2O ----->. H, .OH, e^-(aq.), H_2O_2, H_2, H+

The species responsible for producing crosslinks are OH and H radicals. The hydroxyl radical (OH) plays the major role to form cross-links. Radicals (OH, H) abstract hydrogen atoms and produce carbon centered radicals on polymer chains . The radicals on the polymer chains further decay by forming intermolecular cross-linking(cross-link between two

Role of Hi-Zel in second degree Burns (Old Case)

Second Degree Burns - Second Day

96 hrs After Hi-Zel Dressing

48 hrs After Hi-Zel Dressing

6 Days After Hi-Zel Dressing - HEALED

Leprosy ulcers before (top) and after gel treatment (below)

different polymer chains), which to increases molecular weight and finally a hydrogel, intra-molecular cross-linking (cross-linking within the same chain, loop formation) and disproportionate reactions (scission of chain). While the proportion between recombination and disproportionate reactions is set by the nature of the radicals, the relative proportions of inter and intra-molecular cross-linking can be controlled. High dose rate (electron beam) and lower concentration favours intra-molecular cross-linking where as higher concentration and lower dose rate (gamma rays) favours intermolecular cross-linking. The former method could be used for making micro or nanogels the later is useful for making biomaterials like wound dressing. The mechanism of these fast reactions occurring during irradiation can be studied using pulse radiolysis technique. Thus, radiation processing technology provides an excellent tool for making hydrogel biomaterials. Another unique advantage of radiation is that it can kill micro-organisms. Therefore, not only gel formation, sterilization can be achieved in the same step.

Normally, three to four different types of dressings would be required to meet all the characteristics of an ideal wound dressing given in the box below. The new dressing developed by BARC meets all the requirements and hence is an ideal wound dressing.

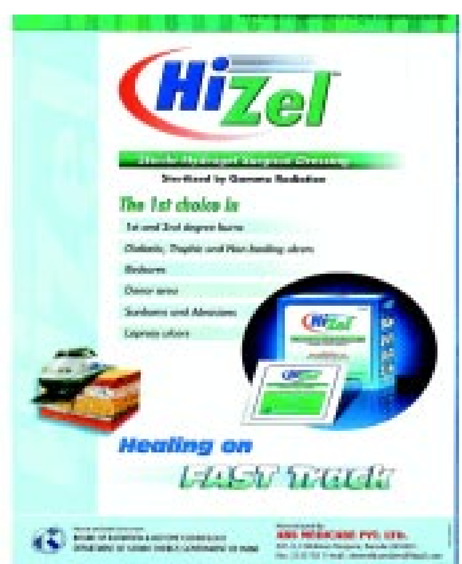
Characteristics of Ideal Dressing

- Maintains moist environment at the wound-dressing interface
- Possible to use on infected wounds
- Low or non-adherent and mechanically strong
- Transparent and flexible
- Provides mechanical protection and cushioning effect.
- Should not require frequent changing
- Comfortable and contour forming
- Safe to use
- Good absorption characteristics
- Impermeable to microorganism
- Sterile
- Available in required sizes
- Possibility of delivering drugs without removing dressing
- Cost effective

Moreover, the technology to produce hydrogel dressing is environment friendly since it leaves no residue or pollutant in the environment.The methodology, approach and applications of the new wound dressing developed at BARC are described below.

In the present process, one of the most biocompatible polymers, polyvinyl alcohol (PVA), and a mixture of naturally occurring polysaccharides like agar and carrageenan are mixed together. The hot aqueous solution of this mixture is poured in disposable plastic trays and sealed in polythene bags. These bags/pouches are then sent to ISOMED (Radiation sterilization plant at Trombay) for irradiation. The unique advantage of radiation processing is that gel formation and sterilization are achieved together during irradiation. Where as in majority of the existing chemical methods, gel is formed using toxic chemical cross-linkers. The unused cross-linkers are removed by extensive washing of the gel. The gels formed by these methods are soft, absorptive and heat sensitive. Therefore, it is difficult to sterilize these gels by known methods. Generally, antimicrobials are added to achieve it. These additive have been observed to cause delay in natural wound healing process.

The present dressing contains about 90 % water, yet has the capacity to absorb further water, almost equal to its weight. On application on wound, it could reduce the skin temperature by 8-10^0 C and maintain this differential for very long time. This property is very useful in reducing depth of burning and restricting the burn damage to the body surface. Hydrogel dressings reduce pain by



Product packing

cooling and covering the open nerve endings and thus are very useful on donor areas in plastic surgery. The present dressing is elastic in nature and has high compression strength. It provides a good cushioning effect and thus can be used in treating bedsores. Dry wounds can be best treated with hydrogels. Hydrogel dressings hydrate the desiccated wounds which is essential for healing. Absorption and hydration properties of the dressing softens the slough wound (wound containing pus) and sucks out the slough, makes the wound clean which helps in early healing. Hydrogel dressings thus reduce depth of burning by cooling the wound, reduce pain, provide humid environment (moist wound healing), form layer of growth promoting biochemical (Growth Factors), retain new skin (non adherent), induce formation of new blood vessels and granulation tissues, which promote early and clean healing.

Most hydrogel dressings available in the international market are not suitable for use on infected wounds. BARC dressing, on the other hand, if desired, can be converted into Iodine-hydrogel (antimicrobial Hydrogel) by the user himself. Thus getting best properties of germicidal Iodine and that of Hydrogel. This antimicrobial Hydrogel could be prepared by simply dipping the dressing for a few seconds in a Iodine solution. Tincture of Iodine (USP), that is easily available from chemist shop, could be used as Iodine source. The transparent gel changes into blue-black coloured gel, absorbing about 1000 ppm (particles per million) of Iodine. The absorbed Iodine is trapped in inter helical spaces of PVA. On applying to the wound, an equilibrium is established between Iodine and wound fluid. Iodine in the gel is released slowly depending on protein matter present in the wound. Iodine has tendency of reacting much faster with bacterial proteins as compared to human proteins and thus inactivate microorganism preferentially. Complete consumption of Iodine is indicated by the gel reverting to its original colour. In the same way, other water soluble drugs can first be absorbed and transported across to the wound. This allows ample freedom to a practitioner to try different medications for treatment.

Normal and Iodine (purple-black) Hydrogel dressing

Although self-adhesive, it is preferred that a secondary bandage is used to secure the hydrogel dressing. The size of the dressing should be larger than the wound perimeter. If dried on the wound, hydrogel dressing should be re-hydrated by first wetting the dressing, using boiled cooled / distilled water for 10-15 minutes to ensure painless removal of the dressing. For exuding wounds, three to four parallel cuts on the gel could be made using surgical knife before application. The excess exudate could then be absorbed into the secondary bandage such as absorbing cotton.

The dressing is for single use and once opened should not be stored for later use. The dressing could be stored under normal conditions in cool and dry places. In hot climate, the dressing should be preferably stored in refrigerator .

BARC hydrogel dressings have so far been used for treating burns, leprosy ulcers, animal bites, diabetic foot ulcers, herpes, fresh scars, bullet injuries, boils, pimples, sun burns, abrasion, surgical wounds of breast cancer, as bolus for radiation therapy in cancer etc.. The use of gels have shown excellent results in healing diabetic ulcers which definitely provides an alternate to expensive biotech products and relief to expanding population of diabetics in India.

Other hydrogel based products which are under development are radiation processed silver nano-particle hydrogels to treat infected wounds and fire blankets to protect defence and fire service personnel from fire and drug delivery devices.

The technology development work on hydrogel dressing was carried out by the author in collaboration with Dr. A.A. Majmudar of RC&CD Divison of BARC.

NPCIL's Annual Report-2004-05

The year that has gone was an eventful year for NPCIL. TAPP-4, India's largest power producing plant (540 MWe Pressurised Heavy Water Reactor at Tarapur) achieved criticality on March 6, 2005 within five years from the first pour of concrete, a target the Company set for itself four years ago. This short construction time compares well with the international benchmark. This achievement has also been heralded as a great national achievement. The Hon'ble President of India, Dr. A.P.J. Kalam, during his 2005 Technology Day address to the nation, mentioned completion of TAPP-4 as one of the four major technological achievements of the government and made a special mention of NPCIL as one of the four institutions playing pivotal role in societal transformation.

The first unit of Kakrapar Atomic Power Station (KAPS-1), on June 15, 2005, broke the longest uninterrupted run record of 272 days held so far by Unit-2 of Narora Atomic Power Station. Such long uninterrupted operations by our power plants have once again demonstrated Company's comprehensive competence.

Based on India Today-CRISIL review of 186 public sector undertakings (PSUs) of Government of India, NPCIL has been ranked number one amongst the PSUs 'with a turnover of more than Rupees 1000 crore' and also ranked number one PSU in the energy sector.

Tsunami tragedy had struck the world and India on December 26, 2004. NPCIL's power plants at Kalpakkam (MAPS-1&2) and ongoing project at Kudankulam were in the affected zone of Tsunami. At Kalpakkam, one unit (MAPS-1) was already under prolonged shut down on account of en-masse coolant channel replacement work. The other unit (MAPS-2) was operating at full power when the Tsunami waves struck. As a part of built-in safety measures, the reactor was brought to safe shut down condition and was made ready for bringing back to power in two days. However, as a matter of abundant caution, the unit

Atomic Power Plants under construction

Tarapur Atomic Power Project-3

Rajasthan Atomic Power Project-5&6

Kaiga Atomic Power Project-3&4

Kudankulam Atomic Power Project-1&2

was re-started on January 2, 2005 only after necessary inspection and authorization by AERB. There was no damage, whatsoever, at the Kudankulam Project where the grade level was higher than the Tsunami wave potential.

TAPP-3&4 was NPCIL's first attempt in scaling up the standardized 220 MWe PHWR design. Many novel concepts like loosely coupled core configuration, the zonal control schemes were incorporated into this 'first of its kind' reactor. Breaching of 5-year barrier has been possible due to various structural, attitudinal and other significant changes in work flow and work culture within your company.

Motivating and galvanizing the human capital to optimum utilization, use of 3-D computer aided design to eliminate interferences, round the clock work, award of mega supply-cum-erection packages, use of high degree of automation, deployment of high capacity cranes to accelerate the installation of very heavy equipment like steam generators, calandria, etc., open top construction, intensive macro and micro level planning and monitoring have all contributed to this feat.

TAPP-4 has demonstrated the ability and maturity of NPCIL in all fields of the nuclear technology. But for a few surprises in the commissioning, which NPCIL overcame successfully, all went as per expectation and the reactor and turbine are operating very satisfactorily and in a robust manner. TAPP-4 containment testing was cleared in the first attempt without requiring any repair. Computer software validation and verification work was completed expeditiously. Similarly, the sophisticated Fuel Handling System was commissioned in about three months. The design work for 700 MWe reactors has been almost completed.

TAPP-4 was synchronized to the grid on June 4, 2005 after the AERB authorized its operation upto 50% of full power.

On the performance front, NPCIL generated 16,709 million units of electricity. The capacity factor of 76% achieved during the year of report is higher than the national average capacity factor of 74%. The Tarapur Atomic Power Station (TAPS-1&2) achieved an overall capacity factor of 92.28% during the year, which is the highest since its commercial operation in 1969. At Narora Atomic Power Station, simultaneous and continuous operation of both the units for 238 days was achieved, which is the highest for any Indian pressurized heavy water station.

The Company has recorded a profit after tax of Rs.1705 crore. NPCIL has been paying dividend regularly to the Government of India. This year also its Board has recommended a dividend of Rs.341.50 crore (Rs.36 per share).

Many of the NPCIL stations have bagged National Award for meritorious performance instituted by the Ministry of Power and Central Electricity Authority. As a part of this national recognition and honour, Station Directors of NPCIL stations received Gold Shield, Silver Shield and Certificate for outstanding, meritorious and good performance respectively from the President of India, on August 24, 2004.

Kudankulam Atomic Power Project received the AERB Industrial Safety Award for Projects under Construction while Narora Station received the AERB Industrial Safety Award for the operating stations.

Certification of all the NPCIL's plants to ISO 14001 has helped in reducing the wastes. The company has also instituted a number of steps for cost (and hence tariff) reduction and energy conservation.

With a view to impact the quality of life of neighborhood population, NPCIL took initiatives to supplement Government efforts in the area of public health, education and infrastructure in areas around the nuclear power stations through the schemes such as Gyana Gangotri and Arogya Sudha. Some of the details are:

- Eye camps, diabetic awareness camps, blood donation camps, de-addiction camps, cancer and cardiac care programmes, etc. were organized from time to time. Nearly 244 villages have been benefited by the mobile clinic sponsored by NPCIL. In addition, the local hospitals were helped in acquiring better and advanced equipment.
- Refurbishment of school buildings, construction of mid-day-meal-kitchen sheds, upgradation of furniture and laboratories in the schools, and donation of books and computers. Help to the meritorious and needy students by way of free books, uniforms and scholarships was given. Financial assistance was also given to the schools. NPCIL also adopts children from adjoining localities and meets their educational expenses upto the 12 th standard.
- Electrification of Tamlao village near Rajasthan Atomic Power Station was completed. The villages adjoining other nuclear power plants were provided with link roads, drinking water facility, electrification and improved seeds and saplings.
- Various other social welfare activities, such as, group marriages and de-addiction camp were organized by Kakrapar Atomic Power Station.

NPCIL is preparing itself for the challenges posed by the changing statutory environment like Electricity Act 2003, National Electricity Policy and National Tariff Policy and the conditions of near perfect competition in the electricity field. Affordable tariff is going to be the Mantra of the day.

R.No. 9002/62

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