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From the Director's Desk

Speech of Dr. Baldev Raj, Director, IGCAR and Chairman, Kalpakkam Management Committee (KMC) on Monday, January 03, 2005

My dear Colleagues, friends, and residents of our township,

On 26th Dec, 2004 Tsunami struck the unsuspecting residents of our coastline and caused large damage and suffering, loss of precious lives and trauma to many of our colleagues and family members. Nature has, in a sudden and cruel blow, wrecked many families at Kalpakkam and disturbed the tranquility and serenity of life in our township. We are deeply grieved to note that the Tsunami has snatched away the lives of 37 residents, of whom 4 were employees of the DAE units and the rest the kith and kin of our employees. Besides, the neighbouring villages have also suffered heavy damage, loss of lives, property and trauma.

I am deeply pained to read the names of the employees and other residents of the DAE township who succumbed to Tsunami:

S.NO.	NAME	DETAILS
1.	SELVAN AASHI	S/O. SHRI R.J.SINGH, CISF
2.	MRS. ALLIRANI	W/O. SHRI T.JAYARAMAN, IGCAR
3.	SELVI J. ANIKA	D/O SHRI U.K. JAYARAMAN, MAPS
4.	MRS.ANNAPURNI	MOTHER-IN-LAW OF SHRI M.KASINATHAN, MAPS
5.	SELVAN ARIVALAGAN	S/O SHRI K. RATINAM, MAPS
6.	SHRI S. ASHOK KUMAR	SO/G, IGCAR
7.	SHRI DEENA DAYALAN	CO-OP. STORES
8.	MRS.DHARANI	W/O. SHRI K.KRISHNAKUMAR, GSO
9.	SELVAN GANESH	VISITING- SHRI K. RATINAM, MAPS
10.	MRS. JAYANTHI	W/O. SHRI V. GUNASEKARAN, IGCAR
11.	SELVI KAMALAMBIKA	D/O. SHRI S. VENKATACHALA-PATHY, KARP
12.	MRS. KANTHARUPI	W/O. SHRI R. DORAIRAJ, GSO
13.	SELVI R. KEERTHIKA	D/O. SHRI S. RAJENDRAN, IGCAR
14.	MRS. KRISHNA SINHA	W/O. SHRI N.K.SINHA, IGCAR
15.	MRS. LALITHA	MOTHER OF . SHRI K. KRISHNA KUMAR, GSO
16.	SELVI MALLIGASWARI	D/O. SHRI E. BOOPALAN, MAPS
17.	SHRI S. M. MANOHAR	SO/E, MAPS
18.	MRS. MARGERET	W/O. SHRI K.A. MANICK, IGCAR
19.	SELVI MONIKA	D/O. SHRI K.H.MAHENDRAN, IGCAR
20.	MRS. MYTHILI ASHOKUMAR	W/O. SHRI S. ASHOK KUMAR, IGCAR
21.	MRS.MYTHILI	W/O. SHRI J. NITHIANANDAN, MAPS
22.	SHRI P. NATARAJAN	FM/B, MAPS

23.	SELVI NICHIE RICHEL	D/O SHRI R.PAUL SURENDRANATH, IGCAR
24.	SELVAN NILAVALAGAN	S/O. SHRI T. CHANDRAN, IGCAR
25.	SELVI PADMAVATHI	D/O. SHRI P. RAJASUNDARAM, IGCAR
26.	MRS. PREMA MARIE	W/O. SHRI SAHAYARAJ, MAPS
27.	MRS. RAJESWARI	W/O. SHRI K.H.MAHENDRAN, IGCAR
28.	MRS. RANI	VISITING- SHRI T. SELVARAJ, IGCAR
29.	SELVI SAROJA DEVI	D/O. SHRI RAMESH, GURKHA
30.	SHRI A. SELVARAJ	SO/H, IGCAR
31.	SELVI SHARMILA	D/O. SHRI V. GUNASEKARAN, IGCAR
32.	SELVAN SHYAM ARAVIND	S/O. SHRI K. H.MAHENDRAN, IGCAR
33.	MRS. K. SIVAGAMI	W/O. SHRI M. KARUNANIDHI, IGCAR
34.	SELVI SRISTI	D/O SHRI R.J.SINGH, CISF
35.	MRS. UDAIKUMARI	VISITING- SHRI J. NITHIANANDAN, MAPS
36.	MRS, VARALAKSHMI	VISITING- SHRI R. RAMESH, IGCAR
37.	SELVAN N. VIJAYARAGHAVAN	SHRI S.L. NARASIMHAN, CISF

Besides the above, we also note with sadness that we are yet to trace our colleague Shri P. Babu of IGCAR.

In this hour of grief, our heart goes out to all the bereaved families. We share with them their profound sorrow and agony. The loss suffered by them can never be compensated. The contributions made by the colleagues who are no more, will be forever remembered. We pray for the departed souls to rest in peace and pray to the Almighty to give strength to the bereaved families to bear the irreparable loss; we resolve to use all the resources at our disposal to provide solace, help and support to bring back normalcy to their lives.

Dear friends, a number of our employees and their family members have also suffered heavy loss of personal property. More than this loss, however, the traumatic experience undergone by the residents who have narrowly escaped from the jaws of death has shaken every one of them to the core. We resolve to learn from this traumatic experience and take necessary steps to ensure adequate protection from natural calamities. We all feel the agony and suffering undergone by the residents of the surrounding villages, and resolve to extend a total support hand to them in this hour of need.

In this hour of grief, Honorable Prime Minister Dr. Manmohan Singh, Chairman, Atomic Energy Commission, Dr. Anil Kakodkar, Principal Scientific Advisor, Dr. R. Chidambaram, Members of Atomic Energy Commission, Prof. C.N.R. Rao and Prof. .P. Rama Rao, Director, BARC, Dr. S. Banerjee, Chairman and Managing Director of NPCIL and Bhavini, Shri S.K. Jain, Director, Institute of Mathematical Sciences, Prof. R. Balasubaramanian, Former Directors of IGCAR, Prof. C.V. Sundaram and Dr. P. Rodriguez and all other heads of DAE Units both present and retired and many friends and well wishers both from India and aboard have come forward to express solidarity with us to tide over the crisis.

The best homage we can pay to the departed souls is to rededicate ourselves to the service of mankind. This is the time for all of us to demonstrate our resilience and resolve to work for the betterment of our community by redoubling efforts in all our endeavors.

As a mark of our remembrance of the departed souls, a memorial would be erected in the township.

(Baldev Raj)
Chairman, Crisis Management Committee (CMC),
Kalpakkam Management Committee (KMC)

CONDOLENCE RESOLUTION

We, record with a profound sense of sorrow the loss of precious lives of our colleagues and members of the fellow residents of the township and its neighborhood in the wake of the unprecedented Tsunami that struck our coast on 26th December 2004. We express our sincere and heart felt condolences to the bereaved families. May God Almighty provide strength and fortitude to the bereaved families to bear the sudden loss of lives of the near and dear ones.

We pray for the departed souls to rest in peace.

New Year Message

My dear Brothers and Sisters,

I feel privileged to wish you and your family a healthy, happy, blissful and successful New Year 2005. I also extend my warm greetings for the Pongal. We all look forward to New Year with lot of hopes and dreams. We do realise that our achievements for the next year significantly depend on our aspirations, actions, commitments and the foundation that we have built to-date. Before we embark on our collective dreams for the next year, it may be a good starting point to take a look at our achievements during the year 2004.

"...Dream, dream and dream. Then translate your dreams into thoughts and then into action..."

– Dr. A. P. J. Abdul Kalam

It is really creditable that the commemorative function for the Golden jubilee year of DAE was conducted at Kalpakkam campus. It is matter of great pride for us that this function took place in the august presence of Dr. Manmohan Singh, the Honourable Prime Minister along with other dignitaries on October 23, 2004. A significant event viz., the launching of the commercial phase of fast reactors programme has been signalled by the Prime Minister, which will stay as one of the historical milestones of DAE. On this occasion, a *Minar*, a stone carved pillar, was inaugurated by him near Homi Bhabha building. In his address, he appreciated the role of the Department for achieving many milestones in the last 50 years and wished that with collective efforts and commitment, we can achieve many more milestones in the future. I am extremely happy that this commemorative function was done to a good measure of excellence due to the sincere efforts and co-operation by all of you.

During the last year, the Centre has achieved significant results in operating FBTR, reprocessing, design and engineering developments, materials, safety, physics, chemistry, instrumentation and control, engineering services and administration etc. With respect to FBTR, the flagship of our centre, we have carried out refurbishment of the intricate components, so as to improve the availability and reliability factors. This would help to achieve higher burn-ups in the next year as compared to the present burn-up of 134 and 38 GWd/t for Mark-1 and PFBR test sub-assemblies, respectively. The latter will certainly shed important light on oxide fuel characteristics, which is crucial for PFBR performance. Post-irradiation examination (PIE) of carbide fuel pins with burn-up of 100 GWd/t has been completed, which validates the fuel performance. It is heartening to know that KAMINI reactor has been used for neutron radiography of 50 and 100 GWd/t fuel pins. The PIE results are extremely useful for obtaining further clearances in attaining higher burn-ups.

It is also noteworthy that the manufacturing drawings for all the major reactor assembly components of 500 MWe FBR project (PFBR) were released after thorough screening and based on the feedback and interactions with various manufacturers. With respect to reprocessing, based on the current campaign for reprocessing of 25 GWd/t carbide fuel in LMC, valuable experiences in chopping, dissolution and solvent extraction were acquired. It is gratifying to note that the recovery and purity of the products were as per the design intent. This experience will help in the design of demonstration fuel reprocessing plant (DFRP). In parallel, efforts are underway to study the fuel dissolution and separation techniques for MOX fuel. Based on the successful efforts in producing lab scale pure elemental boron production, the technology for large scale production has been transferred to Heavy Water Board. It is also noteworthy that rapid strides have been made in developing reliable cover gas and electrochemical hydrogen meters, which are undergoing extensive field tests.

Transfer Arm and Control & Safety Rod Drive Mechanism (CSRDM), which are critical components of PFBR, have undergone extensive air tests and have established reliability and reproducibility. During the year 2005, extensive sodium tests would be carried out. This really adds to our confidence for having designed and tested these critical components and is also a matter of pride that a mature industrial competence has been established within the country for the fabrication of these large components. Important studies pertaining to simulation and validation of core-catcher, sodium leak collection tray, shield designs for PFBR have also been carried out.

On structural and reprocessing materials front, rapid strides have been made in evaluating mechanical, metallurgical and corrosion properties. So as to improve the fuel burn-up as limited by the clad and wrapper materials, important modifications of the existing D9 steel to produce more durable D9I material has been made and already a few heats of this materials has been produced. In this regard, it is a great satisfaction that we have also set up an accelerator-based heavy ion simulation of neutron damage facility, which has provided valuable information on the void-swelling behaviour of D9 material and this facility should be very useful for materials screening. Most of the developmental activities in the area of NDE for in-service inspection of PFBR components have been completed. Many critical and safety related electronics and instrumentation for PFBR were also developed. On the basic science front, state of art laser heated diamond anvil cell, capable of synthesising novel materials under extreme temperatures and pressures, has been set up. On the infrastructural front, we have set up a state-of-art Video Conference facility for liaison with various industries and other DAE units. We are also trying to migrate from conventional library platform to digital era and knowledge-based domains.

One of the most significant events in Golden jubilee year of the Department has been the intense brain-simulating sessions, during March to June 2004, in the form of "Vision Exercise", initiated by our Chairman Dr. Anil Kakodkar. This has been a novel, decisive and collective means of planning for the future of the Department by inviting the Young scientists & engineers of the Department (under 45 yrs) to come up with proposals of research in science, engineering and technology. It is really satisfying that there was a large participation of engineers and scientists from IGCAR in this important exercise. Young colleagues, Mentors and Chief-Mentors from our Centre in diverse fields such as Energy, Fuel cycle, Physical & Chemical Sciences, Materials Science, Electronics, Computers, NDT, Robotics and Sensors etc., took active part in this vision exercise and contributed to formulation of the *Vision Document* of the DAE.

It is also worth mentioning that two important internal and external review exercises were carried out at our Centre at the suggestion of our Chairman Dr. Anil Kakodkar, namely (a) the mentoring of Young Officers and (b) the peer review of basic sciences. The former, being an introspection exercise, has given rise to valuable suggestions for improving our working atmosphere to make it more congenial, enjoyable and rewarding for our young officers (joined after 2001). We are taking necessary steps to implement the Mentors' committee's recommendations. The peer review, being an external review of our basic sciences, has been carried out by a panel of eminent academicians and scientists. They have gone through

A few decades back, I had dreamt of global leadership in non-destructive technology for our talented team at IGCAR. We have now achieved this dream. Today, I am dreaming of global leadership in FBR and associated fuel cycle technology for IGCAR by 2020. I want all of you to be the partners in this dream to provide energy security to the nation with global leadership.

detailed technical documents, listened to in-depth presentations and visited important laboratories. They have submitted a report suggesting valuable recommendations for making our basic science research more vibrant, relevant and achieving higher impact. We are also taking steps to carry out similar peer review of our chemical and engineering sciences.

General Services Organisation has achieved significant milestones and I see a paradigm shift in their approach to services. With respect to the township, we are taking steps to build more houses in Anupuram township in various categories at an accelerated fashion. In due course of time, we should be able to provide eligible accommodation to most of our officers and staff, within Kalpakkam and Anupuram townships. Important steps are being taken to improve the hospital and health care facilities. Sincere efforts are being implemented for providing holistic and value-based education to our sons and daughters through enhanced commitment of our Principals and Teachers, working in Kalpakkam and Anupuram Schools.

Our future achievements depend on our current technical strengths, abilities and management system. We should enhance our level of technological development with judicious combination of relevant basic science with excellent engineering research. I am putting my best efforts in this direction. We must forge team-work and collaborations within & outside our Centre and interact with various prominent academic institutions, research centres and industrial organisations.

The goals ahead are clear – timely and necessary inputs to FBR 500 MWe project, robust reprocessing technology, enhancing R&D for realising reliable, safe and economical FBRs and fuel cycle. We must remain at the forefront of basic Sciences. FBR technology must become a truly national mission. We must pursue all this with total commitment to ethics, perfection as well as due concern and feeling for our fellow colleagues at all levels. I am convinced that this Centre can achieve better results and can become a bench mark organisation not only in the country but internationally. A few decades back, I had dreamt of global leadership in non-destructive technology for our talented team at IGCAR. We have now achieved this dream. Today, I am dreaming of global leadership in FBR and associated fuel cycle technology for IGCAR by 2020. I want all of you to be the partners in this dream to provide energy security to the nation with global leadership. We have unique opportunity at this juncture and we must exploit this opportunity to rise to the occasion and fulfil the national needs and aspirations.

A stimulating working environment for the employees with a model township, providing comfortable housing, a quality heath care and value-based education for our children is what we should strive to achieve to make our Centre a healthy, committed and model organisation.

A stimulating working environment for the employees with a model township, providing comfortable housing, a quality heath care and value-based education for our children is what we should strive to achieve to make our Centre a healthy, committed and model organisation. It is appropriate to recall a quotation of our Honourable President Dr. A.P.J. Abdul Kalam *"Dream, dream and dream. Then translate your dreams into thoughts and then into action…"*. I am confident that with dedication, sincere efforts and hard work, we can take our Centre and General Services Organisation to greater heights. By working together with firm commitment to excellence with relevance, we can realise the dreams of our founding fathers, Homi Bhabha and Vikram Sarabhai.

With warm and sincere regards,

Baldev Raj
DIRECTOR

Highlights of a function to commemorate the Golden Jubilee of the Department of Atomic Energy

A function to commemorate the Golden Jubilee of the Department of Atomic Energy and the launching of the commercial phase of India's Fast Breeder Programme was held at the Sarabhai auditorium, IGCAR, Kalpakkam on saturday, October 23, 2004 in the august presence of the Honourable Prime Minister of India Dr. Manmohan Singh. A galaxy of dignitaries namely the Honourable Minister of Communications & Information Technology, Shri Dayanidhi Maran, the Honourable Minister of State in the Prime Minister's Office, Shri Prithviraj Chavan, National Security Advisor, Shri J.N. Dixit, Special Advisor to Prime Minister, Shri M. K. Narayan and Shri. A.K. Moorthy, Member of Parliament, were present for this landmark event. Former chairmen of DAE, distinguished members of Atomic Energy Commission, heads of various DAE units, invitees from academic institutes and industries, members of the press attended this memorable function.

Dr. Anil Kakodkar, Chairman, AEC and Secretary, DAE welcomed the distinguished guests and outlined the philosophy of the three stage power programme of DAE and commitment of the Department to meet the energy security of the nation. The Honourable Prime Minister Dr. Manmohan Singh, during his address, recalled the contributions made by Dr. Bhabha and the subsequent leaders of DAE, which have set DAE on a path of excellence and social relevance, in spite of the challenges faced due to export control regimes. He emphasised that India is a responsible nuclear power and would deploy atomic energy for the benefit of the mankind. He expressed confidence that nuclear power would grow at an adequate pace to meet the energy requirements of the country. (Please see the full text of PM's address). He also unveiled a Minar, a stone pillar sculpted by the artisans of Mahabalipuram, depicting the strong research and technological base of DAE, built over the last 50 years, and its potential for growth and prosperity of the nation. This minar signifies the launching of the commercial phase of FBRs.

A Minar, a stone pillar sculpted by the artisans of Mahabalipuram, depicting the strong research and technological base of DAE, built over the last 50 years, and its potential for growth and prosperity of the nation. This minar signifies the launching of the commercial phase of FBRs.

On this occasion, the Prime Minister released the book *Department of Atomic Energy : Our Collective Vision*, a compilation of the vision proposals by various young scientists and engineers of DAE, and a document, *A Strategy for Growth of Electrical Energy in India*, a perspective on various energy options for India, and the important role of nuclear energy for providing the energy security for our country. A Hindi book entitled *Bharat ka Atmanirbhar Nabhakiya Karyakra* and *The Beginning ..... Milestones of Atomic Energy in India*, were released by Shri Prithviraj Chavan and Shri J.N. Dixit, as a part of the Golden Jubilee celebrations. Shri S. K. Jain, Chairman and Managing Director, NPCIL and BHAVINI, Dr. S.Banerjee, Director, BARC, and Dr. Baldev Raj, Director IGCAR, spoke during this landmark event.

Prior to the commemorative function, the Prime Minister visited the project site of the FBR 500 MWe reactor, and initiated the concrete pouring to mark the beginning of construction activities. The Prime minister and his entourage also visited important DAE facilities at Kalpakkam viz., Nuclear Desalination Demonstration Plant (NDDP), Madras Atomic Power Station (MAPS) and the Fast Breeder Test Reactor (FBTR).

Honourable Prime Minister Dr. Manmohan Singh delivering the speech. Seen in the photo are Member of Parliament, Shri A. K. Moorty, Special Advisor, Shri M. K. Narayan, Honourable Minister of State, Shri Prithvi Raj Chavan, Chairman & Managing Director of NPCIL, Shri S. K. Jain, Honourable Minister of Communications & Information Technology, Shri Dayanidhi Maran.

The Prime Minister releasing a document on *"A Strategy for Growth of Electrical Energy in India "*. Seen in the photo are Shri Prithvi Raj Chavan and Dr. Baldev Raj, Director, IGCAR.

Dr. Anil Kakodkar, Chairman, AEC & Secretary, DAE presenting a memento to the Prime Minister. Seen in the photo are Shri S. K. Jain and Shri Dayanidhi Maran

PM's address at the Golden Jubilee function of the Department of Atomic Energy, October 23, 2004

Chairman of the Atomic Energy Commission, Dr. Kakodkar, Director of IGCAR and other dignitaries and Friends,

It is a pleasure to be present on this historic occasion which marks the Golden Jubilee of the Department of Atomic Energy and coinciding with the commencement of Fast Breeder Technology (FB Tech).

Our nuclear programme takes a major step forward today with launching of the commercial phase of the fast breeder programme. This is an occasion to celebrate and also to reflect on our past achievements and also to look to the future with hope, courage and confidence. The progress during past 50 years have made us proud.

Under Jawaharlal Nehru's wise leadership, India was among the first group of countries to recognize the vast potential of unlocking the powers of the atom. The Department of Atomic Energy was established in August 1954. Even prior to that, as early as 1948, steps were already afoot to develop our country's capabilities in harnessing the tremendous potential of atomic energy for peaceful purposes.

In the last 50 years, we have crossed several milestones in this arduous journey. This has been a tireless quest for scientific and technological excellence some of which I would like to recall. APSARA, set up in Trombay was the first research reactor in Asia. Trombay was also the site where the first lot of fuel elements for CIRUS was fabricated. It was as early as in 1965 that the plutonium plant stated functioning. In 1974, the country conducted a peaceful nuclear explosion. In the mid-1980s, steps were taken to diversify our nuclear programme further. Some of these programmes have come to fruition today.

Our nation owes a debt of gratitude to the founders of our nuclear programme. Dr. Homi Bhabha, the father of India's atomic energy programme, was a great visionary. He laid the foundations of this national treasure of self-reliant development, nurturing a whole generation of outstanding scientists and engineers. As a former Member of the Atomic Energy Commission, I remember working with Dr. Homi Sethna and Dr. Raja Ramanna who played an outstanding role in the growth and development of our atomic energy programme. I also recall with gratitude and pride the excellent contributions made by Dr. Iyengar, Dr. Srinivasan, Dr. Chidambaram and now, Dr. Kakodkar. It is therefore sad that Dr. Ramanna is not with us at this juncture when we are celebrating the Golden Jubilee of the Department of Atomic Energy. I would also like to recognize the contributions of all the scientists and employees of the Department who have contributed so magnificently to the nation's achievements in this field of national endeavour.

The activities of the Department of Atomic Energy range from fundamental scientific research to developmental applications of use to the common man – in the fields of health, industry, food preservation and water desalination projects. It is

a matter of deep satisfaction that our scientists have mastered practically all the aspects related to the release of nuclear energy. This has contributed to our nation's security and well being in a fundamental sense.

Energy Security is an issue of vital importance, particularly in the context of the accelerating pace of our economic growth. If we succeed in instituting an optimal mix of energy resources in which nuclear energy is an important component, we will be able to ensure our energy security. India's low per capital energy consumption currently cannot for long go hand in hand with our quest for an accelerated pace of economic growth. Energy Security is therefore a national imperative. We must break the constraining limits of power shortages, which retard our development. Nuclear energy is not only cost effective, it is also a cleaner alternative to fossil fuels. We are determined as a nation to utilize its full potential for the national good. It can also be a much needed cushion against fluctuations of prices of petroleum products. Nuclear power today accounts for only two per cent of our overall installed capacity. We have now embarked on a major programme to generate 20,000 megawatts of nuclear power by the year 2020. By 2008, we hope to add 4000 megawatts including the two 1000-megawatt nuclear reactors coming up at Kudankutam in collaboration with the Russian Federation. It is a matter of national pride that India has development comprehensive capabilities in the entire gamut of fuel cycle operations. India is also among the select group of countries which have the ability to recover plutonium from irradiated nuclear fuel and use it to produce power in thermal as well as in fast reactors. This path will ensure for us a large quantum of nuclear power on a sustainable basis. Ladies and gentlemen, India is uniquely placed to utilize technologies required for launching the third stage of our nuclear power programme based on the utilization of thorium. The technology roadmap prepared by the Department of Atomic Energy for this purpose will receive our Government's fullest support. Fast breeder reactor technology is of crucial importance in enhancing our nuclear power capacity. By launching its commercial applications, we are indeed entering a new and more advanced stage of nuclear energy production, a technology mastered only by a very small group of countries. The Department of Atomic Energy has been able to consolidate and strengthen our indigenous capabilities in the face of externally imposed limitations and constraints. These have, however, spurred us to greater levels of achievement. The founding principles of 'Atomic for Peace" were subverted by restrictions derived from an ineffective non-proliferation region. Despite these limitations, our scientists to their great credit have excelled time and again in demonstrating our indigenous capabilities measuring to the highest standards in the global nuclear industry. India is a responsible nuclear power. We are fully conscious of the immense responsibilities that come with the possession of advanced technologies, both civilian and strategic. While we are determined to utilize our indigenous resources and capabilities to fulfill our national interests, we are doing so in a manner that is not contrary to the larger goals of nuclear nonproliferation. India will not be the source of proliferation of sensitive technologies. We will also ensure the safeguarding of those technologies that we already possess. We will remain faithful to this approach, as we have been for the last several decades. We have done so despite the well-known glaring examples of proliferation which have directly affected our security interests. The limitations of the present non-proliferation regime should not be further accentuated by artificial restrictions on genuine peaceful nuclear applications. Technology denial and closing avenues for international cooperation in such an important field is tantamount to the denial of developmental benefits to millions of people, whose lives can be transformed by the utilization of nuclear energy and relevant technologies. We call upon other advanced nuclear powers, and all those who have a stake in the future of nuclear energy, to come together for a constructive dialogue to evolve more effective measures that would stem the tide of proliferation without unduly constraining the peaceful uses of nuclear energy. Constraining those who are responsible amounts, in effect, to rewarding those who are irresponsible. The international community must face up to the implications of this choice. We in India are willing to shoulder our share of international obligations provided our legitimate interests are met. India has actively embraced globalisation. There is no reason why nuclear energy production should be an exception. These functions of the Department of Atomic Energy are closely intertwined with our nation's needs and aspirations. It is important to ensure that the nation's best scientific talent enters our research institutions, and that we develop an environment in which excellence is recognized, nurtured and rewarded. The nation expects that the Department of Atomic Energy, as one such center of excellence, will continue to be at the cutting edge of scientific pursuit, national dedication and social commitment. The nation is proud of your achievements and is grateful for your contribution. However, we have a long and arduous journey ahead of us and many milestones to cross. It is my sincere hope that the Department will live up to our expectations. In this task, the Department can count on the sustained support of our government and the people of our country.

Jai Hind.

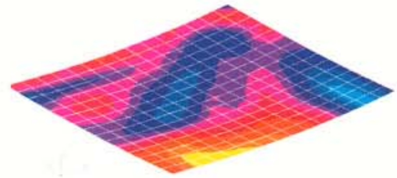
REMARKS

We are living in a world where science and technology have become the major determinant of power and wealth of a nation. The Department of Atomic Energy has served our nation with great distinction. The development of fast breeder technology and its commercialisation are giant step forward in our nation's quest for self sustained development. My heartiest congratulations and best wishes to all those associated with the Deptt of Atomic Energy and its various allied organisations

Manmohan Singh
23.10.2004

Remarks of the Honorable Prime Minister Dr. Manmohan Singh in the visitor's book, after his visit to Fast Breeder Test Reactor (FBTR) complex.

Optimization of Die Profile and Assembly Sequence of Petals for PFBR Main Vessel



The fabrication of main vessel, safety vessel, inner vessel and transition pieces of 500 MWe pool type Fast Breeder Reactor (PFBR) involves pressing of petals and assembling and welding of these petals to form the final shape. These petals need to be fabricated with stringent dimensional tolerances in order to fabricate the vessels within the desired level of tolerance. Springback is a major factor controlling the dimensional accuracy of the petals for the fabrication of large vessels of PFBR. The correction operations to meet the required dimensions are tedious and induce some amount of cold work in localized areas. This would result in non-uniformity in the cold work level in the component which may locally exceed maximum permissible limit of 6%. Hence, the correction should be as minimal as possible to avoid any inhomogenities in the cold work levels in the components. This can be achieved by manufacturing the petals in a single pressing or using a process that involves pressing the petals to near net-shape in one set of dies and finish pressing in another die. For near-net shape forming, proper design of the dies and punches, mounting fixtures and press guides are crucial.

Springback occurs due to recovery of the elastic strains after removal of the bending punch at the end of the bending operation and the dies need to be designed for corrections for the springback. For sheet metal forming, the use of Finite Element Method (FEM) to design the profile of dies has proved to be useful, economical and flexible. With available commercial FEM packages, the forming process can be simulated and the parametric studies can be carried out in computer, with a limited number of experiments under industrial conditions to further tuning the model. However, similar attempts for forming of thicker plates have not been reported in open literature. Therefore an FEM based process model for plate forming operation was developed and experimentally validated to predict the springback after forming as well as to design the dies and punches for forming petals of PFBR vessels. The experimental data of selected configurations are needed to both validate and fine-tune the FEM models. A large amount of experimental work has been reported in the literature on springback in thin sheets (up to 3 mm thickness). However, data on springback in profile bending of thicker plates (of the order of thickness of plates used in PFBR design) are not available in open literature. Keeping this in view, an experimental program was drawn up for experimental evaluation of springback in thick plates and also to both validate and fine-tune the FEM models for plate forming processes.

To begin with, plane-strain finite element analyses (FEA) were carried out on single curvature profile bending of 316L(N) stainless steel to analyze various possible FEM solution schemes, viz. implicit FEM for both bending and unloading phases, sequential explicit FEM for bending and implicit FEM for unloading and fully explicit FEM for both bending and unloading. This 2-D model also helped in assessing the effects of various parameters (viz. friction, plate thickness, material properties, stiffness of die and punch). Banking on the numerical experience from the two-dimensional FEM modeling the plate forming process was simulated sequentially using a dynamic explicit formulation with contact modeling for the pressing phase and a static implicit approach for springback calculation in the Lagrangian framework. This approach was found to be very efficient both with respect to computational time and accuracy. The plate forming process includes both membrane and bending effects in the workpiece and so a shell formulation was used to account for both these effects. The dynamic explicit FEM is a conditionally stable scheme with stable time increments of the order of 10^{-7}s for 316L(N) stainless steel and so use of reduced integration elements would be economical without losing accuracy of solution. The plate-forming process was simulated in one step with by applying a constant velocity of the punch throughout the step. This is the characteristic of the hydraulic press used in the plate forming trials. The results from the explicit analysis were imported into an implicit FEM code and a static analysis was performed to determine the springback that occurs after release of the punch and the residual stress state in the plate after springback. The nonlinear geometry option was used to tackle the springback, which may be occasionally quite large. During the static analysis, an artificial stress state that equilibrates the imported stress state is automatically applied by the implicit FEM code and gradually removed during the step. The displacement obtained at the end of the step is the springback and the stresses and strains give the residual stress-strain state in the material after springback.

The experimental programme was carefully planned with thirteen sets of dies so that it completely covers

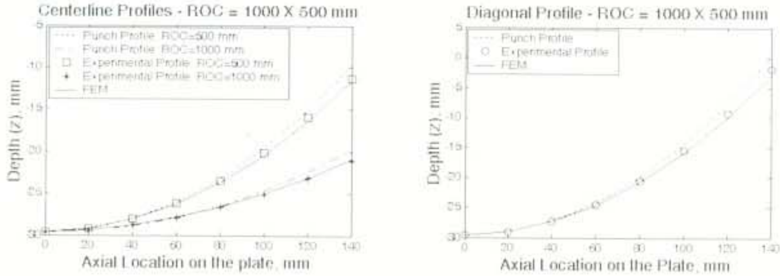


Fig. 1: Centerline and Diagonal profiles of the plate

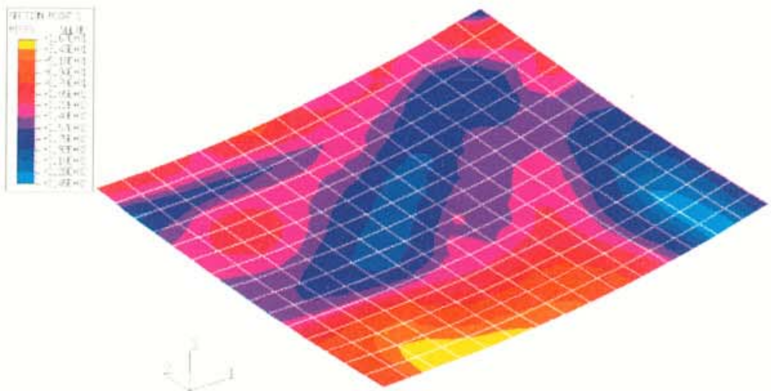


Fig. 2. FE meshes before and after springback – Radius of Curvature: 1000 & 500 mm

all possible combinations of R/t and the ratio of the deflection to the projected length (y/L) in a plane that are envisaged in the vessels of PFBR. The profiles of the pressed plates were measured using the ZEISS Universal Measuring Machine (UMM 550) at the Central Workshop, IGCAR. UMM 550 is a computer numerically controlled coordinate measuring machine with a measuring accuracy of 0.2 mm. The sectional profiles of the top surface of the pressed plates were extracted from the tabulated coordinate data as well as from the FEM results. Figure 1 shows centerline and diagonal sectional profiles from both experimental and FEM results superimposed on the desired (punch) surface profile. Figure 2 shows the plate configurations before and after springback. From Fig. 1 it is evident that the FEM simulations of the plate forming trials compare well with the experiments, the differences between the simulated and the experimental profiles of the plates being within 6-10%. The deviation of the simulated profiles from experimental ones is more towards the edge of the plate than that at the centerline.

The radii of curvature values give a quantitative estimate of the amount of springback in the plate after removal of the punch. A MATLAB routine was developed for least square fitting of general circle equation through the sectional depth profiles of the pressed plate to determine the radii of curvature at individual cross-sections of the pressed plates. It was found that springback increases towards the central sections of the plate. Near the edges of the plate the two curvatures influence each other and so constraints for opening up of the plate is more and hence springback is less. This constraint effect reduces towards the centre of the plate and hence springback increases. Moreover, for a work hardening material like 316L(N) stainless steel springback increases with increase in the strain level. From the FEM results it was found that the strain increase towards the plate center and so springback also increases towards center of the plate. From the FEM results it was found that the equivalent plastic strain is maximum at the center due to maximum deformation occurring in the centre during forming. The equivalent plastic strain contour depicts the distribution of the amount of cold work imparted to the plate due to forming. The differential distribution of strains that occurs during plate forming leads to differential springback in the plate and this in turn leads to a product shape different from the die and punch shapes. So the springback correction on the dies and punches has to be imparted to obtain the desired product shape. An FEM based process model has been developed and experimentally validated for prediction of springback during forming of thick plates. This model can be applied to design of dies and punches for forming the petals of PFBR vessels like main, safety and inner vessels, dished end of sodium tanks etc. This model predicts the final shape of the product for a given die, punch and plate configuration and this information can be used to correct the die and punch shapes for springback to manufacture the petals to the desired accuracy.

(Reported by Utpal Borah, P. V. Sivaprasad and S. Venugopal, Materials & Metallurgy Group)

Laser welding of rupture disc to steam generator tube for study of sodium-water reaction

A leak simulator is used in a sodium-water reaction test facility of Sodium Technology Division, IGCAR to inject steam at high pressure into sodium. The leak simulator consists of a small length of the steam generator tube (9Cr – 1Mo tube, 17.2 mm OD and 3 mm WT), which has a pinhole, or a crack, which is covered by a small rupture disc. During normal operation of the test facility, the rupture disc will separate the sodium and watersides of the circuit. The rupture disc is designed to open up at a pressure of 14 MPa and allow leakage of steam into the sodium. The development of welding procedure for welding of the rupture disc to the steam generator tube was taken up by IDEAS section.

The steam generator tube is a thick walled tube having a wall thickness of 3 mm. The rupture disc is a stainless steel sheet of thickness 0.05 mm. The diameter of the disc is 8 mm. The surface of the tube is machined locally to provide a flat seat for the rupture disc. A micro hole is machined in the centre of this area to provide a communication between the inside of the tube and the outside of the tube. The rupture disc is placed, covering this hole, on this flat surface and welded to the tube. The weld is a dissimilar metal weld. The weld is autogenous and the finished weld should be sound and withstand internal pressure of 17 MPa exerted inside the tube without any leakage.

Laser welding was selected as the process to be used as a Nd:YAG laser welding system was available and this avoids problem of burnout of the rupture disc during welding, which has to be considered if TIG or other conventional torch welding process is used.

As a first step, spot welding of the stainless steel disc sample on to a plate was carried out and the welding parameters were recorded. A welding fixture was designed and made for holding the tube in position below the laser gun. The fixture is designed suitable for mounting on a computer controlled rotary table. When a spot weld is made on one edge of the disc, the opposite edge of the disc gets lifted due to shrinkage of the spot weld. To counter this, a finger clamp and slotted pressure plate were designed for mounting on the tube holding fixture. The slotted plate has four slots at 90 degree intervals and allows spot welding of two opposite edges of the disc in the same setting. One end of the tube was blocked using a threaded blank and the other end was provided with a connector suitable for connecting to a vacuum pump using a flexible hose.

The tube holding fixture was placed on the CNC rotary table and centered with respect to the laser beam. The tube was inserted in the fixture and adjusted such that the micro hole in the tube was centered with respect to the laser beam. The stainless steel disc was placed in position over the tube and the tube was evacuated. This holds the disc in place due to external pressure of atmosphere. The disc was adjusted till it is centered with respect to the laser beam. The slotted pressure plate was placed on the disc and the finger clamp was positioned over it and the disc was locked in position. Photograph of the tube and rupture disc positioned on the CNC rotary table for welding is shown in Fig.1

The laser was now focused in one of the slots adjacent to the finger clamp and a spot weld was made on the disc. The rotary table was moved through 180 degrees and a spot weld was made on the disc opposite to the earlier spot-weld. The table was again rotated backwards by 90 degrees and a spot weld was made in the third position. The finger clamp was released and repositioned on the opposite side of the fixture to enable spot welding in the last slot. The vacuum hose was disconnected and the finger clamp and slotted plate were removed from the fixture. The table was now moved in increments of 3 degrees and a series of overlapping spot welds were made to cover the entire edge, thus completing the weld.

Fig. 1 : Tube and rupture disc positioned on the CNC rotary table for welding.

Fig. 2 : View of rupture disc after bursting

The finished weld was tested using helium leak test with a sensitivity of 10E-6 std cc/sec. After successful completion of the leak test, the tube was pressurized in the sodium-water reaction test set up. The strength of the weld was demonstrated to be well above the strength of the disc. The weld was sectioned and etched to reveal the penetration of the weld. The weld penetration was about 160 micrometres. Photograph of a rupture disc after bursting at the desired pressure is shown in fig. 2.

Procedure for laser welding of rupture disc to thick walled tube was successfully developed and standardized to meet the requirements of the experiments in sodium water reaction test facility. Repeatability of the weld has been ensured by systematic efforts.

(K.A.Gopal and P.V.Kumar, IDEAS)

FORUM
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Experimental Determination of Velocity Distribution around Control Plug using 1/4 Scale Model of PFBR

Shri Indranil Banerjee (DOB-12/08/1973) obtained his B.E degree (Mechanical Engineering) from Jadavpur University in 1996. He joined IGCAR directly as Scientific Officer (SO/C) in January 2002.

A 500 MWe capacity sodium cooled pool type fast breeder reactor (PFBR) is currently under construction at Kalpakkam. One of the important component in the upper part of the core of PFBR is the control plug. The control plug houses all control rods, shroud tubes, thermocouple tubes, neutron detectors and FFLM. The outer shell of is porous. A part of the flow coming out from the core enters the control plug through the annular space between control rods and their shroud tubes. This part of flow comes out radially outward from the control plug through the porous shell and mixes with the hot pool. The remaining part of the core flow is deflected horizontally by the porous plates in the bottom of the control plug and travels along the inner vessel towards the free surface and then is deflected radialy inward.

The internal geometry of the control plug is very complex and due to this the theoretical determination of flow pattern inside the control plug and the fraction of flow entering the control plug is very difficult. The determination of velocity distribution around the control plug is important because the flow coming out of the control plug shell can influence the overall flow pattern in the hot pool. The knowledge of velocity distribution is also required because the flow streams coming out of the control plug at the elevation of sodium free surface will interact with other streams leading to formation of humps, vortices etc., which can further lead to undesirable

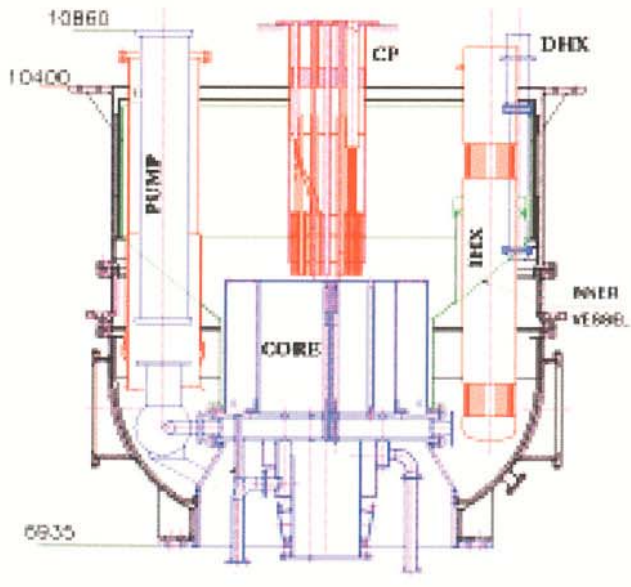


Fig. 1: Assembly view of the ¼ scale model

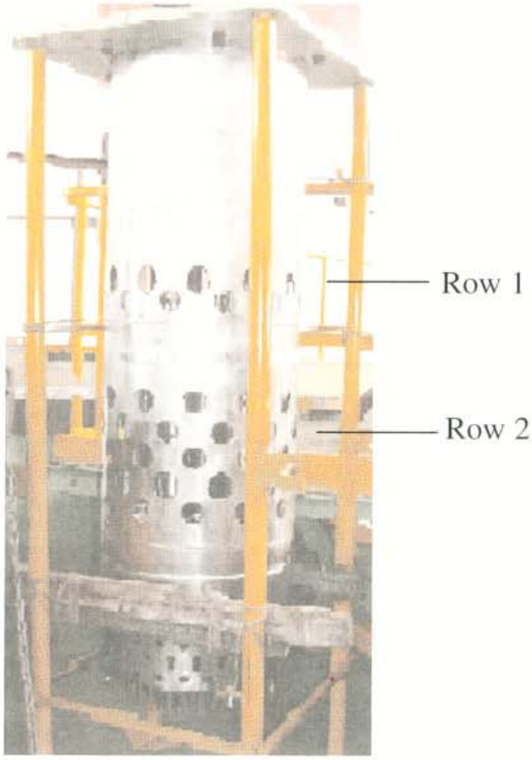


Fig. 2: Control plug model

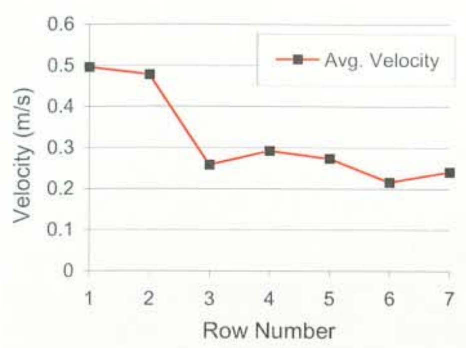


Fig. 3: Radial velocity distribution at different rows

Fig. 4: Circumferential distribution of velocity at the top row of holes

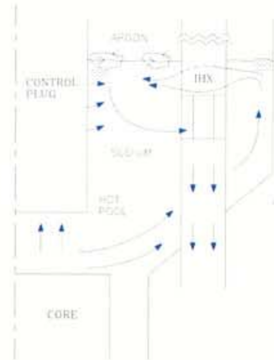


Fig. 5: Sketch showing flow pattern in hot pool

entrainment of cover gas in to the primary sodium.

The study to determine the fraction of flow entering the control plug and flow around control plug using water as working fluid was carried out on a ¼ Scale model of PFBR primary circuit, which was commissioned at Engg. Hall-II. The assembly view of ¼ scale model is presented in Fig.1. The control plug model is presented in Fig.2.

Froude (Fr) similitude (ratio of inertia force and gravity force) was respected for this experiment. This is because whenever there is a jet issuing into a pool of fluid with a free surface, the flow path of each fluid particle is predominantly influenced by the gravity force acting on it against its own inertial force. However the Reynolds number (Re) of the jets coming out from the core is found to be in highly turbulent regime thus the effect of viscous force is negligible.

Initially the model was filled with water up to the level corresponding to the free level in the reactor and flow was circulated through all core subassembly positions according to Fr similitude. The porous shell of the control plug contains 7 rows of holes each having 12 nos of holes as shown in Fig. 2. Radial velocity of flow stream, coming out from the shell is measured by using a miniature propeller type anemometer (Make: Schiltknecht, Size: 11 mm) having an accuracy of 1% FSD. The flow meter accuracy is also 1% FSD.

The model results were transposed to reactor condition by using appropriate equations derived from similarity criteria. The average centerline radial velocity is plotted for each row of holes and presented in Fig. 3. It can be observed that the average velocity is more at the top two rows (row 1 and row 2) of holes and approximately comes down to half of it at the rest of the rows (row 3-7). This is because of the internal flow pattern inside the control plug. The average velocity of streams coming out of the control plug at the free surface is 0.5 m/s. The maximum flow stream velocity coming out from the control plug is experimentally determined as 0.75 m/s.

The circumferential distribution of radial velocity at the top row, which is at the free surface, is illustrated in Fig. 4. The non uniformity in the radial velocity is due to the influence of internal geometry of control plug on the flow pattern. The flow pattern in the hot pool is illustrated in Fig. 5. From the velocity distribution the flow rate coming out from the control plug is estimated by integrating the flow rate coming out from each hole. It is found that the flow entering into the control plug is 14.3% of total core flow, which is in fair agreement with the theoretically estimated value of 10.2%. This velocity distribution forms a vital input for calculating the thermal gradients on the internal components of the control plug.

(Indranil Banerjee and colleagues, Experimental Thermal Hydraulics Section, Separation Technology & Hydraulics Division, Fast Reactor Technology Group)

Gammatography for evaluating PFBR concrete roof slab model

Gammatography is a reliable and comparatively higher sensitive NDT technique developed earlier at Radiological Safety Division (RSD) for evaluating the shielding integrity of lead poured vessels of FBTR. It differs from conventional radiometry method where a higher energy gamma source of higher activity is placed at the center of the vessel and the external wall is scanned by dose rate measuring survey units, which a limited accuracy in the low dose rate levels. Also a specification of 4% tolerance and below is impossible to detect by this method. This and many other technical difficulties have been overcome by the gammatography method in which, instead of measuring the transmitted dose rate, the transmitted virgin gamma ray flux is measured.

The transmitted intensity of virgin gamma ray flux through any material decreases in proportion to thickness. Presence of voids, poor bonding and/ or reduction in theoretical density of the shield material would increase the transmitted gamma ray flux compared to the estimated one. This principle is utilized in the gammatography technique. The schematic of the same is shown in Fig.1

The transmitted virgin gamma ray flux is measured in terms of counts for a preset time of 10 seconds using a gamma ray spectrometer (GRS). Counting the virgin gamma ray flux under the photo peak of the selected energy using Single Channel Analyser (SCA) makes this technique a more refined one than the conventional radiometry. i.e., this avoids completely the scattered gamma component, resulting in better sensitivity and accuracy. Due to the avoidance of scattered component, gamma ray attenuation equation can directly be applied in the evaluation of shield thickness of the vessel/structure.

Based on the dimensions of the vessel/structure to be tested (thickness of shield material and the source to detector distance), the source strength is arrived at. The dose rate at the detector location corresponding to I_0 is calculated and converted into counts(C_o) using the sensitivity factor viz., counts for 10s/ unit dose rate. Then the expected count rate C_1 for the actual thickness t_1 is calculated. $C_1 = C_0 e^{-\mu t_1}$ [1]

C_1 is compared with observed count rate C_2. If the thickness and density of the shield material are as per the designed ones, C_1 and C_2 should be the same. If any of the defects is present there will be an increase in the observed count rate C_2.

$$C_2 = C_0 e^{-\mu t_2} \quad [2]$$

The difference in thickness (t_1-t_2) can be calculated using the formula:

Ms. Annalakshmi (DOB-25/07/1977) obtained her M.Sc degree (Physics) from Manonmaniam Sundaranar University in 2000. She joined IGCAR directly as Scientific Officer (SO/C) in October 2001.

$$t_1 - t_2 = \frac{\ln(C_2) - \ln(C_1)}{\mu} \quad [3]$$

PFBR Roof Slab: This technique was employed to test the integrity of the concrete pouring at different depths in general and in particular to confirm whether the flow of concrete was uniform near the corners and around the interfering internal structures present. Two different models of the structure were tested. The PFBR roof slab structure is a double walled steel structure with a filling of 1.2 m thick high density concrete (3.6 g/cc)

Site model: This model was not having double steel wall arrangement and instead it was with perspex as single wall to view the concrete flow

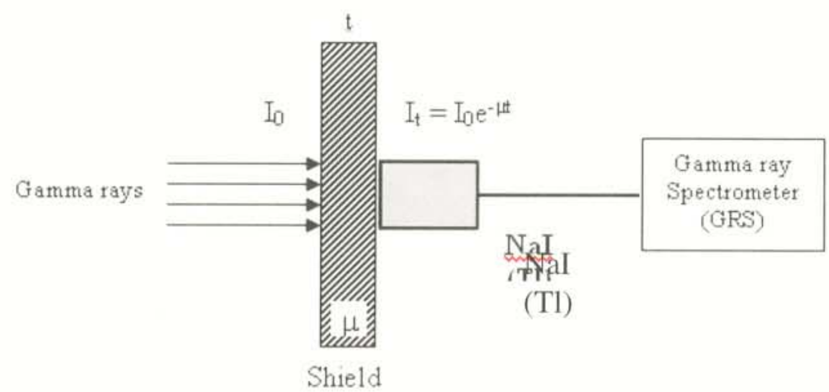


Fig. 1 Schematic of Gammatography technique

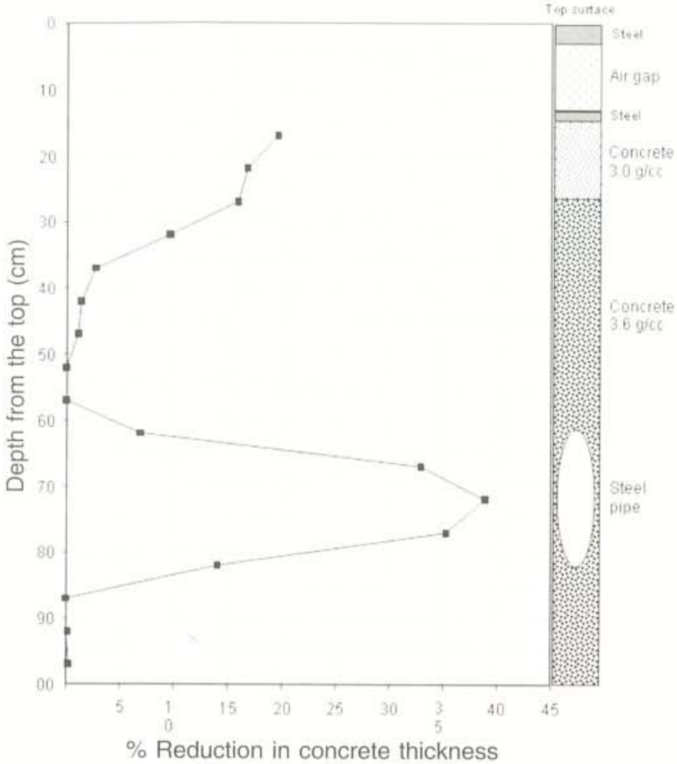


Fig. 3 : Concrete thickness reduction profile along depth at a location having a interfering structure (pipe)

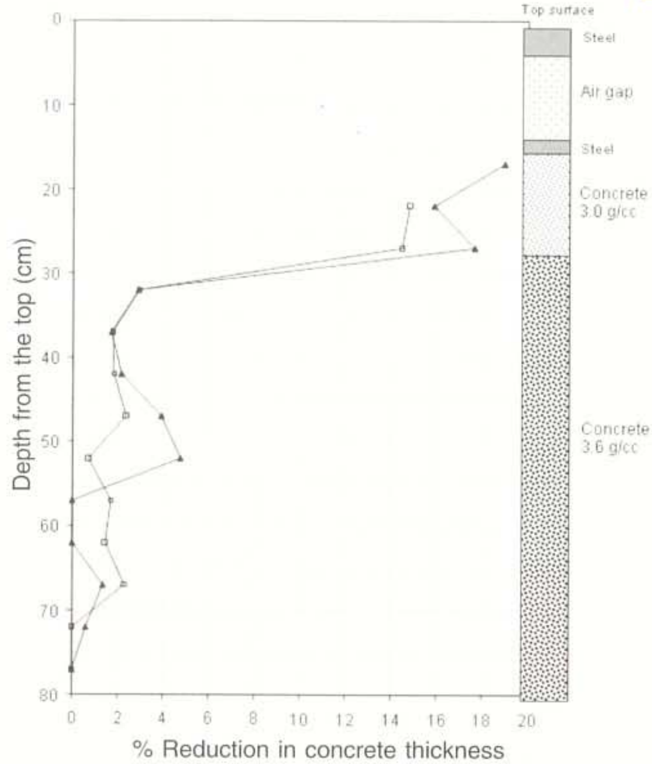


Fig. 2 : Concrete thickness reduction profile along the depth

while pouring. The interfering structures were simulated by pouring ordinary concrete in corresponding places. Gammatography testing in 'site' model showed that the concrete pouring was good at the bottom side of the roof slab, but required improvement at the side top portions of the roof slab.

Sector model: This model was having double steel walls and a modified mix design. Gammatography testing on the 'sector' model has shown that the pouring of concrete at the bottom is fully satisfactory. The profile of percentage reduction in concrete thickness in locations having no interfering structures is plotted in Fig. 2. The thickness details of walls, concrete layers are also provided schematically by the side of the graph for better interpretation. From the profile it is clearly seen that the concrete thickness variation is within 5% for the depth 30 cm to 77 cm. This ensures the uniform pouring of concrete over this depth. The sharp change in the percentage thickness reduction (14% to 19%) at the depth of 27cm is observed. This is due to the reduction of density in concrete (from 3.6 g/cc to 3 g/cc). As per design the top portion of the concrete layer (15 cm to 27 cm) is poured with concrete of lesser density 3.06 g/cc. The readings corresponding to the depths 17 cm, 22 cm and 27 cm also show variations within 5%. This indicates that the pouring is uniform in the lesser density concrete portion.

The profile of percentage reduction in concrete thickness (density and / or mass) at a location having a large interfering internal structural material (pipe) across is shown in Fig. 3. The profile clearly indicates that the concrete thickness variation is within 3% in regions where there are no interfering structures. The increased reduction observed in the grid locations between 67cm and 87 cm from the top could clearly be correlated to the presence of a 20 cm dia. Pipe. Even the wall thickness of the pipe could clearly be estimated a 6 mm from the counts obtained during the testing which exactly matches with the actual one. The flat trend of the counts obtained in and around the pipe structure indicated that the flow of concrete around the interfering pipe is excellent and devoid of voids and poor bonding.

(Ms. Annalakshmi and colleagues, Radiation Safety Section, Radiological Safety Division, Safety Group)

Report on Workshop on *Quality Circles*
August 11-12, 2004

The Steering Committee of Quality Circles in Engineering Services Group has organised a one day Workshop on "Quality Circles" at the Seminar hall of ESG Extension Building. Due to overwhelming response, the workshop had to be conducted for two days for different batches on 11th and 12th August 2004. Participants were drawn from almost all Divisions of IGCAR & GSO including Administration and Accounts. A total of 105 participants were benefited with this workshop. The participants were taught the basics and the tools and techniques to go about the problem solving including a practical session. The faculties were drawn from QCFI (Chennai Chapter), MAPS and IGCAR. These faculties were S/Shri N. Parasuraman, S. Jawahar, R.S. Ragavendran and K.I. John. A typical case study presentation was demonstrated by SAMURAI Quality Circle from Central Workshop, IGCAR. As summed up from the opinion of the participants, the workshop has been a very educative and informative.

(K. I. John, Secretary, Steering Committee, Quality Circles, ESG)

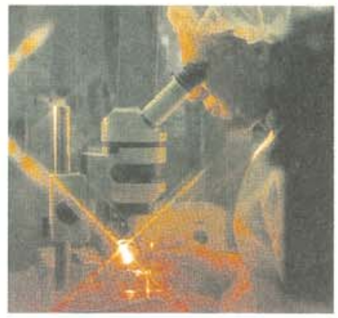
"...The emphasis throughout has been on developing know-how indigenously and on growing people, able to tackle the tasks, which lie ahead..."

- Homi J. Bhabha

"... There is a need for a constant interplay between basic sciences, technology and industrial practice if economic progress is to result from the activity undertaken. The wearing of several hats by the same person and the mobility of personnel from one type of activity to another have provided the impetus for growth in the projects of the Department of Atomic Energy... "

- Vikram Sarabhai

Awards & Honours



Congratulations

- Dr. Baldev Raj has been selected *ISNT Lifetime achievement award* for the year 2004 by Indian Society for Non-destructive Testing (ISNT), for his significant and outstanding contributions to the cause of NDE Science & Technology. He had also been awarded Raman-Chandrasekhar Interdisciplinary Award by Accoustical Foundation for Education and Charitable Trust during Annual Meeting of the Accoustical Society of India at Mysore during December 2004.

- Shri S. C. Chetal, Reactor Engineering Group has been awarded the prestigious INS Award for the year 2003 by Indian Nuclear Society (INS) for his outstanding achievements in the field of Nuclear related High Technology.

- Dr. B. P. C. Rao, Non-destructive Evaluation Division, has been awarded *National NDT Award in the R&D category* for the year 2004 by ISNT.

- Shri Shekhar Kumar, Reprocessing Group has been awarded *INS Gold Medal* for the year 2003 by INS.

- Corrosion Science & Technology Division (CSTD) had been conferred with the *prestigious NIIS Award for a National Laboratory Award* by NACE International Indian Section (NIIS) for the year 2004.

A Minar, signifying the launching of commercial phase of fast reactor programme, inaugurated by the Prime Minister Dr. Manmohan Singh on October 23, 2004 at IGCAR.

The Prime Minister Dr. Manmohan Singh accompanied by Dr. Anil Kakodkar, Chairman, AEC & Secretary, DAE visiting Fast Breeder Test Reactor (FBTR) complex.

Chairman, Editorial Committee : Dr. Baldev Raj, Advisory Member : Shri S.C. Chetal.
Members : Dr. P.R. Vasudeva Rao, Dr. K. Govinda Rajan, Shri. V.S. Krishnamachari, Shri. M. Somasekharan and Dr. G. Amarendra.
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