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SYNTHESIS OF ISOTOPICALLY PURE ^{236}Pu TRACER

S.P. Dange, G.K. Gubbi, A. Ramaswami and S.B. Manohar

Radiochemistry Division

and

Pramilla D. Sawant

Internal Dosimetry Division

Introduction

One of the important prerequisites for successful operation of a nuclear material handling facility is the effective radiation protection of its workers and the environment. Adequate radiation protection measures are followed at various stages of nuclear fuel cycle operations. With increased utilisation of plutonium as a nuclear fuel in the nuclear energy program, the accurate monitoring of plutonium inhalation by radiation workers and the environmental materials has become very important. The method of monitoring of plutonium by bioassay is effective and sensitive to evaluate the annual intake for calculation of personal dose as recommended by ICRP. The standard method employed for the bioassay of the sample consists of radiochemical separation of plutonium, sample preparation by electrodeposition and assay by alpha spectrometry. The method requires a suitable plutonium tracer for eliminating the uncertainties due to the chemical yield in the separation, electrodeposition and counting efficiency.

The most ideal tracer isotope of plutonium is ^{236}Pu . It has a convenient half-life of 2.85 years and alpha particle energies (5.73, 5.76 MeV) are well separated from

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BARC scientists honoured

those of reactor grade plutonium isotopes. As the tracer isotope is used for the assay of biological samples, the condition of isotopic purity is stringent. The total alpha activity of $^{238,239,240}\text{Pu}$ should be less than 1% of the ^{236}Pu alpha activity. ^{236}Pu is produced by various nuclear reactions [1].

The most promising reaction for the production of ^{236}Pu is by proton irradiation of ^{237}Np [1]. This reaction was used for the synthesis of trace levels of isotopically pure ^{236}Pu by the recoil catcher technique. The catcher foil was subjected to chemical treatment and radiochemical purification to separate the ^{236}Pu .

Experimental

Target preparation and irradiation

Electrodeposited Neptunium targets on 2.0 mg/cm² thick super pure aluminium backing were prepared. The purity of the targets was checked by alpha spectrometry, and the alpha activity of $^{238,239,240}\text{Pu}$ was found to be about 0.1 % of ^{237}Np activity. Ten targets having thickness in the range of 30 μg/cm² – 1mg/cm² were prepared. A special target holder was designed and fabricated in collaboration with PAO & M section of NPD for use at 30° N beam line of BARC-TIFR Pelletron Facility. The target holder is shown in Fig.1. The target holder facilitates easy loading and unloading of multiple target/catcher foil assemblies with minimum surface contamination. The target and catcher foil assembly is schematically shown in Fig.2. Aluminium catcher foil of 2.0 mg/cm² was used for the collection of reaction products recoiling in the forward direction. The stack of ten targets and forward catcher foils was housed in the target holder. The targets were irradiated with proton beam ($E_p = 23.5$ MeV) at BARC-TIFR Pelletron Facility, Mumbai. Proton energy loss in the target and catcher foils was calculated from stopping power tables [2] and the proton energy at the last target was 22.9 MeV.

The proton irradiation was carried out for about 130 hrs. The average proton current was about 30 nA. After the irradiation, the stack was cooled

for 15 days for allowing the complete decay of $^{236\text{m}}\text{Np}$ to ^{236}Pu . The nuclear data of reaction products produced in $p + ^{237}\text{Np}$ reaction are given in Table 1.

Surface decontamination and assay of recoil catcher foils

The catcher foils were assayed using a silicon surface barrier detector coupled to a 4K Multi Channel Analyser. The absolute detection efficiency was 20%. Both ^{236}Pu and ^{237}Np activities were detected on the catcher foils. The formation of ^{237}Pu is also expected in the proton induced reaction of ^{237}Np . The branching intensity of alpha decay in ^{237}Pu being less than 0.003%, its activity was not detected in the catcher foil. The yield of ^{236}Pu as well as the neptunium contamination increased with target thickness.

The surface contamination of ^{237}Np is loosely bound, compared to embedded recoils of ^{236}Pu . The neptunium contamination on the catcher foil is associated with its $^{238,239,240}\text{Pu}$ impurities and it has to be removed to the extent possible before the radiochemical separation of ^{236}Pu . It was necessary to carry out surface decontamination of catcher foils before radiochemical separation. This was an important step in obtaining isotopically pure ^{236}Pu .

The catcher foils were kept immersed in 0.01M EDTA solution for 15 minutes. The foils were dried and cleaned with a gentle rub using tissue paper and dipped in water for 90 minutes. After the water treatment, the foils were cleaned and dried with acetone. The process yielded a decontamination factor of 2.5 for neptunium and no significant reduction of ^{236}Pu activity was observed. The activity of neptunium was not completely removed but was still comparable to ^{236}Pu activity. However $^{238,239,240}\text{Pu}$ activities (< 0.1% of ^{237}Np activity) were not detected. Further purification from ^{237}Np activity was carried out by radiochemical separation.

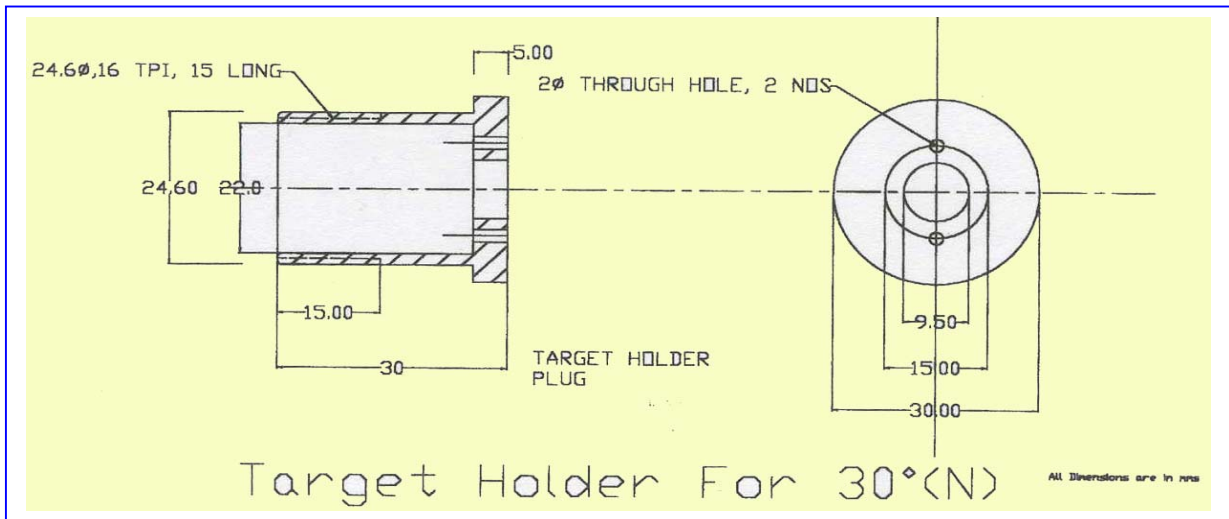


Fig.1 Target holder for irradiation of ^{237}Np targets

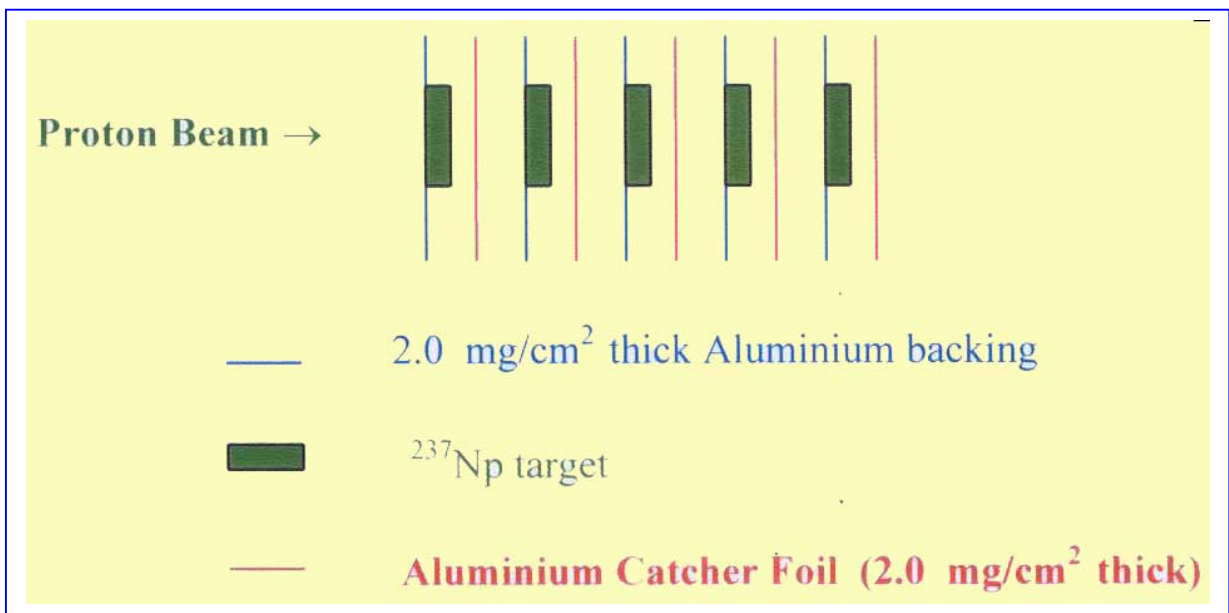


Fig. 2 Schematic of target / catcher foil configuration

Table 1 : Nuclear data of reaction products formed in $p + ^{237}\text{Np}$

Nuclide	Half life	Decay Mode	Alpha particle Energy (MeV)	Branching Intensity (%)	Formation Cross section at $E_p = 23.5 \text{ MeV}$ (mb) [1]
^{236m}Np	22.5 h	β^- EC		47.0 53.0	69.1 ± 3.6
^{236}Pu	2.85 y	Alpha	5.767 5.730	69.14 30.76	4.35 ± 0.17
^{237}Pu	45.13 d	EC Alpha		99 + <0.003	5.45 ± 0.36

Radiochemical separation

The catcher foils were dissolved in 4M HNO₃. The alpha activities of ²³⁶Pu and ²³⁷Np in the solution were found to be comparable by alpha spectrometric assay. A method based on solvent extraction was standardised for effective removal of ²³⁷Np from the solution containing ²³⁶Pu. The solution was evaporated to dryness and then taken in 1M HNO₃. 250 µl of 1M sodium nitrite was added to oxidise plutonium to Pu (IV). Plutonium was extracted in 5 ml of 0.5 M HTTA in Xylene, followed by back extraction in 8M HNO₃. In each cycle, about 90 % of ²³⁶Pu and 15% of ²³⁷Np activities were back extracted from the organic phase. The decontamination factor was about 6 in each cycle. Three extraction cycles were required and the net recovery of plutonium was better than 60%. An electro deposited source was prepared using 50 µl of 5ml stock solution. The sample was assayed by alpha spectrometry at Radiochemistry Division as well as at IDD laboratory. The absolute detection efficiency of the detector (IDD laboratory) was 40.6% and the counting time was 82000 s. The alpha spectrum is shown in Fig.3. The concentration of ²³⁶Pu activity was about 2.5 mBq/50µl and the activities of ^{238,239,240}Pu as well as ²³⁷Np were below the detection limit (< 0.5mBq). Thus, about 250 mBq of tracer grade ²³⁶Pu activity in 8M HNO₃ has been prepared.

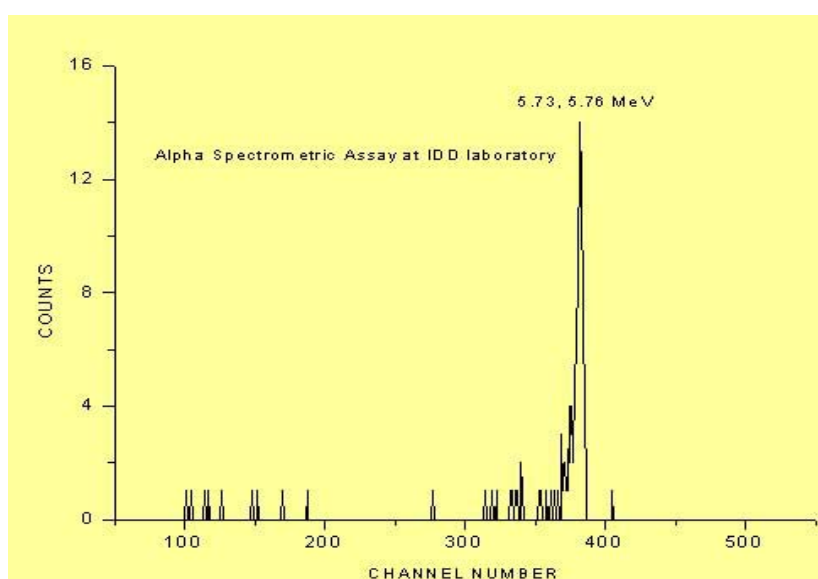


Fig.3 Alpha spectrum of radiochemically separated sample of ²³⁶Pu

Recovery of ²³⁶Pu from the irradiated ²³⁷Np

target

²³⁶Pu produced in an irradiated ²³⁷Np target was also recovered. The ²³⁷Np target of thickness 1044 µg/cm² was dissolved along with its aluminium backing, in 6M HNO₃ with a few drops of 0.01M HF. The solution was evaporated to dryness and was taken in 5ml of 1M HNO₃. The solution was assayed alpha spectrometrically and alpha activity ratio of ²³⁷Np to ²³⁶Pu was found to be about 200. The total ²³⁶Pu activity was estimated to be 25 Bq. The solvent extraction method mentioned above was used for the radiochemical separation of ²³⁶Pu. Five cycles were required for the effective removal of ²³⁷Np. The activity of ²³⁶Pu is about four times the activity of ^{238,239,240}Pu in the plutonium recovered from the target. The activity could be used as a tracer for the assay of plutonium by Isotope Dilution Alpha Spectrometry. A stock solution of about 1500 mBq of ²³⁶Pu in 5 ml of 8M HNO₃ is available for use.

Conclusion

Isotopically pure ²³⁶Pu was produced by proton irradiation of ²³⁷Np at BARC-TIFR Pelletron Facility, using recoil catcher foil technique followed by radiochemical separation. The optimum thickness of ²³⁷Np target was found to be about 1mg/cm². The surface decontamination

process effectively reduces the level of ²³⁷Np and plutonium contamination without significant loss of ²³⁶Pu activity. The radiochemical separation of ²³⁶Pu removes the remaining traces of ²³⁷Np. The thick target catcher foil yield of ²³⁶Pu was about 0.06mBq/nAhr. The target yield is much higher and is about 6mBq/nAhr. The ²³⁶Pu activity recovered from the target could be a useful tracer for estimation of plutonium by Isotope Dilution Alpha Spectrometry.

In order to produce higher

amounts of ^{236}Pu activity, it is essential to have a proton ($E_p \approx 24 \text{ MeV}$) irradiation facility with current of the order of microamperes. The other important factor is the requirement of ultra pure ^{237}Np targets. Further efforts in this direction are in progress.

References

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DEVELOPMENT AND VALIDATION OF PC-BASED HIGH RESOLUTION DIRECT CURRENT POTENTIAL DROP (DCPD) SYSTEM

Measurement of crack length in a specimen under load is often an integral part of many materials test set-ups, such as, fracture and fatigue monitoring systems. There are several methods which can be used to measure crack length, such as, visual examination, using traveling microscope, strain gauged displacement measurements to measure the compliance of the cracked body, ultrasonic, eddy current based techniques, etc. DCPD method offers many advantages, when on-line crack growth monitoring is required under elevated temperatures and at higher rates of testing. In this method, highly stable DC current of fixed magnitude is passed through the specimen under test. Typical currents required are $\approx 100 \text{ amp}$. with a few parts per million stability. Based on the crack length, there is a change in the resistance of the material, leading to a variation in the potential drop across the specimen, which is amplified and accurately measured. Since DCPD technique can detect very small changes in the specimen resistance as a crack propagates, the method offers very high sensitivity and the increase in specimen resistance can be fairly accurately related to the actual crack length.

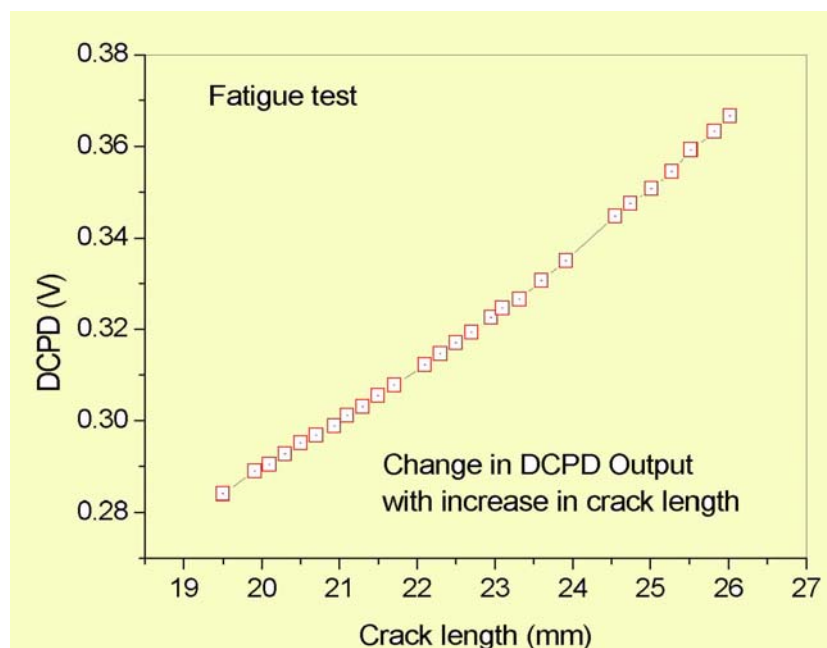


Fig. 1 Calibration of DCPD output with crack length measured by compliance method.

A high resolution PC-based DCPD system has been developed and validated to measure crack extensions in fatigue and fracture tests. This development has been done by TPPED and validation was carried out in Materials Science Division, BARC. The developed system includes:

1. Ultra high stability and PC control compatible current source (range: 0 to 60 amps, voltage compliance : 2.5V, stability: $<10 \text{ PPM}$, no minimum load required);
2. Signal conditioning electronics (amplifier gain: 1000, resolution: 100 nV, two separate amplifiers for actual & reference samples);

3. Acquisition of voltage data with very high resolution, using in house built PC based system;
4. Software for control and data acquisition; and
5. Software for post processing of test results and DCPD output.



Fig. 2 DCPD unit connected with a servohydraulic test frame for fracture testing.

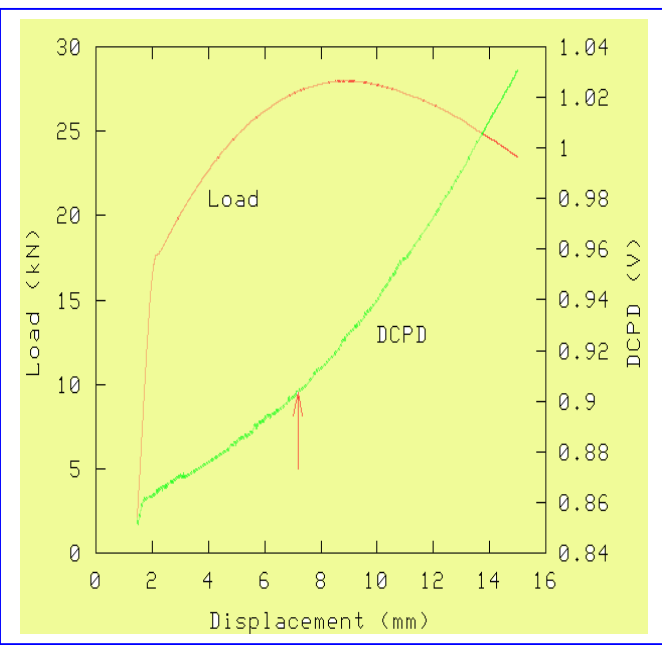
Fig. 3 Detection of initiation of crack growth (marked by the arrow), during fracture toughness test using DCPD.

The system is such that it can be synchronized with the universal testing machine controller software or can be operated independently as a stand-alone unit. Many validation experiments have been conducted on different specimen sizes to confirm that the crack length results delivered by our set up match those produced by other systems, such as, compliance based and visual measurements. Some of the results are shown in the diagrams given below. The results obtained

were satisfactory and the complete system is now in use for regular material test applications in the laboratory.

NISARGRUNA PLANT INAUGURATED

Inaugural function of "Nisargruna" plant, constructed near Training School Hostel at Anushaktinagar, was held on October 17, 2002. It was followed by a seminar on "Alternate Energy Resources : Present and Future". Officials from Brihanmumbai Municipal Corporation (BMC), Thane Municipal Corporation (TMC), Navi Mumbai Municipal Corporation (NMMC), Kalyan Dombivli Municipal Corporation (KDMC), Stree Mukti Sanghatana, Tata Institute of Social Sciences, Indian Institute of Technology and many other noted environmentalists attended the function. Dr. Jayantrao Patil, Member, State Planning Commission, Maharashtra State, was the Chief Guest. Dr. K.B. Sainis, Associate Director, Bioscience Group, BARC, welcomed the delegates. Dr. S.F. D'Souza, Head, Nuclear Agriculture and Biotechnology Division (NABTD), in his introductory remarks, emphasised the importance of microorganisms in Biotechnology. Mr. B. Bhattacharjee, Director, BARC, delivered the keynote address on "Nisargruna" project. He explained the concept of "Nisargruna" by stating its environmental utility in waste disposal. He elaborated on the differences in "Nisargruna" and conventional biogas plants.





Inaugural function of Nisargruna Plant

1. Type of waste : Conventional plant can handle only gobar and/or human waste. "Nisargruna" plant can process almost any biodegradable waste including kitchen waste, paper, grass, gobar, dry leaves, etc.
2. Use of mixer : Solid waste is difficult to be digested for microorganisms. A 5HP mixer is used to make slurry of the solid waste with 1:1 water. This water can be recycled.
3. Biphasic separation : The "Nisargruna" plant has two tanks for aerobic and anaerobic processing of the waste. The slurry enters the aerobic tank where it is largely converted to butyric, fumaric, acetic and other organic acids. This acidic slurry is then converted to methane in anaerobic tank. This separation helps in reducing the processing time and increasing the quality of methane gas and manure.



Dr Jayantrao Patil, Chief Guest, formally inaugurating the Nisargruna Plant

4. Thermophilic bacteria : In the aerobic tank, thermophilic bacteria are selectively permitted to develop using hot water. These bacteria can degrade the waste faster. This also helps in hygienisation of the waste. The hot water is obtained using solar water heater.

Dr Jayantrao Patil, in his address, expressed the hope that "Nisargruna" plant would offer an excellent opportunity for replenishing the

topsoil layer and restore the fertility of the soil. He appreciated the efforts made by BARC in the protection of environment. Mr Gautam Chatterjee, Additional Municipal Corporator, BMC, while speaking on this occasion, said that the "Nisargruna" plant would be tried at some locations in BMC area on priority basis. Dr S.P. Kale proposed the vote of thanks.

The inaugural function was followed by a seminar on "Alternate Energy Resources : Present and Future". In this seminar, Dr G.P. Srivastava, Head, Control Instrumentation Division, Mr H.S. Kamath, Consultant, DAE and former Chairman and CEO, Heavy Water Board, Dr S.P. Kale, Nuclear Agriculture & Biotechnology Division, BARC, Mr S.S. Bhagwat, OSD, BMC, Ms Jyoti Mhapsekar, President, Stree Mukti Sanghtana and Dr (Ms) Sneha Palnitkar, Director, All India Institute for Local Self Governments, presented papers on various aspects of Alternate Energy Resources. Dr S.F. D'Souza, Head, NABTD, and Prof. Dr V.S. Bawasakar, Agricultural Consultant, Pune, chaired this session and summarised the proceedings. The session was followed by a demonstration of the functioning of "Nisargruna" plant by Mr S.T. Mehetre and P.D. Sherkhane, NABTD, BARC.

VARIABLE

OPENING SLIT

Centre for Design and Manufacture has designed and developed a variable opening slit using a special mechanism. This slit can be used in a vacuum line. Cooling arrangement for slit edge can also be provided, if required. This job was taken up because synchrotron beam lines require vacuum compatible variable opening slit and in some cases with cooling arrangement. Conventionally available slit consists of many small components, which are neither suitable for vacuum nor have the cooling arrangement.

This design is based on two numbers of parallel four bar mechanisms made from a single plate of stainless steel. Detail analysis was done using high end design software. One slit edge is fixed on each of the two four bar mechanisms. One wedge is pushed between the rollers, which are fixed on four bar mechanisms, with the help of a fine pitch screw for controlling the width of the slit. Slit width varies from 0.010mm to 2.00mm with a resolution of 0.0025mm.



Fig.1 Variable opening slit



Fig. 2 Four bar mechanism

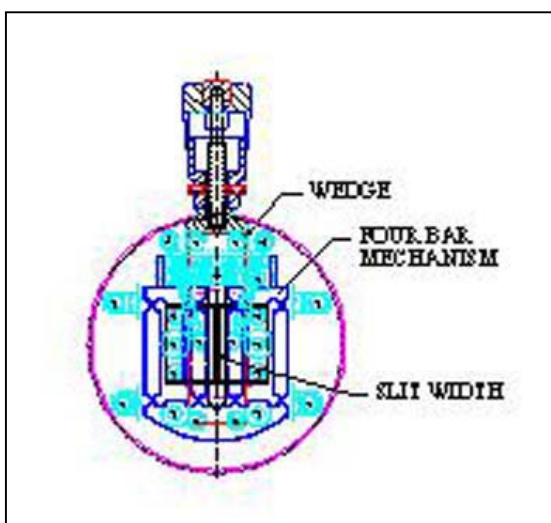


Fig. 3 Sectional view of variable opening slit



Fig. 4 Internal details of variable opening slit

Two numbers of prototype slits have been made based on this principle and both of them were used in 0.5 meter Scanning Monochromator, an instrument which has been developed for Spectroscopy Division. Manufacturing of additional six numbers of slits is in progress for Spectroscopy Division.

Design & development of second prototype slit with its vacuum chamber, along with cooling arrangement, is under progress.

BARC TRANSFERS TECHNOLOGY OF DUST RESPIRATOR & AIRLINE RESPIRATOR

Dust respirators and airline respirators developed by Health Physics Division, BARC, as an import substitute, meet the stringent requirements needed for use in a highly toxic environment.



While signing the agreement on the occasion of technology transfer ceremony, seen from left to right are Mr A.K. Bhattacharya, HPD, Mr A.M. Patankar, Head, TT&CD, Mr Kirit Sheth, Partner, M/s. Sheth & Co., Mumbai, Dr V. Venkat Raj, Director, HS&EG, Mr A.S. Bagadi, TT&CD, Mr R.M. Sharma, Head, HPD, Mr Sameer Sheth, Manager, M/s Sheth & Co., Mumbai, and Mr K.A. Pendharkar, Head, FRSS, HPD.

Dust Respirator : This is an air-purifying respirator. It is a half-mask respirator, which covers the nose and mouth. Normally, the mask is fitted with a pair of high efficiency filters to provide protection in an environment

contaminated with fumes, mists and highly toxic particulates, including radionuclides. Respirator can also be fitted with a pair of combination (impregnated charcoal + HEPA) filter cartridges to remove organic and iodine vapours in addition to particulates from breathing atmosphere. These respirators are mainly used in atmosphere where protection against fine toxic particles such as radioactive dusts, bacteria and some viruses is required.

Airline Respirator : This is a continuous flow air-supplied respirator. It has a half-face mask to which respirable air at the rate of 120 l/min is continuously fed by means of an air-hose. Positive pressure inside the face-piece gives very little possibility for outside contaminated atmosphere to leak in. Airline respirators are mainly used in conjunction with plastic suits to provide fresh air for breathing, the latter to prevent skin contamination in all the nuclear facilities. They also protect the personnel against dusts, vapours and gases.

The technical know-how of the Dust Respirator & Airline Respirator was transferred to M/s Sheth & Co., Mumbai, on November 14, 2002 by BARC. Technology Transfer and Collaboration Division coordinated all activities related to the transfer of this technology, such as preparation of technical brochure, technology transfer document, advertisement of the technology, transfer agreement preparation and the signing of agreement.

BARC TRANSFERS TECHNOLOGY TO M/s SENERGY INTELLUTION

The technology of "On Line Set Point Servo System (OLSPSS)" developed by Reactor Control Division, BARC, was transferred to M/s Senergy Intellution Pvt. Ltd., Mumbai, on September 16, 2002. OLSPSS provides facility to

test trip points of plant safety system by servoing the input signals around the set point strictly one at a time. It provides steering facility to connect a floating current source to different inputs of the system under test (SUT). This automated system aids the plant maintenance, as wiring need not be disconnected to calibrate or to test safety signals.



Mr G. Govindrajan, Director, E&I Group and A&M Group, BARC, handing over the Technology Transfer Document to Mr N.B. Patil, Director, M/s Senergy Intellution Pvt. Ltd., Mumbai, after signing the agreement. Other dignitaries seen from right to left are : Mr A.M. Patankar, Head, TT&CD, Dr R.B. Grover, Associate Director, TC&IRG, Mr R.K. Patil, Head, RCnD, Mr R.P. Agarwal, TT&CD, Mr B. Biswas, Head, RR&PSS, RCnD.

OLSPSS works on the principle of current injection through floating source of 0-25 mA having current step resolution of 14 BITS and has 3 modes of operation, viz. Response test, Accuracy test and Calibration mode. OLSPSS can be used for OEM applications for test and monitoring of the computer for plant safety system for on-line live checking and to make hand-held live field calibrators.

Technology Transfer and Collaboration Division, BARC, co-ordinated all the activities related to technology transfer from advertisement of the technology to Technology Transfer Agreement signing, including the preparation of technical documents.

WORKSHOP ON RADIOCHEMISTRY AND

APPLICATIONS OF RADIOISOTOPES

Indian Association of Nuclear Chemists and Allied Scientists (IANCAS) conducted its 48th National Workshop on "Radiochemistry and Applications of Radioisotopes" at the Department of Chemistry, DDU Gorakhpur University, Gorakhpur, during October 19-28, 2002.



Inauguration of the 48th BRNS-IANCAS National Workshop. Seated from left to right are Dr S.S. Das, Organising Secretary; Prof. N.B.Singh, Workshop Director; Prof. K. Pandey, Dean of Science Faculties; Prof. R.R. Pandey, Vice-chancellor, DDU Gorakhpur University; Dr S.B. Manohar, Head, Radiochemistry Division, President, IANCAS; Dr N.L. Misra, Coordinator of the Workshop

The Workshop was inaugurated by Prof. R.R.Pandey, Vice-Chancellor, DDU Gorakhpur University. Prof. Pandey emphasised the significance of power in India's progress and the strides that the Department of Atomic energy has made towards achieving it. While welcoming the delegates, Dr N.B. Singh, Director of the Workshop, thanked IANCAS for accepting the invitation to conduct the Workshop. Dr S.B. Manohar, Head, Radiochemistry Division, BARC, and President, IANCAS, also the Chief Guest in the function, briefed the accomplishments of IANCAS in promoting the subject of Radiochemistry and application of Radioisotopes among the academics through National Workshops and publication of periodic thematic bulletins resulting in a manifold impact in the educational institutions. He delivered the Key Note address on 'Activities of Department of Atomic energy' covering the entire spectrum of

nuclear fuel cycle. He referred to the involvement of DAE in several applications of radioisotopes in Desalination, Food Preservation and other agricultural applications. Dr N.L. Misra, Coordinator of the Workshop, explained the objective of the Workshop and the contents planned for this course. Dr (Ms) Veena Sagar coordinated the experimental work with the help of other resource persons.



Prof. R.R. Pandey, Vice-chancellor, DDU Gorakhpur University, inaugurating the Nuclear Chemistry Laboratory; also seen in the photograph is Dr. V. Venugopal, Head, Fuel Chemistry Division, BARC and Vice-president, IANCAS, who presided over the function

There were many requests from the colleges and schools in Gorakhpur to hold a one-day workshop for the students of 12th Std. upto final B.Sc. One-day workshops were held at 5 colleges with a lecture on 'Radioactivity' and a demonstration experiment on 'Measurement of half-life'. As a part of college workshops, Dr V. Venugopal, Head, Fuel Chemistry Division, BARC, and Vice-President, IANCAS, gave a motivating talk on the topic 'Why should India pursue the Atomic Energy Programme?'.

All the proceedings of the Workshop and the experimental work were covered extensively by TV, Radio and local newspapers such as *Swatantra Chetana*, *Aaj*, *Dainik Jagaran* and *Rashtriya Sahara*. Dr Venugopal gave a one-to-one interview to *Swatantra Chetana* newspaper on request. Similar interview was also sought by Sahara TV for their regional channel on the need of pursuing Atomic Energy Programme in India. On popular demand, Dr. Venugopal gave a faculty lecture on 'Atomic Energy Programme – A Vision' in the Physics Department of DDU Gorakhpur

University, exclusively for the faculty members of physical and biological sciences.



Experiment on radiation measurement with gamma ray spectrometer conducted by Mr T.P. Chaturvedi in the laboratory

In a function presided over by Dr Venugopal, Prof. R.R. Pandey, Vice-chancellor of the University, inaugurated the Nuclear Chemistry Laboratory in the University. Dr Venugopal donated two detectors to the laboratory on behalf of DAE/BRNS. He wished that the department would make better use of the equipment by exposing this subject through simple experiments not only to the university but also to the young students in schools and colleges.



Dr V. Venugopal with the Radiation Detectors donated by DAE/BRNS to the Nuclear Chemistry Laboratory, DDU Gorakhpur University

A feedback session was held on the last day of the Workshop to respond to the comments submitted by the participants. Dr Misra, coordinator on behalf of IANCAS, replied to the queries. Dr Venugopal distributed the certificates to the participants and donated the equipment. Prof. R.R. Pandey, Vice-chancellor, DDU Gorakhpur University, presided over the function and expressed pleasure in organising the

Workshop and congratulated the organisers of the Workshop.

FIFTH TRAINING COURSE IN "BASIC RADIATION PROTECTION"

The BARC Safety Council (BSC) Secretariat, Radiation Safety Systems Division (RSSD), BARC, conducted the fifth three-day training course in "Basic Radiation Protection" at the AFD Conference Room, South Site, during October 23-25, 2002, for the benefit of the staff members working in the front end of nuclear fuel cycle of the BARC. The course was hosted by the Atomic



Mr H.S. Kamath, Director, Nuclear Fuels Group, BARC, with the participants and organisers of the course.

Fuels Division (AFD), BARC.

Mr R.P. Singh, Head, AFD, welcomed the participants and said that the aim of the training course was to bring the safety culture of the individual employees to the level of conscious competence, and that the employees should themselves make the safe practices a habit and subsequently become competent even unconsciously. Dr Pushparaja, Head, Radiation Hazard Control Section, RSSD, talked about radiation protection training requirements in the front end of the nuclear fuel cycle. He said that

regulatory requirements have become more stringent and that we should plan to bring down the dose. He also said that in uranium handling, inhalation was the main problem and that better ventilation, mechanisation, remotisation and containment should be provided.

Dr M.C. Abani, Head, RSSD, BARC, in his opening remarks, said that this was the fifth in a series of courses conducted by the RSSD and the BARC Safety Council (BSC). He said that since human senses cannot detect radiation, the people working in the radiation environment should be well acquainted with it, more so because the latent period for radiation-induced diseases is long. He added that the protection of man, machine and environment is important. Dr S. Banerjee, Director, Materials Group, BARC, in his

inaugural address, congratulated the RSSD for taking the lead in organising the course for continuously keeping the younger staff members well informed. He also said that to keep the two reactors working at full power, it is necessary to supply fuel at the rate of 50 t/y. He emphasised the need for the best way of laying the flow-sheet, material handling, good housekeeping and proper ventilation in fuel handling facilities. Dr K.L.

Narasimharao, BSC Secretariat, RSSD, proposed the vote of thanks.

Thirty-five participants from AFD, Uranium Extraction Division, Materials Processing Division and RSSD attended the course. The faculty included Mr D.V. Venkata Rao, Mr T. Krishnamohanam, Mr S. Kannan, Mr S. Soundararajan, Mr A. Raju, Dr P.C. Gupta, Dr M.V. Dingankar, Dr Pushparaja, Dr K.L. Narasimharao and Dr K.S. Pradeepkumar of RSSD; Dr B.S. Rao of Radiological Physics & Advisory Division; Dr R.K. Singhal of Health

Physics Division and Ms Pramilla Sawant of Internal Dosimetry Division.

The course consisted of 14 lectures covering various subjects, namely, radiation and health physics aspects, dose calculation, biological effects of radiation, health physics instruments, dose limits, handling of hazardous chemicals, industrial hygiene & safety, environmental monitoring, health physics procedures in nuclear fuel processing plants, radiation emergency response, internal dosimetry, transport of radioactive materials, and unusual incidents in fuel processing plants. Dr (Ms) S.B. Roy, Head, UED, and Mr N.G. Dutta, AFD, gave invited lectures on "Production of Uranium Metal in India", and "Management Overview of Safety", respectively.

The course was organised by Dr K.L. Narasimharao, with the active help and co-operation of all the members of BSC Secretariat. Mr H.S. Kamath, Director, Nuclear Fuels Group, BARC, in his concluding remarks, thanked Dr Abani for arranging the course and said that safety and productivity are two sides of the same coin and that the Department of Atomic Energy has achieved a level of safety, which the conventional industry could not achieve. He appreciated the efforts put in conducting the training course and assured that the organisers had taken note of the opinions expressed in the feedback session.

ISOMED BAGS EXCELLENCE AWARD FOR SIXTH TIME

ISOMED, the first and largest industrial gamma sterilization plant for healthcare products in the country, under Board of Radiation & Isotope Technology (BRIT), Department of Atomic Energy, has been offering radiation sterilization services to the healthcare sector since the past 30 years. This facility has obtained ISO-9002 accreditation. Over 1500 customers spread all

over India are availing ISOMED services on a regular basis.



Dr N. Ramamoorthy, Chief Executive, BRIT, receiving the award from Mr Rajesh Dalal, President & Executive Director, Professional Products Division, Johnson & Johnson.

To be successful in a dynamic market environment, it is essential to holistically optimise the entire production process chain of healthcare products, of which a significant link is ISOMED. Holistic means not only looking at price but all dimensions such as quality, delivery, reliability, flexibility and most important - trust. Being an important part of the process chain in the healthcare sector, ISOMED services influence all the above parameters. Although ISOMED and its customers work independently, both are extensively inter-dependent on each other. Therefore, working together on a common mission of being the most competitive offers ISOMED the opportunity to grow together with its customers. The horizon of opportunities is wide and ISOMED realises this in a profitable way.

In recognition of the significant role played by their various business associates in their quality endeavours, the Professional Products Division of M/s. Johnson & Johnson Ltd., a pharma major, has been holding "Supplier Recognition Nite", once in a year.

In such an august function arranged by them on November 29, 2002 at Hotel Taj Lands End, Band Stand, Bandra, ISOMED bagged the award for "Excellence in Customer Services". Dr N. Ramamoorthy, Chief Executive, BRIT, received the award from Mr Rajesh Dalal, President & Executive Director, Professional Products Division, J & J Ltd. Dr I.J. Singh, Sr. Vice

President from the host organisation, Mr J.K. Ghosh, Dy. Chief Executive, BRIT, and P. Madhusoodanan, General Manager, Gamma Radiation Processing Services, ISOMED, BRIT, were also present during the award giving ceremony.

The function was also attended by other management teams and staff of J&J as well as a host of other business associates of J&J. This is the sixth time in succession that ISOMED bags this prestigious award for Excellence in Customer Service. The function had also enlightening talks from eminent management executives of J&J and from other dignitaries of their business partners on inter-dependence of business activities.

RECREATION CENTRE AT BAL KALYAN NAGARI INAUGURATED

Mr B. Bhattacharjee, Director, BARC, revealed another facet of his personality when he, accompanied by his wife, visited Bal Kalyan Nagari (BKN) on November 9, 2002 for inaugurating a Recreation Centre for the inmates there. BKN is an institution for the socially deprived children and is situated near the main gate of Anushaktinagar. The couple evinced keen enthusiasm by visiting the children's dormitories (Kutirs), the tailoring classes for the children, the common kitchen, where the food for 400 children is being prepared, and also the vacant plot of land where saplings of fruit bearing trees are proposed to be planted.



Mr B. Bhattacharjee, Director, BARC, and his wife going around the precincts of Bal Kalyana Nagari at Mankhurd.

It is important to note that last year BARC had gifted six PCs to BKN and helped them in starting a Computer Centre there. This year also BARC gifted four Pentium-PII PCs and four Dot Matrix printers to BKN. Mr Bhattacharjee visited the computer centre also and showed keen interest in its working.

The staff and the children of BKN had arranged a small programme in honour of the Chief Guest and his wife. Ms Murthy, Administrator, Remand Home for Children at Mankhurd, gave the welcome speech. Ms Kamal Abani from Anushaktinagar, who has been doing social service at BKN for the past many years, introduced the Chief Guest to the audience. Mr M.S.S. Murthy, the Deputy Chief Officer of Children's Aid Society (CAS), the parent body of BKN, who spoke on the occasion, explained how BKN came into existence in 1974. Incidentally, Mr Murthy has also recently written a book titled "Stories Waiting to be Told" which contains heart-rending true-life stories of some of the inmates of such institutions. He presented a copy of this book to Mr Bhattacharjee.

Mr Bhattacharjee, in his address to the children, expressed happiness about the progress made by the children. He also appreciated the efforts put in by the staff of BARC (residing in Anushaktinagar) who regularly visit BKN for social work. He exhorted the children to work hard to achieve their goals in life. He pointed out that he himself had to overcome many difficulties in young age. He also assured of continued support by BARC to the activities undertaken towards social development of children at BKN. Mr S.A. Jadhav, Administrator, BKN, in his address of vote of thanks, made special mention about the help given by BARC officers, especially Mr G. Govindarajan, Mr H.K. Haura, Mr P.S. Dhekne, Dr S.P. Garg, Mr R.S. Chhokra, Dr Vijai Kumar, Dr M.C. Abani and Mr R. Sadagopan. The programme ended with distribution of savouries to the children. The children were very happy on the occasion.

भा.प. अ. केंद्र के वैज्ञानिकों को सम्मान / BARC SCIENTISTS HONOURED

डॉ. जय पाल मित्तल को पद्मश्री पुरस्कार



• डॉ. जयपाल मित्तल, विशिष्ट वैज्ञानिक एवं निदेशक, रासायनिकी एवं आइसोटोप वर्ग, भाभा परमाणु अनुसंधान केंद्र, को विज्ञान तथा इंजीनियरिंग के क्षेत्र में विशिष्ट योगदान के लिये भारत के माननीय राष्ट्रपति के द्वारा पद्मश्री पुरस्कार से

सम्मानित किया गया।

डॉ. मित्तल का जन्म 1940 में मेरठ में हुआ। उन्होंने 1959 में रसायनिकी में स्नातकोत्तर उपाधि प्राप्त की तथा परमाणु उर्जा संस्थान ट्राम्बे, जो अब भाभा परमाणु अनुसंधान केंद्र के नाम से जाना जाता है, में कार्य भार ग्रहण किया। उन्होंने 1967 नोर्ट्रे डेम विश्वविद्यालय से पी.एच.डी. तथा नोबल सम्मानित डबल्यू.एफ. लिब्बी के साथ लॉस एंजिल्स के केलिफोर्निया विश्वविद्यालय से पोस्ट डाक्टरल अध्ययन किया। वे यू.एस. सेना प्रयोगशाला, नेटिक (1971-72), तथा नोर्ट्रे डेम विश्वविद्यालय (1981-1982) में अभ्यागत वैज्ञानिक रहे।

भाभा परमाणु अनुसंधान केंद्र में अपने सुविख्यात कार्यकाल के दौरान डॉ. मित्तल ने विकिरण रासायनिकी, विकिरण जीव-विज्ञान, प्रकाश रासायनिकी, प्रकाश जीव-विज्ञान, लेजर रसायनिकी, अति तीव्र रासायनिक, संसाधन एवं रसायन गतिकी के क्षेत्र में 280 से भी अधिक उत्कृष्ट शोध-पत्र प्रकाशित किए, जिनको अंतरराष्ट्रीय स्तर पर ख्याति प्राप्त हुई।

डॉ. मित्तल ने अब तक 30 पी.एच.डी. विद्यार्थियों का मार्गदर्शन किया। वे देश के कुछ ही रासायन वैज्ञानिकों में से एक हैं जिन्होंने 500 से अधिक प्रशस्ति पत्र प्राप्त किये हैं।

डॉ. मित्तल विभिन्न परियोजनाओं का संचालन करते रहते हैं जिनमें रासायन विज्ञान का मूल अनुसंधान तथा आइसोटोप अनुप्रयोग एवं विकिरण प्रौद्योगिकी का प्रयोग भी शामिल है।

इन दिनों वे विभिन्न क्षेत्रों के 350 वैज्ञानिकों का मार्ग दर्शन कर रहे हैं जिसका प्रभाव राष्ट्रीय तथा अंतरराष्ट्रीय वैज्ञानिक अनुसंधान के विकास पर पड़ रहा है। डॉ. मित्तल कई राष्ट्रीय तथा अंतरराष्ट्रीय पुरस्कार प्राप्त कर चुके हैं जिनमें जर्मनी का हेमबोल्ट विशिष्ट पुरस्कार भी शामिल है।

उनकी उत्कृष्ट वैज्ञानिक मान्यता के कारण उन्हें समस्त राष्ट्रीय वैज्ञानिक अकादमियों और थर्ड वर्ल्ड अकादमी, इटली द्वारा सम्मानित सदस्यता से गौरवान्वित किया गया। वे भारतीय रासायनिक सोसायटी (ICS) के अध्यक्ष भी रह चुके हैं तथा इस समय भारत की राष्ट्रीय वैज्ञानिक अकादमी के अध्यक्ष हैं।

डॉ. मित्तल ISRAPs के संस्थापक सदस्यों में से एक हैं जिन्होंने सचिव, अध्यक्ष तथा उपाध्यक्ष के रूप में संस्था की सेवा की है।

अपनी प्रतिभा तथा व्यक्तित्व के कारण डॉ. मित्तल अपने सहकर्मियों के लिये एक पथ प्रदर्शक, परामर्शदाता और अच्छे मित्र हैं। सहवैज्ञानिक उन्हें भविष्य के युवा वैज्ञानिकों के लिए एक आदर्श के रूप में मानते हैं।

Dr Jai Pal Mittal awarded PADMA SHRI

Dr Jai Pal Mittal, Distinguished Scientist and Director, Chemistry & Isotope Group, BARC, has been awarded Padma Shri by the Honourable President, Government of India, in recognition of his distinguished service in the field of Science and Engineering.

Born in 1940 in Meerut, Dr Mittal received his Master's degree in Chemistry in 1959 and joined the Atomic Energy Establishment, Trombay, presently known as Bhabha Atomic Research Centre. He received his Ph.D. from University of Notre Dame in 1967, and did his post-doctoral work in the University of California, Los Angeles, with Nobel laureate Prof. W.F. Libby. He was a visiting scientist at US Army Laboratory, Natick (1971-72) and University of Notre Dame (1981-82).

During his illustrious career at BARC, Dr Mittal has published over 280 outstanding research papers in internationally peer-reviewed high impact journals in the field of radiation chemistry, radiation biology, photochemistry, photobiology, laser chemistry, ultra fast chemical processes and chemical dynamics. He has so far guided 30 Ph.D. students. Dr Mittal is one of the few chemists in the country having more than 500 citations.

He has been directing various research projects involving chemical sciences, both in basic

research and in the applied areas of isotope application and radiation technology.

Currently, he is leading a multidisciplinary team of 350 scientists in an exemplary fashion, making a high impact on the development of science research in the national and international scene.

Dr Mittal is the recipient of several National and International awards and honours, including the prestigious Humboldt Research Award Germany. Based on the excellent scientific recognition, he has also been conferred the Honorary Fellowship of all the Indian National Science Academies and Third World Academy of Sciences, Italy. He has been the President of the Indian Chemical Society (ICS). He is presently the President of the National Academy of Sciences, India.

Dr Mittal is one of the founder-members of ISRAPS and served the society in various capacities as Secretary, Vice-president and President.

A guide, mentor and a great friend to his colleagues, Dr Mittal, by the force of his intellect and personality, has always been exerting a profound influence on all who are fortunate to have come in contact with him. Fellow scientists look upon him as a role model for many blossoming young researchers.

पुरस्कार उन्हें मोडुलर स्लज्ज लान्सिंग इन्फुमेंट फोर मशरूम टाइप स्टीम जनरेटरस आफ प्रशराइज्ड हैवी वाटर रियक्टरस (PHWRs) की प्रस्तुति के लिये दिया गया है।

इसके लेखक, रियक्टर इंजीनियरिंग प्रभाग के श्री एस.नवाथे, श्रीमती जे. अपर्णा, श्री के.एल.सोनी, श्री बी.बी.रूपानी, श्री जे.एन. कायल, श्री एल. आर.मोहन और श्री एच.पी.व्यास हैं।

Mr Shirish Nawathe of Reactor Engineering Division (RED), BARC, received the first prize for the best poster paper presentation at the 13th Annual Conference of Indian Nuclear Society (INSAC-2002) on "Nuclear Technology Catalyst for National Development" held at Mumbai during October 9-11, 2002. The award is for the paper, "Modular Sludge Lancing Equipment for Mushroom Type Steam Generators of Pressurised Heavy Water Reactors (PHWRs)" by S. Nawathe, J. Aparna, K.L. Soni, B.B. Rupani, J.N. Kayal, L.R. Mohan and H.P. Vyas of RED, BARC.

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प्रौद्योगिकी उत्प्रेरक राष्ट्रीय विकास के लिये भारतीय नाभिकीय सोसाइटी (INSAC-2002) से उच्चकोटि पोस्टर प्रस्तुतिकरण पर प्रथम पुरस्कार प्राप्त किया। यह



डॉ. आर.चिदांबरम, अध्यक्ष, भारतीय नाभिकीय सोसाइटी,
श्री एस.नवाथे को पुरस्कृत करते हुए

Dr R Chidambaram, President, INS, presenting award to Mr S. Nawathe