ISSUE NO. 278

MARCH 2007

बीएआरसी न्यूज़लैटर

BARC NEWSLETTER

IN THIS ISSUE

बीएआरसी न्यूज़लेटर
BARC NEWSLETTER

REDUCTION OF SHOCK LOAD BY DISC SPRINGS INSIDE THE SHUT - OFF ROD GUIDE TUBE OF THE AHWR 'CRITICAL FACILITY'

M.K. Mishra, D.N. Badodkar and Manjit Singh
Division of Remote Handling & Robotics (DRHR)
&
N. Dharmaraju and A. Rama Rao
Reactor Engineering Division (RED)

Introduction

The 'Critical Facility' (CF) is a research reactor being commissioned at BARC, Trombay to facilitate reactor physics experiments, related to advanced PHWRs and the Advanced Heavy Water Reactor (AHWR). Reactor shutdown system consists of six fast-acting mechanical shut-off rods (SRs). Under normal reactor operation, all the shut-off rods are parked above the reactor core. On reactor trip, all SRs fall freely into the core. During reactor start-up, shut-off rods are withdrawn, one rod at a time, in a predetermined sequence at a given withdrawal speed. This is to ensure reactivity addition rate from reactor physics design. In case of CF, on actuation of reactor trip, moderator is also dumped to a predetermined level, giving additional shut down margin.

An electromechanical cable-winch type drive mechanism, called Shut-off Rod Drive Mechanism (SRDM), is used to impart desired motion to the shut-off rods (absorber element). The design of SRDM adopts a fail-safe, replaceable and simple criterion, ensuring high reliablity in operation. The drive mechanism is custom-built to meet the technical specifications for given reactor layout. Being a safety critical equipment, SRDM design is qualified for reactor use through prototyping and life-cycle testing of the prototype on full-scale test facility.

Cadmium is used as an absorber and this is sandwiched between two Aluminium tubes. The absorber element moves inside the guide tube, which has closed bottom end in 'CF'. The absorber element is attached to the mechanism through stainless steel wire rope. Weight of the absorber element is about 8 Kgs. and the total stroke length is 2400 mm.

The absorber assembly consists of absorber element, guide tube locator, guide tube, push tube sub-assembly and disc spring sub-assembly. Fig.1 shows cross sectional drawing of the absorber assembly used in 'CF'. As can be seen, the guide tube passing through the guide tube locator, rests on the girder, which is a component of the reactor structure.

In case of a rope-snap accident, when the absorber element is parked at the TOP (an element of 8 Kgs. load falling by about 2500 mm height), the result is a huge shock load both to the guide tube and the girder. In order to reduce this shock load, a disc spring assembly is used as a shock-absorbing device, which rests at the bottom of the guide tube. This paper deals with the design of the disc spring assembly and experimental validation to ensure its effectiveness in reducing the shock load experienced by the guide tube and the girder of 'CF'.

Shock load experienced by the guide tube: calculations

The guide tube is a Class-I reactor component and is designed as per ASME Section III, Sub-section NB. Service conditions are taken as per para NCA 2142 of ASME

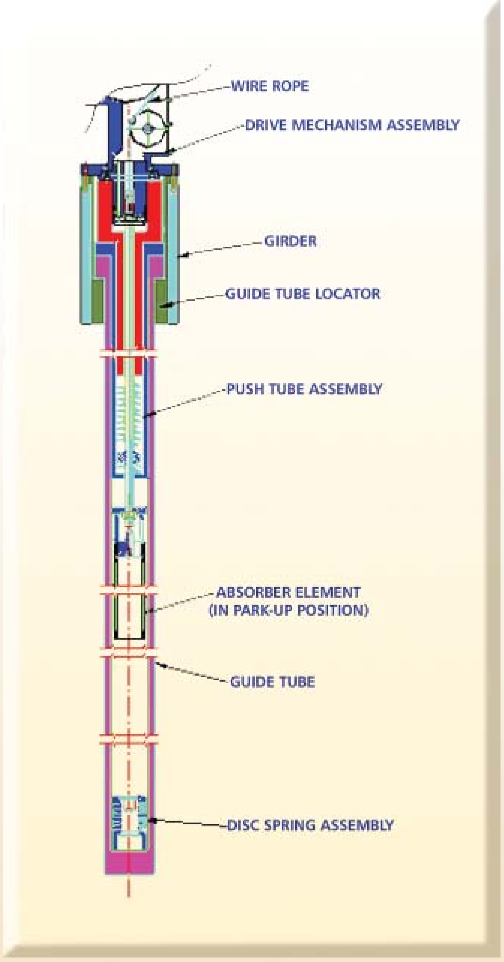


Fig. 1: Shut-off rod assembly for 'CF'

Section III, Div. I Sub-section NCA. The design accounts for level-B loading, under a postulated rope snap, from top parking position of the absorber element.

The guide tube material is Aluminium (Grade: 57S) of 78 mm ID, 110 mm OD and 5354 mm long. In case of postulated accidental event of rope snap, when the shut-off rod (about 8 Kgs) is in the top parked condition (rod fall from the height of about 2500 mm), the impact load W_i experienced by the guide tube is calculated as:

$$W_i = W\left[1 + \sqrt{1 + \frac{2.h.A.E}{W.l}}\right]$$

Where, W = Weight of falling element, h = height of fall, A = Cross-sectional area of guide tube, E = Young's modulus of elasticity of guide tube material and l = length of guide tube.

The calculated impact load on the guide tube is 15,700 Kgf. The guide tube locator and the girder of the reactor will also experience the shock load.

Design Considerations of Disc Spring Assembly

The disc spring assembly is used at the bottom of the guide tube, to reduce the impact load experienced by the guide tube and the connected parts under rope snap condition. The compact disc spring assembly is designed to fit at the bottom of the guide tube. Fig. 2 shows a photograph of the disc spring assembly.

Fig. 2: Disc springs and disc spring assembly

A disc spring type of assembly was chosen for this purpose, because of the following inherent advantages:

- High Load / Space ratio
- Short axial length when installed

- Combination use in modular spring element
- High energy storage capacity
- Fail-safe capability, with combination stacks of Discs
- Uniform annular loading
- Symmetrical component, ideal for rotating applications
- Non-tangle characteristics which make automatic assembly easy.

The ability to change the Force vs Deflection characteristics, by varying the cone height to thickness ratio, is a useful feature of the disc spring. Fig. 3 shows a typical disc spring.

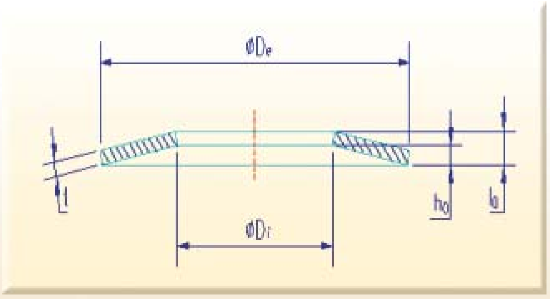


Fig. 3: A typical disc spring

Fig. 4 shows Force vs Deflection curves of the disc spring with different cone height-to-thickness ratios. Up to a ratio of 1.5, the disc springs may safely be taken to be 'flat' or stacked in columns.

The disc spring, to be accommodated in the guide tube, is selected with D_e = 71 mm; D_i = 36 mm; t = 2 mm; h_0 = 2.6 mm and l_0 = 4.6 mm. The disc spring assembly consists of 20 such springs stacked together in series, as shown in Fig. 5. Experimental results for Force vs Deflection for the Disc Spring assembly (stack of 20 in series) are given in Fig. 6.

Spring stiffness (K) of a single disc spring = 2.636 x 10^6 N/m.

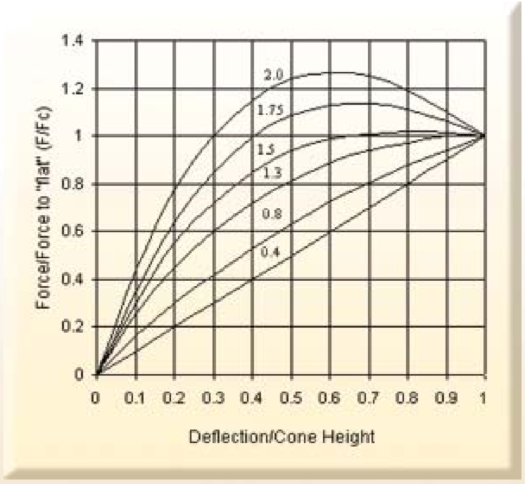


Fig. 4: Force vs Deflection for different (h_0/t) ratio

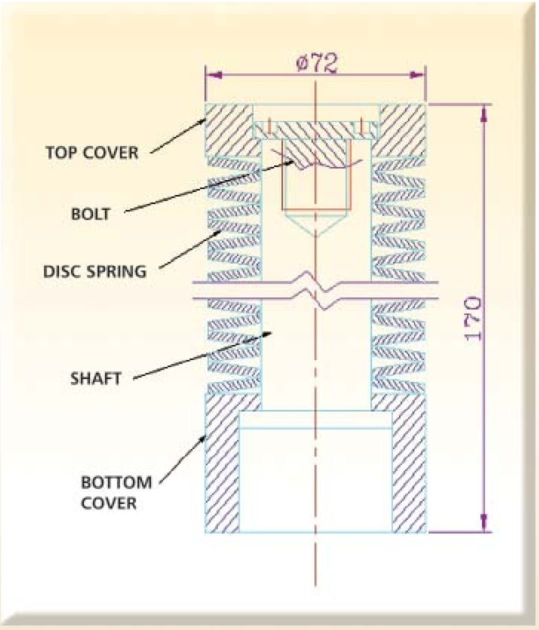


Fig. 5: Shock absorbing disc spring sub-assembly

Effective stiffness (K_{eff}) for the assembly = 131.8 x 10^3 N/m (20 disc springs in series as shown in Fig. 5) Total deflection of the disc spring assembly x = 52 mm.

So, energy absorbed by the assembly $E_{sp} = \frac{1}{2}Kx^2 \approx 178$ J Maximum potential energy of the absorber rod $E_{ab} \approx$ 196 J (assuming rope-snap occurs when the rod is at 'Parked UP' position).

Energy absorbed by Guide Tube E_{gt} = 18 J

Load experienced by the guide tube (In case of rope-snap and disc spring assembly in place) =

$$\sqrt{2.E_{gt}.K_{gt}} = 4700 \text{ Kgf}$$

Where, E_{gt} and K_{gt} are Energy absorbed and Stiffness of the guide tube, respectively.

For simplification and conservative calculation, K_{eff} has been taken as constant, upto 75% of deflection, from the actual curve. However, the actual energy absorbed by the spring, will be more than the calculated value as is evident from the characteristic curve (Fig. 6). Also, the guide the tube absorbs some amount of energy, which further reduces the impact load experienced by the girder. This fact has not been taken into account, while calculating the load experienced by the girder.

Disc Spring Design Analysis Through Experiment

Experiments were carried out with a dummy absorber element with similar size and weight as that of the actual element. The dummy rod was repeatedly dropped from different heights on the disc spring assemblies (in different combinations). The impact shock experienced by the dummy element, guide tube and the girder were measured by accelerometers, mounted on individual components as shown in Figs. 7, 8 and 9. The accelerometer mounted on the dummy element, travels along with the element during every drop. The accelerometer mounted at the bottom of the guide tube measures resultant shock, after attenuation by the disc spring assembly. The difference in the shock amplitudes measured by the element and the guide tube, gives the

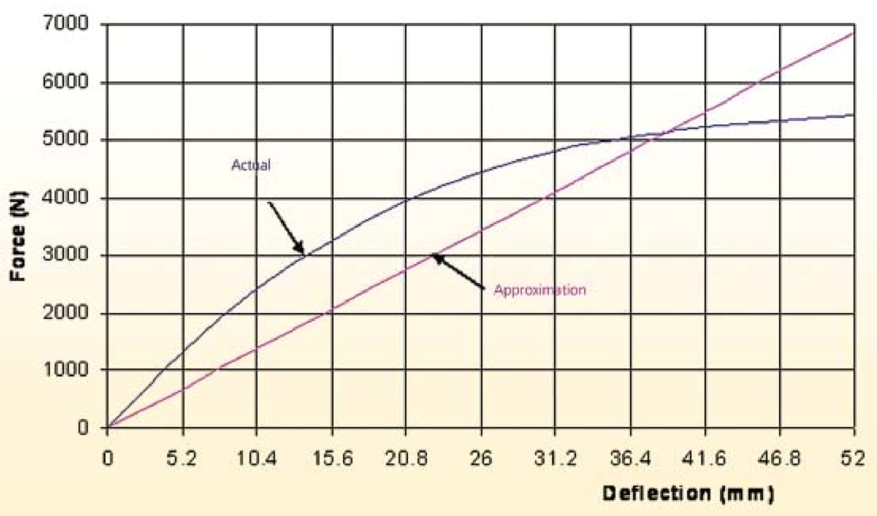


Fig. 6: Force vs Deflection curve for disc spring assembly

Fig. 7: Accelerometer attached to the dummy element and the top side of the guide tube

Fig. 8: Dummy element with accelerometer is being dropped into the guide tube

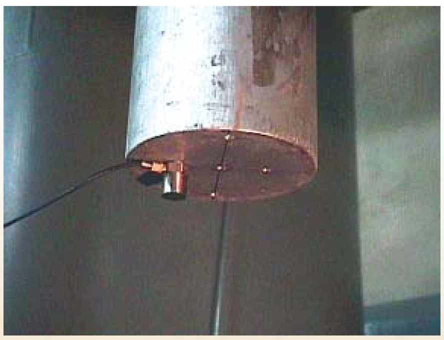


Fig. 9: Accelerometer attached to the bottom side of the guide tube

measure of shock absorbed by the disc springs. Design values and experimental results for final disc spring assembly (for reactor use) are presented here (disc spring assembly consisting of 20 disc springs of 2.0 mm thick stacked as shown in Fig. 5).

The natural frequency of the disc spring assembly plays an important role in the dynamics of shock absorption. The natural frequency was experimentally obtained by subjecting the spring assembly to sweep sinusoidal excitation on an electro-dynamic shaker. The measured natural frequency of the spring assembly was found to be 104 Hz as shown in Fig. 10.

Typical shock amplitude, seen by the dummy element, for the drop height of 2000 mm on spring assembly, is shown in Fig. 11. The shock response spectrum for the spring assembly is shown in Fig. 12. The spectrum shows the shock absorbing capacity of the disc spring assembly.

The shock amplitudes measured on the three components (dummy element, guide tube and the girder) are given in Table 1.

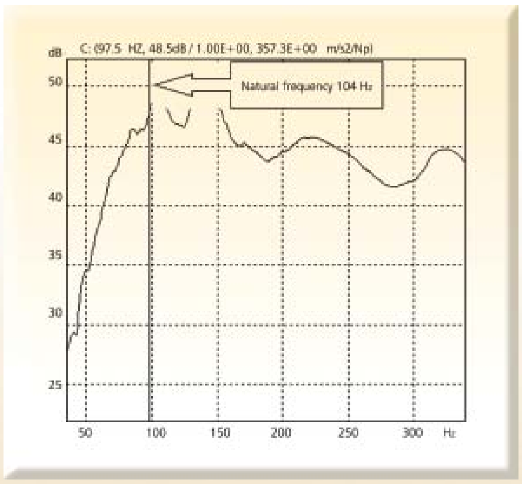


Fig. 10: Frequency response function for disc spring assembly

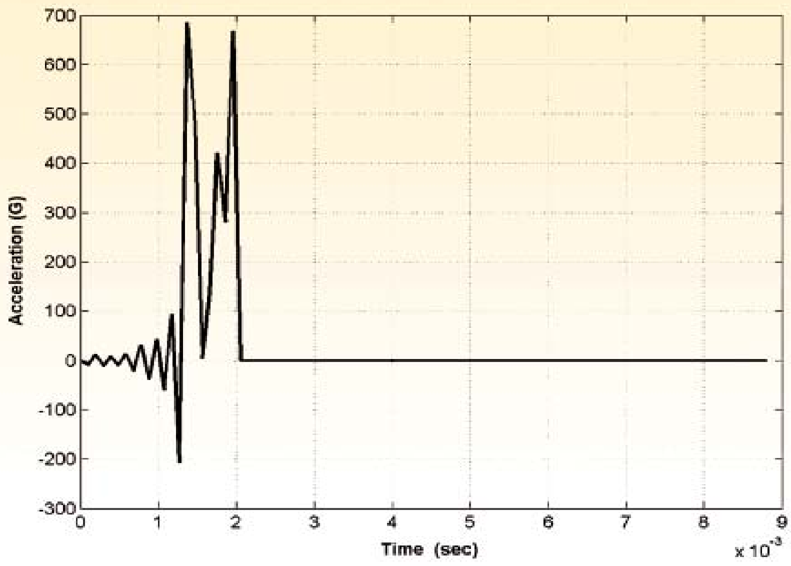


Fig. 11: Typical shock amplitude seen by the dummy element
(Drop Height of 2000 mm)

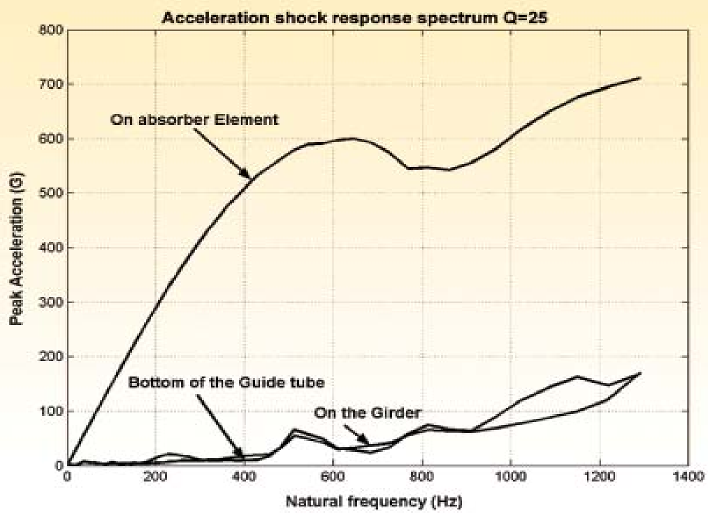


Fig. 12: Shock response spectrum of Disc Spring Assembly

Table 1: Maximum shock acceleration amplitudes for disc spring assembly

Drop Height (mm)	Maximum Acceleration Values (g)		
	Guide tube Bottom	Girder Top	Absorber element (Dummy)
500	75.19	57.86	528.58
1000	111.90	73.97	598.18
1500	157.49	163.63	551.51
2000	174.28	208.53	685.25
2500	220.01	200.80	576.50

Conclusion

Snapping of the wire rope is a highly unlikely event, that can be expected during the lifetime of the reactor. Nevertheless, the postulated event has been accounted for in the final design. The worst position for the rope snap is, when the element is parked at the top of the core, wherein the free fall height for the element is 2.5 meters. Such a fall is estimated to give a shock load of 15,700 Kgf on the guide tube and the girder (without disc spring assembly).

With the disc spring assembly in place, the experimental shock load was measured to be about 1,760 Kgf on the guide tube and about 1,600 Kgf on the girder. The experiment reveals the effectiveness of the disc spring assembly in reducing the shock load significantly, in case of a rope snap incident. The experiment was repeated several times to ensure consistent test results.

The experimental results also show that the calculated value of the shock load is on the conservative side.

Additional Reading:

1. "Test report on life-cycle testing of prototype shut-off rod drive mechanism for Critical Facility", Report No.: DRHR/CMS/CF/2006/02, June 2006.
2. N. Dharmaraju and A. Rama Rao, "Seismic analysis of shut-off rod absorber assembly for AHWR Critical Facility", Report No.: RED/VLS/04-05/04, April 2005.
3. N. K. Singh, M. K. Mishra, N. S. Dalal, G. Veda Vyas, C. B. Kothari, D. N. Badodkar, Manjit Singh, "Design and development of shut-off rod drive mechanism for Critical Facility", BARC Newsletter, No. 247, August 2004, pg. 1-10.
4. Earthquake resistant design of nuclear facilities with limited radioactivity inventory: IAEA TECDOC-348 (Revised Draft of March 1999).
5. AERB Safety Guides on 'Safety critical systems' (AERB/SG/D-10); on 'Core Reactivity Control' (AERB/SG/D-7); on 'Design Basis Events' (AERB/SG/D-5).

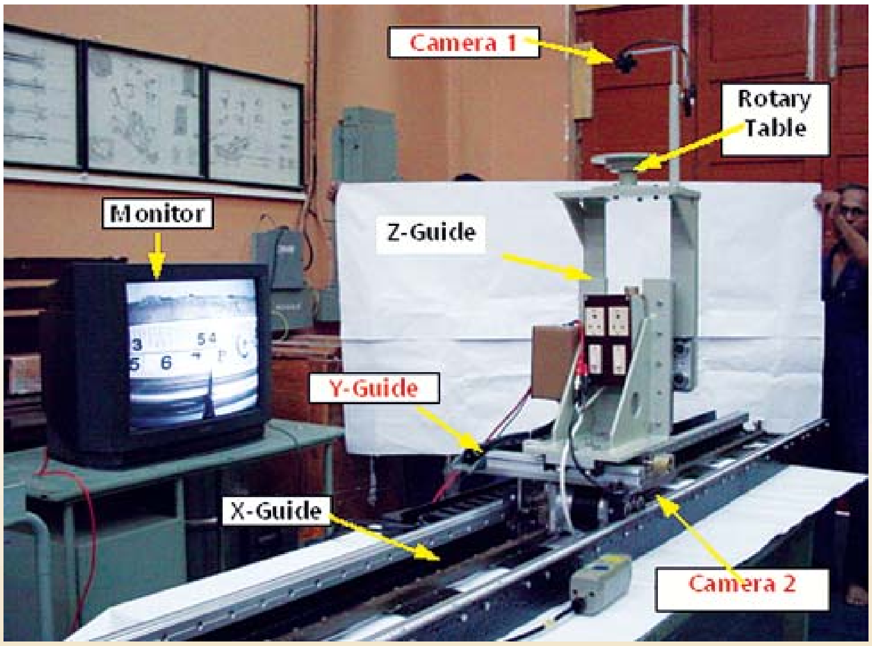
बीएआरसी न्यूज़लेटर
BARC NEWSLETTER

LINEAR DISTANCING SYSTEM FOR CALIBRATION OF RADIATION DETECTORS

Centre for Design and Manufacture

This equipment has been designed and manufactured at the Centre for Design and Manufacture, BARC in collaboration with the Radiation Safety Systems Division. This equipment has been supplied to the Indian Army base workshops at Delhi and Pune and to the Health Physics Unit, TAPS, BARC.

This nifty equipment is useful, to remotely position any object to within an accuracy of 1.0 mm over X–axis travel of 2735mm. This system is explicitly designed to calibrate radiation detectors for their performance and sensitivity. The equipment has a dual camera system for remote viewing. The reading on the radiation detector, which is placed on the instrument table, is viewed on a remote monitor and is recorded using Camera-1 (Fig. 1). The detector is positioned at various distances (along X–axis) along the direction of the radiation beam. The position reading on a linear scale (on X–axis) is viewed and recorded, using Camera-2. Since the radiation source has to be exposed during calibration of the detector, personnel are prohibited in the vicinity of the equipment and the calibration is remotely done, using a tele-operated switching circuit. This device is used for calibration of gamma ray detectors, and has to be installed in an adequately shielded room with proper radiometry dome from the outside. The instrument platform has four motions, viz. Rotational, X, Y and Z,



Linear Distancing System

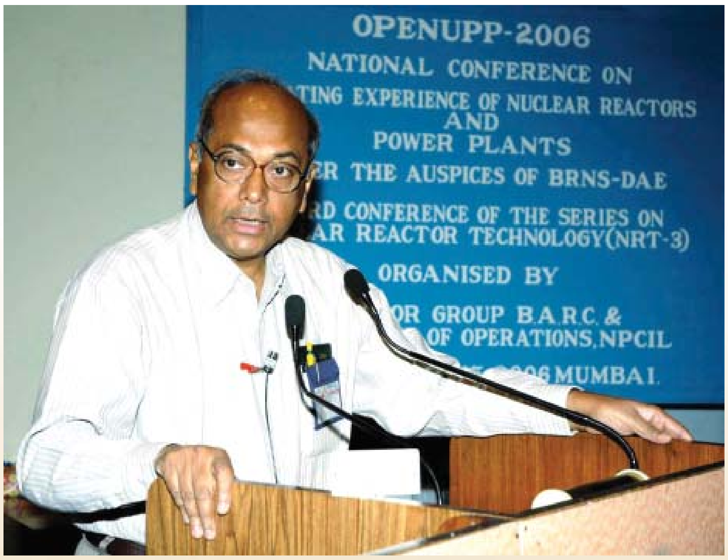
out of which only X travel only is motorized. Other movements are required only during the initial alignment of the detector with the incoming gamma rays. This alignment is accomplished in the "shutter off" condition of the radiation source. After initial alignment, the detector is exposed to gamma rays at varying and known (X) distances and the corresponding detector's scale reading is seen on the remote monitor and recorded. The detector carriage structure is made of Aluminium material, to avoid any back scattering which would affect the reading of the detector. The technical specifications of the system are given below.

Technical Specifications

- Total X-Travel (Sampling direction): 2735 mm motorized rack and pinion drive with geared synchronous motor. A linear scale is provided along X-axis.
- Total Y-Travel: 135 mm, manual screw drive.
- Total Z-Travel: 150 mm, manual screw drive.
- Rotary table (optional): 150 diameter manual movement for 360 degrees.
- Maximum height of the system: 1100 mm from ground level.
- Maximum width of the system: 400 mm
- Total weight: 200 Kg.
- No. of camera mounts: 2 CCD cameras with video output. One is for reading X-axis position on the linear scale and the other is for reading radiation detector scale.
- Camera interface: auto/ manual channel switcher with video output socket.
- Viewing system: TV Monitor or a PC monitor with video input
- Positional accuracy: 1 mm on X-axis, 0.2 mm on Y and Z axis.
- Electrical cable harnessing: Polyurethane cable drag chain.
- Travel constraints:Two limit switches on two extreme ends of X-axis travel.
- Alignment with source: low power laser source
- Source type: Co_{60} or Cs_{137}
- Controls: tele-operated from operator's room
- Material of construction: To minimise Gamma scattering, components in the vicinity of detector table are remotely made of Aluminium alloy.
- Prerequisites: adequate biological shielding of the detector room, accepted after radiometry tests.

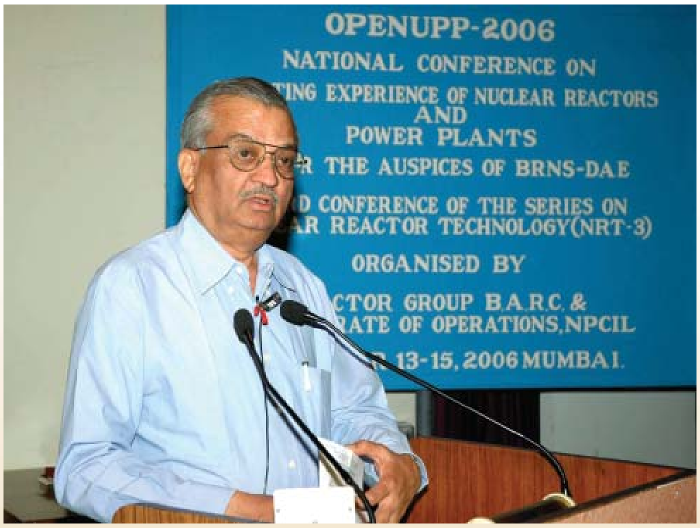
NATIONAL CONFERENCE ON OPERATING EXPERIENCE OF NUCLEAR REACTORS AND POWER PLANTS: A REPORT

A three-day National Conference on Operating Experience of Nuclear Rectors and Power Plants (OPENUPP-2006) was held at the Central Complex Auditorium, BARC, Mumbai from 13th to 15th November, 2006. The conference was jointly convened by Mr S.K. Agarwal, Head, Reactor Operations Division, Reactor Group, BARC and Mr Subhash Mittal, Director (Operations), NPCIL under the auspices of the Board of Research in Nuclear Sciences. The conference provided a platform to the scientists and engineers to share the experience gained over the years, in the field of Operations and Maintenance (O&M) of nuclear reactors and power plants. Dr Srikumar Banerjee, Director, BARC delivered the inaugural address. Dr Anil Kakodkar, Chairman, Atomic Energy Commission was the Chief Guest at the inaugural function and addressed the gathering. Dr Kakodkar highlighted the importance of such conferences in the management of existing plants and in the design of future ones. He emphasized the need to include feed back gathered during such conferences in to a central electronic data base, such that, it can be accessed by each and every plant operator online, as and when needed. He also stressed the need to employ knowledge-based resources like simulators for modeling of futuristic systems and optimisation of processes to reduce the operating costs as much as practically achievable. While touching upon the need to upgrade and update O & M procedures and practices, he also suggested that O&M community has to prepare itself to face the problems arising out of transitions in future O&M practices. From present technologies (Pressurized Heavy Water Systems) to emerging technologies like fast reactor technology, compact high temperature technology, safe passive system technology, accelerator driven sub-critical system technology - that will enter the commercial domain in the near future. He complimented the organisers for timely conduct of this conference and in bringing out the pre-print of the compiled papers on O&M experiences in book form.



Dr Srikumar Banerjee, Director, BARC inaugurated the conference OPENUPP-2006

Mr S.K. Sharma, Chairman, Atomic Energy Regulatory Board released the pre-print of the papers presented at the Conference. Mr S.K. Jain, Chairman & Managing Director of the Nuclear Power Corporation of India Ltd. delivered the presidential



Dr Anil Kakodkar, Chairman, AEC and Secretary DAE delivering the chief guest address

address. Mr Rakesh Nath, Chairperson, Central Electricity Authority (CEA), Mr K. Prakasa Rao, Executive Director (Engg.), NTPC and Mr Masayoshi Takahashi, WANO delivered key note addresses. The Chairman & Managing Director, NPCIL, traced the evolution of nuclear power industry in India, its early problems and constraints and its growth from infancy to robust maturity with the promise of a bright future and readiness to share the burden of fulfilling the nation's energy needs.

Mr Rakesh Nath, Chairperson, CEA spoke on the present energy scenario of the country and future plans to reach an installed capacity of 2,00,000 MWe by the end of the XI Plan. He also highlighted various efforts towards energy conservation; reduction of transmission and distribution losses as also plans for the refurbishment and renovation of existing plants, to increase plant efficiency and plant load factors.

Mr S. Duraisamy, Reactor Superintendent, Dhruva and Conference Secretary proposed the vote of thanks.

Over 500 participants attended the three day conference. Twenty two invited talks on Core Physics and Fuel management, Commissioning of facilities and systems, Operational experience, Fuel handling, Computer-based Control systems, Passive and innovative designs for future plants, Chemistry control, Radiation emergency preparedness etc were delivered. An impressive exhibition was also set up by fourteen exhibitors from the power industry.

Chairman AEC and secretary DAE inaugurating the exhibition and interacting with the exhibitors

बीएआरसी न्यूज़लेटर
BARC NEWSLETTER

BRNS THEME MEETING ON MODELLING OF GROUND WATER CONTAMINATION

The Health, Safety and Environment Group, BARC organised the BRNS Theme Meeting on 'Modelling of Groundwater Contamination' between 8-12 January 2007, at the CT&CRS Building, Anushaktinagar, Mumbai. The objectives of the meeting were to enhance and share knowledge on existing practices and advanced techniques, on groundwater contaminant transport modelling, among scientists and engineers from the different units of DAE and from academia. This meeting examined and discussed a range of subjects including hydrogeology, subsurface flow, aquifer tests, radionuclide transport in porous media and related analytical and numerical techniques. These objectives have a special relevance to radioactive waste management throughout the nuclear fuel cycle. The Theme Meeting was organized with the above preambles in mind, to impart in-depth knowledge, about the subsurface environment and modelling techniques on the participants.

Dr Srikumar Banerjee, Director, BARC inaugurating the BRNS Theme Meeting

The Theme Meeting was inaugurated by Dr Srikumar Banerjee, Director, BARC and chaired by Mr H.S. Kushwaha, Director, Health, Safety and Environment Group, BARC. Dr P. P. Chandrachoodan, Programme Officer, BRNS welcomed the gathering and Mr V.D. Puranik offered the vote of thanks. Dr Banerjee in his inaugural address opined that the Theme Meeting was organised to cater to the different requirements of the DAE. He stressed the relevance of ground water modelling at the different stages of nuclear fuel cycle; starting from the front end fuel cycle to the back end fuel cycle. Each stage has different requirements in terms of design and operation of radioactive disposal facilities. The concept of ground water modelling is simple as it consists of mainly source, pathways from source to the environment and its impact. However, the interaction between ground water and source is a complex phenomenon and can take place in different ways including diffusion controlled kinetics. Geochemistry is very important in evaluating this interaction as its determines the different oxidation/reduction states of the subsurface environment. The importance of geochemistry is quite evident in the mineralization of uranium in narrow belts wherein preferential ground water flow occurred previously. He also emphasized the importance of water resources and their development for sustaining civilization. In India water harvesting was practised since ancient times. He said that in Mumbai, more than hundred times the water quantity requirement is being wasted as overland flow and it was a major drawback in the water resource development programme. He pointed out the efforts of the Isotope Applications Division, which identified the recharge areas in a water scarce locality in Uttaranchal through isotope tracer applications. Proper measures were taken, to increase the recharge in the identified recharge areas. Now the extinct springs have reappeared and new springs are also being developed. Dr Banerjee pointed out the need to develop deep geological repositories and related modelling in near future. While designing and constructing such repositories, care should be taken to see that the groundwater should not be contaminated. He raised many issues in the field of ground water modelling such as long-term prediction, complicated geochemistry, effects of retardation, different modes of source releases and validation of models. Finally he stressed the need for organizing more such Theme Meetings in future, as short term courses.

Mr Kushwaha in his presidential address explained the activities of different divisions in BARC in the field of groundwater modelling. He emphasised the need for geophysical investigations, to obtain detailed characterisation of waste disposal sites. He said that the Theme Meeting was organised with a hope that the participants would be able to enhance their knowledge on various aspects of hydrogeology and ground water modelling from experts and thus they would be able to continue their pursuit in ground water modelling studies, with a new understanding.

About 35 participants from BARC and other DAE units attended the Theme Meeting. The units included EAD, HPD, RSSD, IAD, BETDD, ROD from BARC; NPCIL, IGCAR and AERB from other DAE units. All these divisions and units are directly or indirectly involved in many aspects of radioactive waste management and related ground water modelling.

The experts who took part in the deliberations include: Prof. Elango from Anna University, Chennai; Prof. Viswanadham and Prof. Eldho from IIT, Mumbai; Dr Senthil Kumar from Central Ground Water Board, Ahmedabad and Mr H. S. Kushwaha, Dr Y. S. Mayya, Dr R. N. Nair, Dr Brindaban Ghosh and Dr R. R. Rakesh from BARC.

The topics that were deliberated in the Meeting include:

- Basics of hydrogeology
- Introduction to ground water modelling
- Well hydraulics and pumping tests
- Data requirement
- Numerical modelling of contaminant transport in porous media
- Ground water modelling using finite element method
- Analytical solutions of advection-dispersion equations
- Solution techniques for non-linear differential equations
- Modelling migration of radionuclides from near surface radioactive disposal facilities
- Radionuclide transport through fractured porous media
- Centrifuge model tests on pollutant movement in soils.

Mr H.S. Kushwaha, Director, HS&E Group delivering the presidential address (sitting from left: Dr R.N. Nair, EAD; Mr V.D. Puranik, Head, EAD; Dr S. Banerjee, Director, BARC; Dr P.P. Chandrachoodan, Programme Officer, BRNS)

Apart from these topics, the Theme Meeting conducted hands-on exercises on various topics in hydrogeology and ground water modelling. The ground water modelling software, "GMS" was demonstrated to the participants.

INTERNATIONAL BLIND PROBLEM EXERCISE ON MODELLING OF PHWR FUEL BEHAVIOUR AT EXTENDED BURNUP

A blind problem exercise was organised on PHWR fuel modelling, to investigate the predictive capability of existing codes, for their application at extended burnup and to identify areas for improvement. The blind problem for this exercise, was based on data generated with a PHWR fuel bundle, irradiated in Kaiga Atomic Power Station Unit 1 (KAPS-1) up to about 15,000 MWd/TU and subjected to detailed post-irradiation examination in PIED hot cell facility.

The participants of this exercise were provided with a data package consisting of (i) design, fabrication and pre-characterisation data of fuel, cladding and fuel pins of the bundle; (ii) irradiation power history of the fuel pins of the bundle and (iii) coolant temperature and fast neutron flux data for irradiation period.

The participants were required to provide blind predictions of fuel temperature, fission gas release, internal gas pressure and other performance parameters. The actual experimental PIE results were withheld and were revealed to the participants only after receiving the results of their blind calculations of the problem.

Eleven computer codes from seven countries including India were tested in this exercise. Table I shows the list of codes / countries which participated in this exercise. The results of the blind exercise were presented and discussed at the IAEA Technical Meeting on PHWR Fuel Modelling held at Mumbai during December 5 - 8, 2006. During this Technical Meeting, an entire day was dedicated to the blind problem exercise and analysis of

Fig.1: A session in progress at the IAEA TM on PHWR Fuel Modelling

results. Fig.1 shows a technical session in progress at the IAEA meeting.

An analysis of the results of code predictions was presented by Mr D.N. Sah, Head, PIED, BARC. The irradiation power histories and the corresponding blind predictions of fuel centerline temperature, by various codes in outer fuel pin, are shown in Fig.2. Most codes showed an almost similar trend of temperature evolution, during the irradiation period. However, the fission gas release (FGR) predictions showed a large variation, with most of the codes underpredicting FGR and the end-of-life pin pressure.

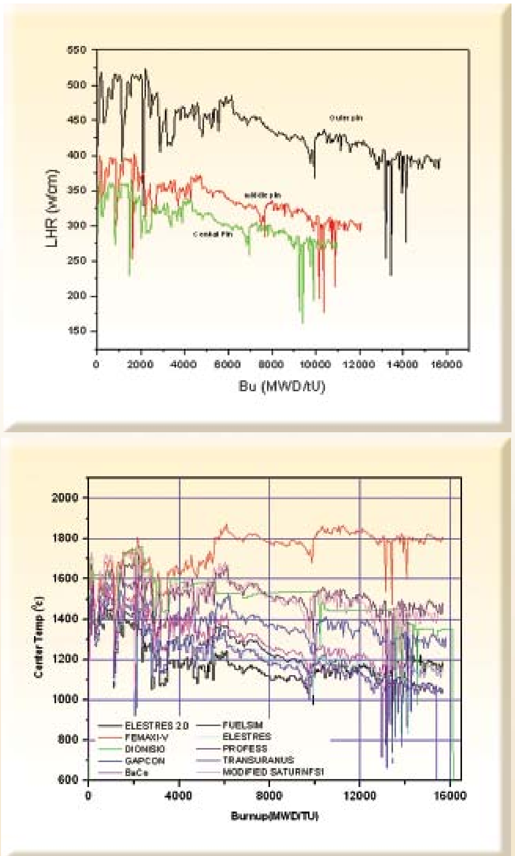


Fig. 2: Irradiation power histories and the corresponding fuel centreline temperatures in the outer fuel pin predicted by various codes.

From the discussions held at the IAEA Technical Meeting, several points emerged with regard to the differences in FGR predictions:

- Microstructure of the pellet and its influence on FGR
- Minor impurities and their influence on thermal conductivity of the fuel
- Uncertainty in pin power data
- Method of modelling FGR in each code Based on the discussion, the following recommendations were made:
- Recalculation of the cases accounting for uncertainty in thermal conductivity and pin power
- Irradiation of PHWR fuel pin with in- pile instrumentation for temperature and internal gas pressure measurement
- Detailed characterization of microstructure and chemistry of fuel and measurement of thermal conductivity / diffusivity of fuel

Table 1: List of computer codes used in the blind problem exercise

S. No	Name of Code	Organisation	Country
1.	PROFESS	BARC	India
2.	ELESTRES 2.0	AECL	Canada
3.	FEMAXI- V	NRI Rez plc	Czech republic
4.	DIONISIO	CNEA	Argentina
5.	GAPCON	BARC	India
6.	BaCo	CNEA	Argentina
7.	TRANSURANUS*	INR	Romania
8.	FUELSIM*	INR	Romania
9.	SATURN-FS1	IGCAR	India
10.	ELESTRES	KAERI	Korea
11.		CIAE	China

*only outer pin analysed

BRNS-IANCAS NATIONAL WORKSHOP ON "RADIOCHEMISTRY AND APPLICATION OF RADIOISOTOPES": A REPORT

The 62nd BRNS-IANCAS National Workshop on "Radiochemistry and Application of Radioisotopes' was held at the Department of Biochemistry, Osmania University, during December 4-11, 2006. While inaugurating the workshop Prof. Lalji Singh, Director, CCMB, Hyderabad enumerated several applications of radioisotopes in various fields and their active role in future. Presiding over the function Prof. Siddique, Vice-Chancellor, Osmania University, complimented the department of Biochemistry for organising this workshop and appreciated the efforts of the organisers, in training the teachers in the basics of Radiochemistry and the use of radioisotopes. Prof. Venkata Ramana Devi, Head, Department of Biochemistry, welcomed the participants. Speaking on the occasion Dr V.K. Manchanda, President, IANCAS referred to various popular programmes undertaken by IANCAS, during the Silver Jubilee year of the association, in meeting its objective of popularizing the subject of Radiochemistry, among the teachers of universities/colleges. He also explained the participants about the promotion of research projects from universities by BRNS. Dr G.A. Rama Rao, Secretary, IANCAS briefed the participants regarding the contents of the Workshop. The inauguration concluded with a formal vote of thanks by Prof. Sobhanaditya, chairman, Biosciences, Osmania University.

53 teachers with a majority of them from biosciences participated in the Workshop. Apart from the six resource persons who conducted the workshop with theory lectures in the morning and experiments in the afternoon, there were six guest lectures by Dr Sanjeev Kumar, CCCM, Hyderabad, Dr N. Shivaprasad, BRIT, Dr K.S. Reddy, NABTD, Dr V.K. Manchanda and Dr K.L. Ramakumar, BARC. The lecture on 'Non-fossil fuel resources and their

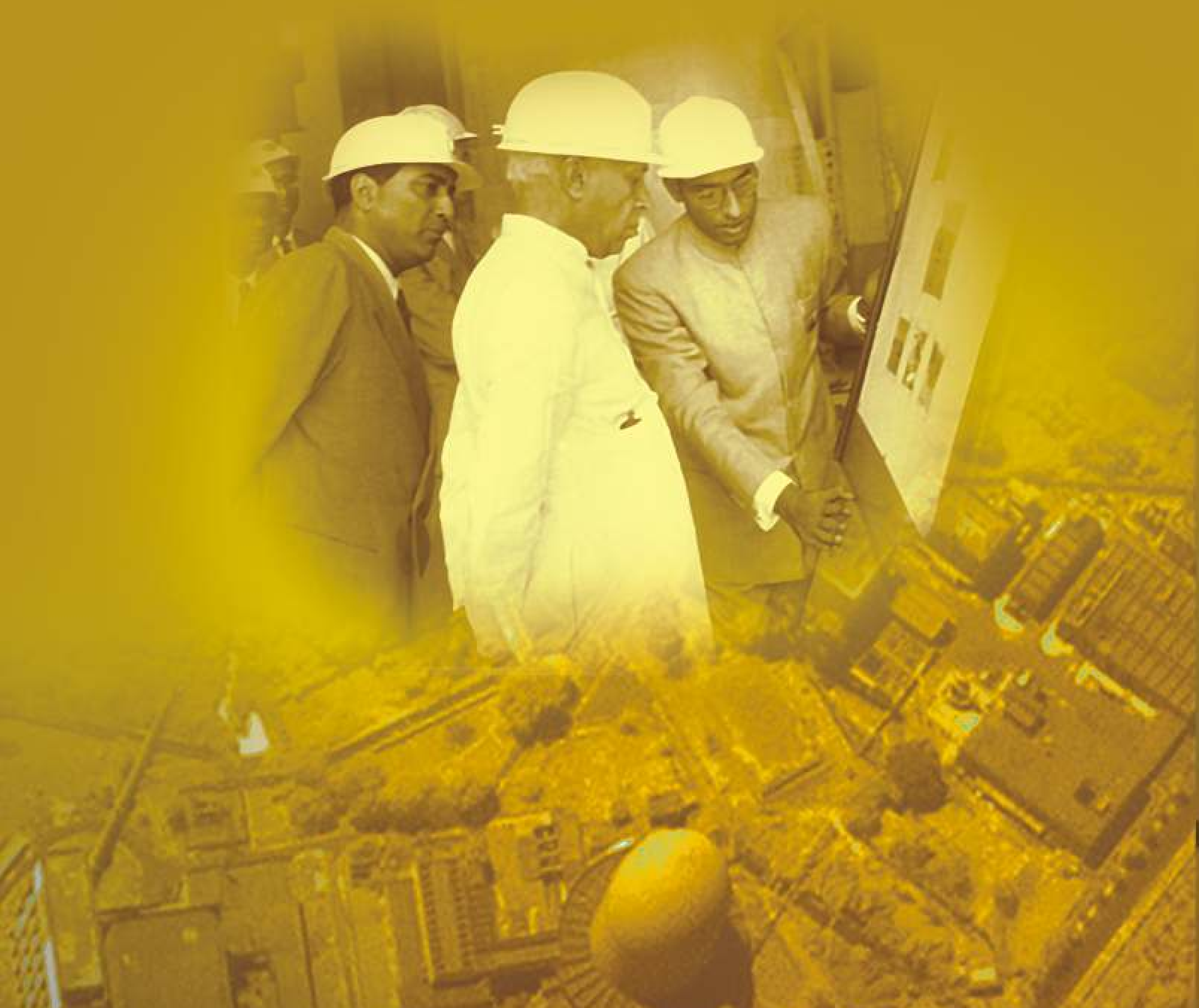
At the Inauguration: (L-R) Prof. Ms Ramana Devi, Head, Dept. of Biochemistry, Prof. Sobhanaditya, Chairman, Biosciences, Prof. Siddique, Vice-Chancellor, Osmania University, Prof. Lalji Singh, Director, CCMB, Hyderabad, Dr V.K. Manchanda, President, IANCAS and G.A. Rama Rao, Secretaty, IANCAS exploration' by Mr P.B. Maithani, Additional Director, AMD, Hyderabad created interest among the participants as Mr Maithani cited a few places in Andhra Pradesh which have future prospects for exploration.

A special demonstration experiment on 'DNA-labeling' by Dr N. Krishnamurthy, Jonaki lab, BRIT in CCMB was well appreciated. A visit to Nuclear Fuel Complex, Hyderabad was arranged for the participants and the resource persons. The participants were briefed by Dr P. Balakrishna Prasad, Dy. Director and they were taken through pellet handling facility and few metallurgical processing plants by Mr Sairam. The participants comprehended the safety aspects in handling uranium material while maintaining clean surroundings.

A few posters on FACTS & FIGURES giving comparison of fossil and non-fossil fuels in the areas of energy release and the volume of waste produced and their management drew audience both from the participants and from those who participated in the inauguration and valedictory functions. There were several requests from nearby colleges and schools for demonstration of experiments on radioactivity to be conducted in their respective institutions and so the resource persons visited seven colleges to conduct a half-day programme with a lecture and an experiment on half-life determination. The invitation was from as far as Mehboobnagar, 110 Km away from the city of Hyderabad which was accepted and the programmme was conducted in that college. More than 800 students from several institutions were benefited by this programmes.

The valedictory function was presided over by Prof. P. Mutha Reddy, Registrar, Osmania University and Mr R.N. Jayaraj, Chief Executive, NFC was the Chief Guest. Mr Jayaraj gave away the certificates and donated a set of nuclear counting equipment to Prof. Mutha Reddy and congratulated the participants for completing the training in handling of radioisotopes. He said that the nuclear industry would to play a vital role in meeting future energy demands of the country, considering the alarming situation in terms of greenhouse gases, that have proved to be detrimental to the environment. In his presidential address, Prof. Mutha Reddy said that the feed back from the participants was gratifying and the workshop helped in alleviating the apprehensions of the participants about the safety features of nuclear energy. Prof. Venkata Ramana Devi, the local coordinator brought out the salient features of the workshop while Dr Rama Rao, Coordinator from IANCAS attended to the suggestions from the participants during the feed-back session. Dr K.L. Ramakumar, Vice-President, IANCAS gave an account of the popularity of the association, in propagating the beneficial aspects of radioactivity and the invitations received by IANCAS over the years, for conducting similar workshops in universities.

At the valedictory (L-R): Prof. Ms Ramana Devi, Dr K.L. Ramakumar, Vice-President, IANCAS, Prof. P. Mutha Reddy, Registrar, Osmania University, Mr R.N. Jayaraj, Chief Executive, NFC, and Dr G.A. Rama Rao, IANCAS



Edited & Published by :

Dr. Vijai Kumar,

Associate Director,Knowledge Management Group &

Head, Scientific Information Resource Division,

Bhabha Atomic Research Centre, Trombay, Mumbai 400 085, India.

Editorial Management : Ms. S.C. Deokattey, Computer Graphics & Layout : N. Kanagaraj, SIRD, BARC

BARC Newsletter is also available at URL: http://www.barc.gov.in (for private circulation only)