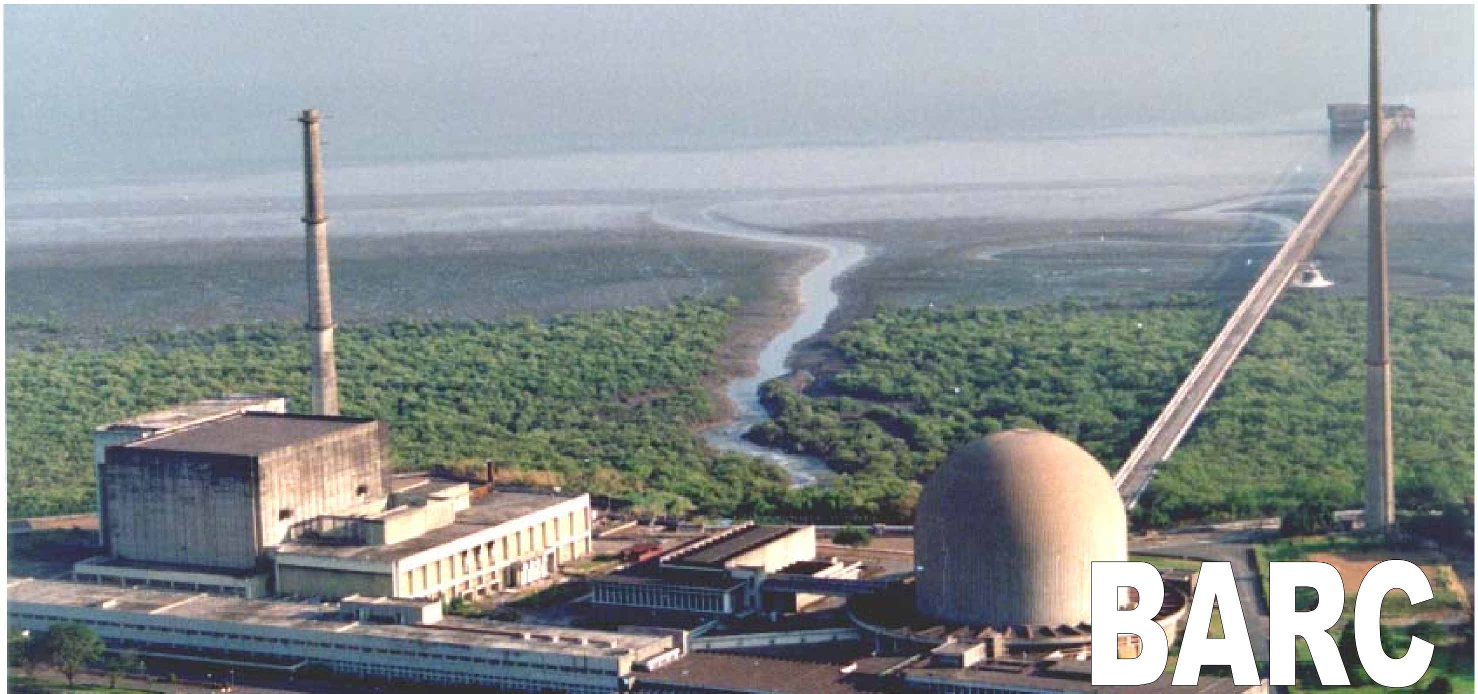

BARC

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Contents

DEVELOPMENT OF MINIATURE "BARC ^{125}I OCU-PROSTA SEEDS" FOR THE TREATMENT OF EYE AND PROSTATE CANCERS

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Introduction

Interstitial brachytherapy using ^{125}I sources for the treatment of eye and prostate cancer is fast emerging as a radiation therapy modality. Radioisotopes emitting low energy ionizing radiations are preferred to treat these types of cancers. On account of the suitable radiation characteristics such as low energy X-rays and γ rays, and a long half-life of around sixty days, ^{125}I is the most common choice among the other available radioisotopes for this modality of treatment.

The Radiopharmaceuticals Division upon the request of Sankara Nethralaya, Chennai, one of the leading eye hospitals of our country, took up the development of the radiation sources for ophthalmic plaque therapy. Using the sources developed by the Radiopharmaceuticals Division, Sankara Nethralaya has started the treatment of retinoblastoma (a type of eye cancer mostly found in infants) and other types of choroidal and ocular melanomas. This article gives an account of the development of the sources which involved very high challenges with respect to source preparation, development of the capsules, laser welding the sources to meet the stringent safety parameters and qualification of the sources for human application, etc. Several Divisions of BARC (Laser Processing and Advanced Welding Section, Centre for Design and Manufacture, Isotope Applications Division, Radiometallurgy Division, Radiological Physics and Advisory Division) as well as external agencies like Atomic Energy Regulatory Board and Hindustan Machine Tools Ltd., Bangalore, contributed in this development.

Historical Perspective

It is well known that tumor tissues as well as normal tissues both respond to irradiation from a radiation source, and when the tissues are exposed to ionizing radiation the cells are killed. Hence, a significant decay of the cancerous cells can be achieved in case of malignant diseases by exposing them to radiation. However, it is of utmost importance that the tumoricidal effect (i.e. the killing of cancerous cells) obtained from a radiation source should not be at the expense of normal tissues. Generally, teletherapy (external beam therapy) and brachytherapy (wherein the source lies in the close proximity of tumor) are adapted as the modes of radiotherapy for treating the malignant tumors. In this perspective, brachytherapy has a distinct advantage over external beam therapy. External beam therapy mostly uses the ionizing sources of high energy and intensity such as those of ^{60}Co, ^{192}Ir, etc. and only deep-seated tumors can be treated more effectively without causing much damage to healthy tissues, whereas, in case of brachytherapy, the ionizing source could be of low energy and low intensity as the source lies very close to the tumor site and the required radiation dose could be easily delivered to the effected lesion without any undue exposure to the nearby healthy tissues. In fact, one of the oldest modalities used in the treatment of prostate cancer was brachytherapy using a naturally occurring radionuclide ^{226}Ra, but owing to the side effects it caused on other organs, it was not much popular and subsequently it was totally discontinued. The technological advancement in the production and isolation of low energy radionuclides such as ^{103}Pd, ^{125}I, ^{106}Ru, etc., the preparation of miniature sources using these radionuclides and the development of easy techniques for implanting these sources (seeds) using ultrasonography, together with advances in dosimetric studies using latest software, led to the commercial exploitation of these sources in the low dose rate (LDR) brachytherapy of malignant tumors.

Radiotherapeutic Management of Eye and Prostate Cancer

Retinoblastoma is a cancerous growth that occurs in the eye of infants. It can be present as white reflex at the pupil of the eye and if ignored, can cause protrusion of the eye ball (Fig. 1) and spread of tumor to other organs like brain etc., which could be fatal to the life of the child.

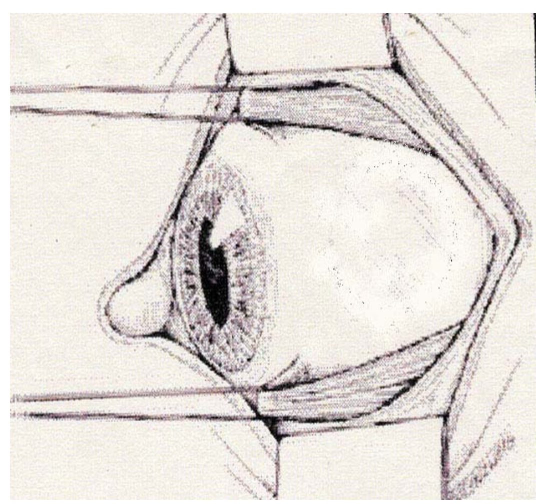


Fig.1 An eye ball with retinonlastoma

Like most of the other cancers, the exact reason in this case also is not known but usually attributed to hereditary factors. Retinoblastoma mainly occurs in one eye of the child but occurrence in both the eyes is not unusual.

The second most common cancer in men is prostate cancer. Radiotherapy is an alternative to radical surgery of the prostate (prostectomy) and has been advocated as a less invasive and more tolerant treatment of prostate cancer. However, external beam therapy has tremendous side effects and other complications arising from radiation to surrounding organs. One way to achieve maximum radiation focusing on the prostate is by interstitial radiotherapy (brachytherapy). Though brachytherapy treatment of prostate cancer began in 1911, it was rediscovered later after the availability of radioactive sources (seeds) using the radioisotopes such as ^{125}I, ^{103}Pd, ^{106}Ru, etc. which have favourable radiation characteristics in terms of half life, energy and dose distribution. In addition to these, the availability of better imaging techniques such as transrectal ultrasound, fluoroscopy, high quality CT scan, etc. have now made permanent prostate implants much more popular in the western countries on an outpatient basis. The low energy radiation miniature source (seeds) with much lower activity (0.5 –1.0 mCi) than that used for ocular or eye cancer (2- 5 mCi) are used for permanent prostate implants. Although prostate cancer occurs quite frequently in Indian male population, radioactive seed implantation is not carried out in India due to various reasons, one of which is the non-availability of the radiaoactive seeds in India. The BARC ^{125}I Ocu-Prosta Seeds could be used for prostate implantation.

Diagnosis and treatment of Retinoblastoma

An ophthalmologist, with the help of ultrasound of the eye and in conjunction with CT scan of the brain, can effectively make a diagnosis of retinoblastoma. In general, most of the cancers are treated either by removing the affected part before it spreads to other parts of the body or by other modes such as radiotherapy and chemotherapy. Usually, the treatment of retinoblastoma is based on combination of all these modes. Surgical removal is considered as an option if the cancer is well advanced. Very small tumors may also be dealt with laser or cryosurgery. Radiation therapy combined with chemotherapy is considered an option to save the eye left with some vision. It has been observed that retinoblstoma is radiosensitive and most often when the external beam radiation treatment is used, the radiotreated tumors usually regress leaving a scarred tissue. In addition to this, the external beam radiation has long-term side effects such as cataracts. The brachytherapy with low energy sources kept in the close proximity of tumors is more safe and effective method to deal with such type of cancers.

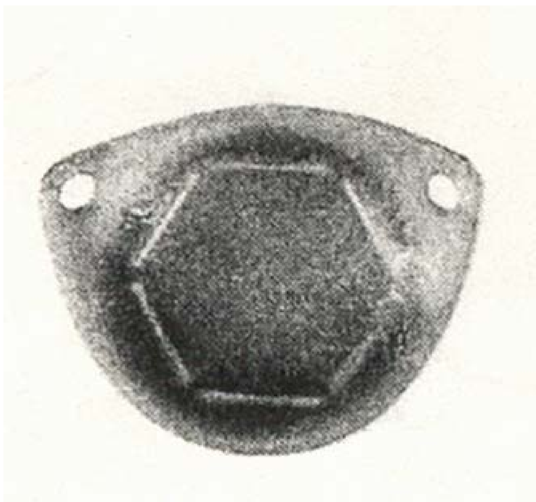


Fig.2 An Eye Plaque containing radiation sources

Radiation Plaque Therapy

Plaque is actually a metallic disc (Fig. 2) containing radioactive sources that were developed in the thirties to irradiate retinoblastoma and now this modality has come a long way. Today plaques are custom built for each patient. Generally, two surgical operations are carried out for this kind of treatment, one to insert the plaque and the other to remove it after a period of three to four days depending on the radiation dose required (40-60Gy) at the tumor apex. Complete remission of the tumor could be achieved by treating the tumor using low energy radio-nuclide "plaque" brachytherapy.

The low energy miniature sources containing ^{106}Ru, ^{125}I or ^{103}Pd are enclosed inside a laser welded titanium capsule and glued with cyanoacrylate polymer into a custom built gold plaque. The plaque is placed in proper position and radiation dose is delivered to the affected lesion over a precalculated duration, which could be a few days.

Choice of Radionuclides for Plaque therapy for Ocular cancer

Radionuclides used in the plaque radiotherapy for retinoblastoma are ^{125}I, ^{103}Pd and ^{106}Ru. The radiation characteristics of these three isotopes are given in Table 1. Iodine and palladium radionuclides may provide equal cell killing. However, the longer half-life of ^{125}I is an advantage over ^{103}Pd. The uranium fission produced ^{106}Ru is not very commonly used, although it is convenient for the user in terms of logistics due to long half life (~1y). But the Bremsstrahlung radiation produced from its daughter ^{106}Rh due to high-energy betas (β_{Max} - 3.5 MeV) are not desirable for the intended use. The high energy (10-50 MeV) cyclotron produced ^{103}Pd is not yet available in India and the logistics and cost considerations of this isotope do not permit its use at present. The reactor production of this isotope is not feasible due to low percentage abundance (~1%) and low neutron absorption cross-section of ^{102}Pd. On the other hand, ^{125}I with its relatively longer half-life and suitable gamma energy coupled with ease of production is a cost effective isotope and can be easily produced by (n,γ) reaction of natural ^{124}Xe gas in a special set up provided in the reactors CIRUS and DHRUVA at BARC. The production and processing procedures for ^{125}I have been already optimised and regular production of this isotope is going to be commenced soon at the Radiopharmaceuticals Division.

Source Requirements

The basic source core for the brachytherapy application demands that the source should have very high specific activity and the source should be incorporated in a solid and non-leachable matrix. The source has to be encapsulated in a capsule made up of non-reactive metal. The outer dimension of the titanium encapsulated source for ocular and prostate radiotherapy is 4.5mm (l) x 0.8mm (OD) with wall thickness of 0.05 mm (Fig. 3). The specifications of these sources are well defined and stipulated by ISO. The sources are encapsulated in tiny titanium capsules by laser welding. There are many techniques and many matrices used for the adsorption of radio-iodine like electrochemical deposition, adsorption on organic materials, coating on to tungsten surface, adsorption on palladium wire, coating on silver and ceramic beads, coating on ion exchange resins, etc. The know-how of most of the coating procedures are trade secrets and are usually covered by patent rights (IPR).

Table 1 : Radiation characteristics of radionuclides used for ocular/ prostate cancers

Isotope	$T_{1/2}$	Mode of Decay	Emissions	Internal Conversion	Energy (KeV)	Range (KeV)	Production methods
^{125}I	60d	EC (100%)	γ - rays (~7%) Te X- rays (~138%)	~ 93%	35. 5 27	27-35	Reactor
^{106}Ru	~1y	Beta	$^{\beta}$max	-	39.4	-	Fission
^{103}Pd	17d	EC (100%)	X-rays	~10%	25	20-25	Cyclotron

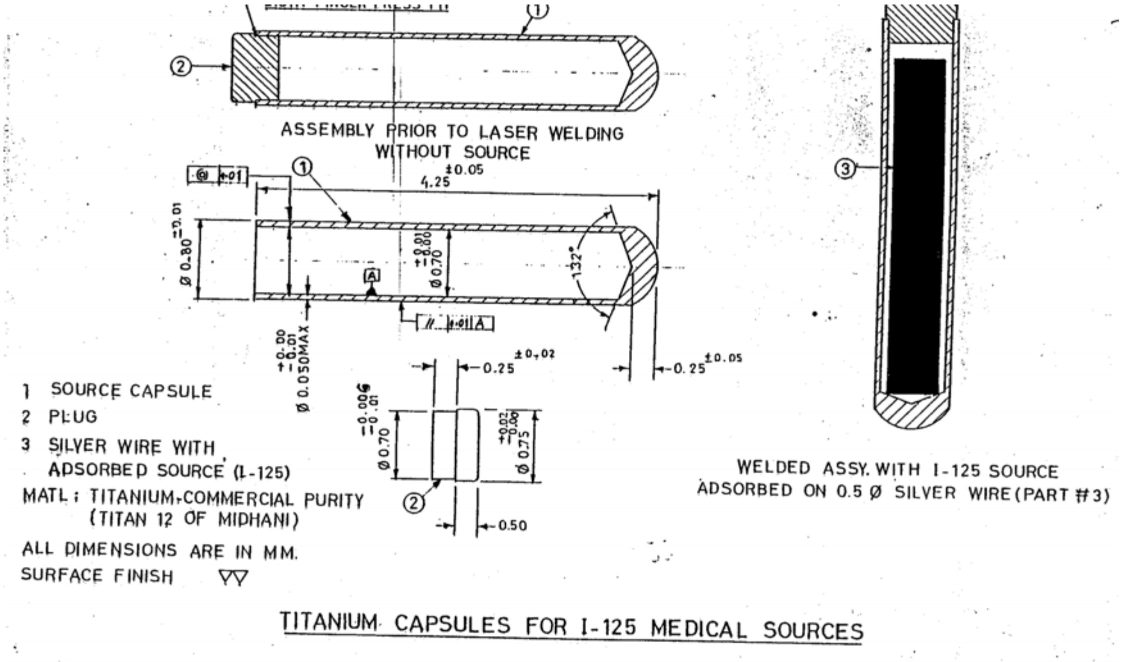


Fig.3 Sketch of titanium capsule

Work carried out at the Radiopharmaceuticals Division, BARC

Preparation of ^{125}I minature sources

The development of miniature sources suitable for eye plaque application started in the late nineties in the erstwhile Isotope Division. A novel method of adsorption of radioiodine (^{125}I) on palladium coated silver wire of guaranteed purity having dimension 3.0 mm in length and 0.5mm (ϕ) was developed and optimized. The experimental conditions like amount of radioactivity, carrier concentration, reaction time, reaction temperature, reaction volume, pH of the reaction mixture, etc. were systematically optimised. By this method, more than 80% of the initial radioactivity could be firmly deposited on the source core and 3 - 4 mCi of radioiodine could be irreversibly adsorbed on the palladium coated silver wires, which have to be encapsulated in ISO specified titanium capsules [1]. The sources with extremely good reproducibility and consistency w.r.t. activity content and other quality parameters could be produced.

Quality control of the unencapsulated (bare) source

Radioctivity content was measured preliminarily by dose - activity relationship at a fixed geometry using a radiation survey meter. Accurate assaying of the activity on the sources was carried out after encapsulation using an ion chamber calibrated with standard Amersham-6711 ^{125}I - seed.

Leachability

Non-leachability of the activity from the source was ascertained by placing the sources individually in distilled water at room temperature for 48h. The released radioactivity in the water was measured in a NaI (Tl) well type scintillation counter. The sources exhibited leachability well below the prescribed AERB limit (i.e.< 0.01% of total activity).

Determination of uniformity of adsorbed ^{125}I activity on the source core

A specially designed gadget was used for estimating the uniformity of adsorption. Using this gadget, one could autoradiograph the radiation emerging from eight directions from a single palladium coated silver wire source, which was placed at the center of the gadget, as shown in (Fig. 4). Optical density (OD) measurements were carried out on the developed radiographic film. The variation in OD values at different positions was generally found to be within ± 5%.

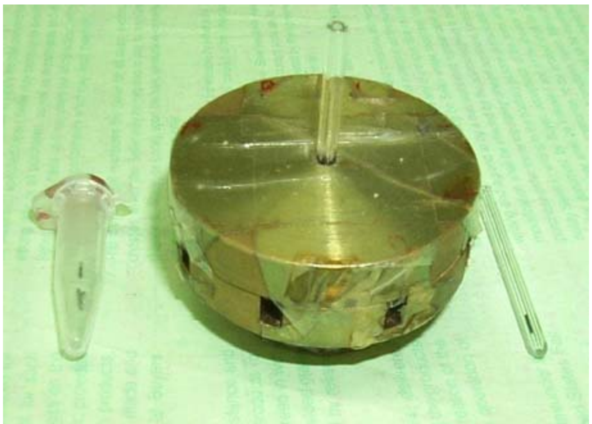


Fig. 4 An autoradiography gadget

Fabrication of titanium capsules

Development of the ISO specified miniature titanium capsules was initiated in the Centre for Design and Manufacture (CDM), BARC. The fabrication of these capsules was subsequently entrusted to the Precision Machinery Division of Hindustan Machine Tools, Bangalore. HMT, Bangalore, has done a yeomen service in developing these capsules and maintaining a steady supply. The capsules were evaluated for quality and dimensions by the Center for Design and Manufacture, BARC.

Sealing of ^{125}I sources in titanium capsules

Iodine is a highly volatile element and the encapsulation of sources containing radioiodine with the help of conventional TIG welding, etc. might lead to loss of radioactivity during encapsulation. Moreover, the sources were to be sealed in a capsule made up of low density and body compatible titanium metal. Due to oxidising nature of titanium, its welding techniques have undergone several modifications in the recent times, the latest being the laser welding. As compared to plasma arc welding, which some manufacturers used in the eighties, laser welding also provides superior precision and low HAZ resulting in more consistency without any appreciable loss of radioactivity.

Laser welding of titanium capsules (initial trials)

Initially, the laser welding was carried out at Laser Processing and Advanced Welding Section. Subsequently, a new 50 W, Nd:YAG laser system was procured exclusively for this work and the welding head was installed in a well-ventilated fume-hood in a radioactive laboratory at Radiopharmaceuticals Division at BARC (Fig. 5). The sources were inserted titanium capsules manually with the help of specially designed gadgets (Fig.6).

Fig. 5 Laser welding set-up inside a fume-hood

Initial laser welding trials were carried out using inactive palladium coated silver wires inserted in titanium capsules. The welding parameters such as energy, frequency, pulse duration, etc. were systematically optimised to obtain good uniform

Fig. 6 Insertion of sources in capsules

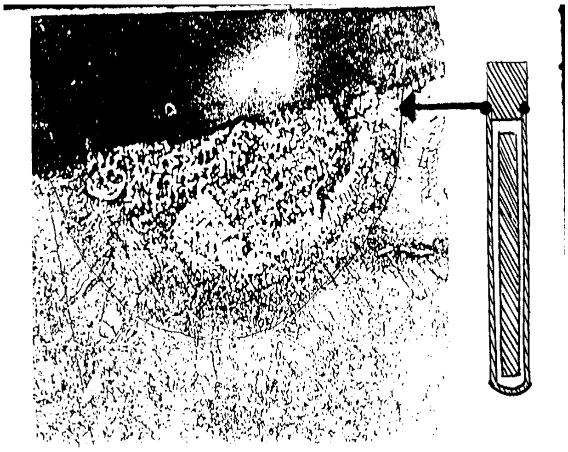


Fig.7 SEM of welded capsule

leak proof welds. The welded samples were evaluated for leak test and metallography. The leak test was carried out in different ways. The samples were kept in hot water and appearance of air bubbles was observed. Later, the samples were kept in helium chamber at 6-atmosphere pressure for 22 hrs. Subsequently, the samples were tested in an UL-200 (Lebold make) unit and found to be leak free. The actual values of leak rate are given in Table 2.

Table 2 : Leak rate of titanium capsules

S.No.	Vacuum (Torr)	Leak Rate (std. cc/sec)
1.	7.3×10^{-3}	0.5×10^{-9}
2.	9.2×10^{-3}	0.7×10^{-9}
3.	1.2×10^{-3}	0.8×10^{-9}
4.	9.0×10^{-3}	0.7×10^{-9}
5.	1.2×10^{-3}	1.1×10^{-9}
6.	9.7×10^{-3}	1.1×10^{-9}

The metallography test of inactive welded capsules was carried out by optical metallography and Scanning Electron Microscopy (Fig. 7). The penetration depth in the samples was found to be ~ 2-3 times the wall thickness of the capsules.

Welding of ^{125}I encapsulated sources.

The radioactive sources were inserted into the titanium capsule. The capsule was manually loaded on to the machine and held vertically. A laser beam was focused to the weld joint horizontally by an optical fiber based delivery system. All laser parameters along with rotation of the capsule including inert gas supply were controlled by a PC. The system was operated remotely. (Manual operation is also possible, if needed). A camera with separate optical lenses based arrangement was provided to view the welding region. The welding of titanium capsules containing radioactive BARC ^{125}I Ocu-Prosta seeds was carried out and quality evaluation was done for regular production [3]. The welded sources were cleaned to remove surface contamination (if present) and tested for leak as prescribed by AERB [2]. The air activity was constantly monitored during the process of welding. Some of the laser-welded capsules are shown in (Fig. 8).

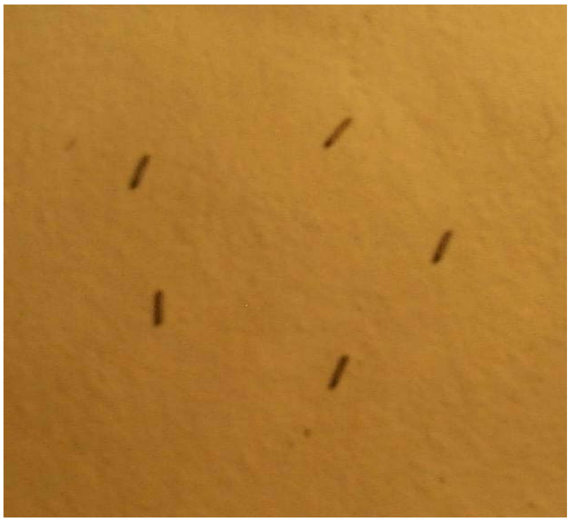


Fig. 8 Laser welded sources

Laser Encapsulation of Sources

The encapsulation of tiny ^{125}I radioactive sources in titanium capsules needed a systematic evaluation and optimisation of laser parameters like laser energy, pulse width, frequency, time of encapsulation, etc. The Nd:YAG laser installed inside the fume- hood of a lab in Radiopharmaceuticals Division is first of its kind in India. The encapsulation of medical radiation sources with the help of laser could be successfully done by taking the laser beam inside the radioactive area with the use of fiber optic cable. The welded samples showed high integrity and superior metallurgical quality. This is one of the finest application of laser in the service of mankind.

Quality assurance of the sealed sources (seeds)

The miniature sources after encapsulation need to be quality assessed for their final use. Accurate measurement of activity, surface contamination, uniformity of activity in the laser welded encapsulated sources, leak tightness, etc. as prescribed by AERB, were all part of the quality assessment of the sources [4]. The welded sources were decontaminated and accurate measurements of activity of individual sources (seeds) were carried out by using two different types of well ionization chambers. Both the ionization chambers were calibrated using Onco-seed model - 6711 at two different accredited dosimetry calibration laboratories, University of Wisconsin, USA, and K&S Associates, USA. The air kerma strength/activity measured on the seeds prepared using both types of chamber agreed within $\pm$ 5%. The uniformity of activity and leakage tests were also carried out.

The dosimetry of low energy photon emitting tiny brachytherapy sources containing radioisotope like ^{125}I is sensitive to source geometry, encapsulation internal structure, etc. Therefore, it is the ultimate responsibility of the medical physicists to validate the clinical dosimetry and other safety parameters. The dosimetric studies of sources were carried out at Radiological Physics and Advisory Division (RP&AD) of BARC, which revealed that the source design produced by Radiopharmaceuticals Division (RPhD) is similar to commercial source 6711 Oncoseed of Amersham International. In phantom dose, values calculated at a few depths by Monte Carlo simulation were also found to be in good agreement with the dosimetry data of type 6711 seed. The RP& AD, BARC, therefore, recommended that the published dosimetry data of similar sources could be used for clinical dosimetry of ^{125}I sources developed at RPhD, BARC.

Dosimetry of BARC ^{125}I Ocu-Prosta Seed

The new model of ^{125}I seed designed and developed by Radiopharmaceuticals Division of BARC, is similar in construction to the Model-6711 seed, produced by Medi-Physics Inc. of Nicomed Amersham, which is considered as the reference standard for similar model seeds. The standardization of the new model seed was done using two different types of well-type ionization chambers, both calibrated for model-6711 seed. The mean value of the air kerma strength ($\pm$2%), measured using the two types of chambers, was used for establishing the dosimetry parameters of the new model seed. The dosimetric parameters of sources were determined by measurements using LiF TLD micro-rods and by Monte Carlo (MC) calculations. The measured dose rate constant, dose rate at 1cm along the perpendicular bisector of the long axis of the source, agrees with MC calculated values within 2%. The mean of the measured and MC calculated dose rate constant (Λ=0.96) was recommended for the clinical dosimetry of BARC ^{125}I Ocu-Prosta seed.This value agrees with the dose rate constant reported for model- 6711 seed, within 1%.

Packing and despatch

Due to small dimensions of these radioactive sources and to keep a proper inventory, the sources are individually packed in suitably labeled screw capped brass containers. These containers are packed in glass vials tightly capped with aluminum cap and the vials are finally kept inside half-inch thick lead shipping containers. The packed sources are despatched to the user through BRIT.

Clinical Application of the Miniature Sources

Only specialised medical oncologists trained for the purpose may carry out ocular and prostate implantation with radiation sources. The "BARC ^{125}I Ocu-Prosta seeds" can be used for the treatment of retinoblastoma and other ocular melanomas. Once a patient is found suitable for brachytherapy (not all patients of retinoblastoma are suitable for this therapy), the tumor dimensions are measured based on clinical examination by ultrasonography or in certain cases by CT/MRI. These parameters are fed into dosimetry programme. The programme is designed to calculate the size of the plaque, radiation dose to be delivered, activity/number of seeds to be used, seed arrangement in the plaque and time duration of the treatment. ^{125}I sources are placed from end to end around inner side of an eye plaque. The eye plaques are made from gold alloy (92% Au and 8% Cu) or pure gold. The metal of plaque attenuates photons by ~99.9% and thus protects external surface of the eye from radiation and directs the energy towards the tumor. Plaques are made with semicircular edge cutouts to allow treatment of tumors lying close to the optical disc. Suture holes of 0.4 mm in diameter are drilled around plaque peripheries. They are usually made in pairs so that non-radioactive plaques can also be used for suture positioning. The radioactive seeds are positioned securely with the help of sterile cyanoacrylate adhesive.The plaque is sutured and left for requisite time to give the required radiation dose. The sources are carefully removed from the plaque after use and inventoried to be stored back. The decayed sources are to be returned to BARC / BRIT.

Clinical Trial with BARC ^{125}I Ocu-Prosta seed

The first clinical trial for the brachytherapy of retinoblastoma (a type of eye cancer found in infants) using BARC ^{125}I Ocu-Prosta seeds was performed at Sankara Nethralaya, Chennai. The AERB approved laser encapsulated ^{125}I radiation sources used in this treatment were prepared in Radiopharmaceuticals Division. The sources were supplied to Sankara Nethralaya, Chennai, through BRIT, for the treatment of a four-year old child suffering from retinoblastoma. Deploying ^{125}I radiation sources in ocular brachytherapy was treatment for the first time in India.

Clinical History of the Patient

A four-year old child was under treatment in Sankara Nethralaya for the last two years. This child had a bilateral tumor in both the eyes. He had vision in both the eyes and this factor could help the ophthalmologists to go ahead with chemoreduction of tumors. After the chemoreduction, the tumors were treated with laser therapy. This treatment could help to eliminate the tumor of one eye and the other eye could not be treated well. The tumor left in the second eye was subsequently treated with external beam therapy using a photon beam obtained from LINAC. This treatment helped the tumor to show some sign of improvement but at a later stage it again started growing with even much faster rate. Since the tumor was growing faster, it could spread upto brain and other parts as well and also there was a threat to the life of the child. The doctors at this stage were left with an option of either removing the eye as a whole or to go for a brachytherapy treatment by placing the low energy radiation sources in the close proximity with the tumor. After taking consent with the parents of the child and getting the clearance from ethical committee of Sankara Nethralaya, they decided to treat this tumor with ^{125}I radiation sources and requested RPhD, BARC, for supply of sources on priority basis.

(Contd...)

Treatment Planning

One fresh batch of ^{125}I brachytherapy sources was processed, sources were laser encapsulated and their quality w.r.t. leakage, surface contamination, etc. was evaluated. A total of 23 sources were supplied to Sankara Nethralaya through BRIT. The treatment using these sources, having a total activity of ~ 36 mCi, was planned to be done on September 11 2003, and the fabrication of plaque (an eye shaped metallic holder made up of gold on which the sources are mounted) was planned to be done on September 10, 2003. Considering the size of tumor, the magnitude of radiation dose to be delivered was decided to be ~45Gy in a total duration of 88 hours. The removal of the plaque was decided to be done on September 15, 2003.

Fabrication of Plaque

The plaque was fabricated on September 10, 2003 by adhering 23 radiation sources on 18 K gold holder with cyanoacrylate glue. Over the adhered sources another layer of glue was applied to ensure the firmness of the sources with the metallic plaque. The plaque was sterilised with 2% lysoformin solution by leaving it overnight in the sterilising solution.The plaque was subsequently washed and the wash solution was tested for any release of activity. There was no detectable release of radioactivity noticed in this operation. The whole operation was performed in a separate room near the operation theatre well equipped with adequate provision of radiation shielding.

Treatment

The treatment using the sterilised plaque was started at 3:45 p.m. on September 11, 2003. The child was given general anesthesia and the sclera of the eye was opened. The tumor was marked with surgical marker and the radioactive plaque was implanted at about 4:15 p.m. After placing the plaque in position, the sclera was again stitched and the eye was closed with a 2mm lead sheathed plastic cup kept over the eye to bring the radiation level around the patient to almost background level. The bandages used in surgery were checked for the presence of any radioactivity and were found to be free from contamination. The plaque was removed on September 15, 2003 following a similar surgical procedure. The radiation field around the patient was monitored regularly throughout the treatment and found to be near background. Other than the regular doctors of Sankara Nethralaya, the treatment was performed in the presence of a consulting oncologist, a consulting physicist and supporting medical personnel. Dr .A.N. Nandakumar, Head, RSD, AERB, also visited on September 12, 2003, and went through all the records. Subsequently, Dr N. Ramamoorthy, Associate Director, Isotope Group, BARC, and Dr (Ms) Meera Venkatesh, Head, RPCS, RPhD, BARC, also visited Sankara Nethralaya on September 13, 2003. After the treatment, all the 23 radiation sources were recovered from the plaque by treating the plaque with acetone for about 30 minutes.

The other relevant details related to the treatment are mentioned below:

Size of the Plaque : ~ 22 mm (ϕ) x 12.5 mm R (radius of curvature) x 1.5mm thick
Material of Plaque : 18 K Gold
Size of the tumor : ~ 15 mm (ϕ) x ~6 mm depth.
Total radioactivity used : ~ 36 mCi.
No. of sources used : 23 Nos. (~ 1.56 mCi each on 11/09/03).
Total radiation dose delivered : ~ 45Gy at the apex of tumor.
Duration of treatment : 88 hrs.
Radiation level around the patient after treatment : Background level.

Result

The sources supplied by RPhD, BARC, could be successfully used for the first brachytherapy of retinoblastona in India using ^{125}I radiation sources. There was no increase in the radiation field in and around the body of the child after removal of sources.

In order to evaluate the efficacy of this treatment, the child has been asked to report to Sankara Nethralaya after 3-4 weeks, duration and subsequently after a regular interval of every two weeks. The approximate time to come to know the results regarding the effectiveness of the above treatment is likely to be about three months.

Conclusion

The ^{125}I sources developed at BARC have opened a new therapeutic window for the treatment of ocular and prostate cancer patients in India. The sources are being prepared regularly and the clinical trials are on the way. The first clinical trial using these sources was successfully performed at Sankara Nethralaya, Chennai, on September 11, 2003 (See clinical study report in box).

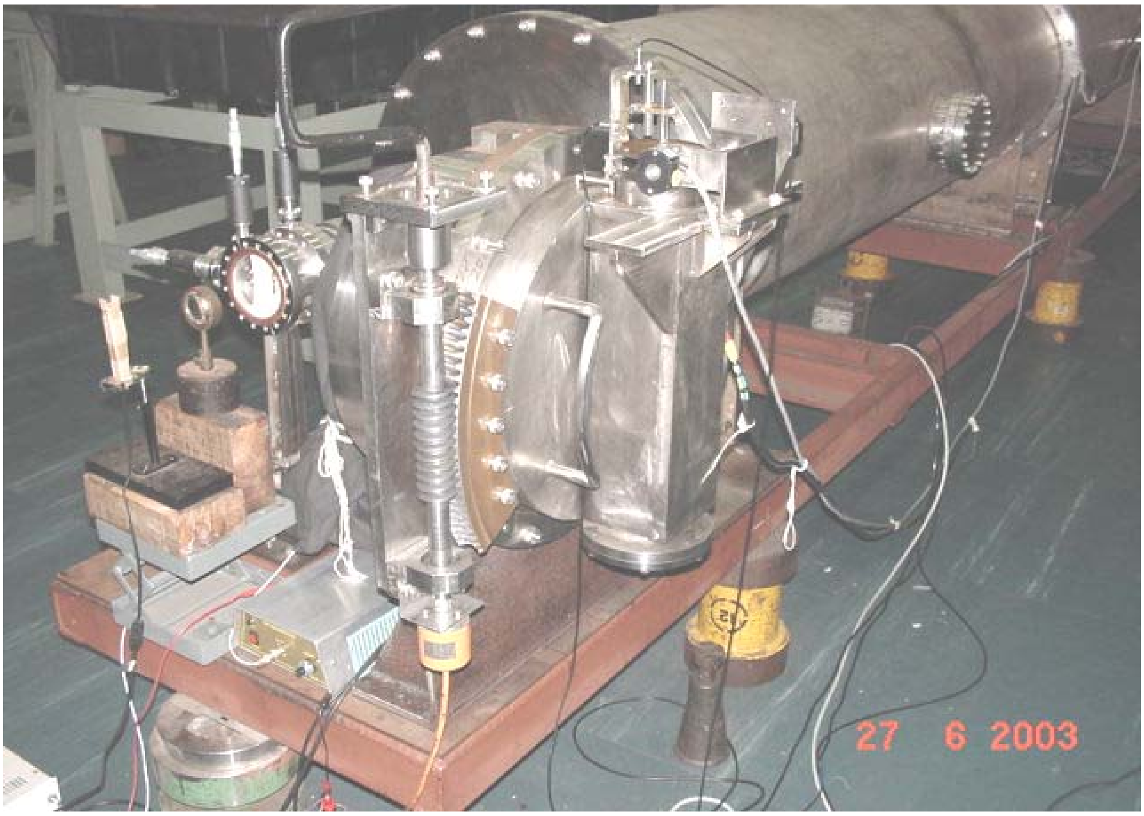
References

1. C. Mathew, M.A.Majali, and S.A. Balakrishnan, "A novel approach for the adsorption of ^{125}I on silver wire as matrix for brachytherapy for the treatment of eye and prostate cancer" - Appl. Rad. Isot, 57, 359-367, 2002.
2. "Testing and classification of sealed radioactive sources - AERB SS-3-1990".
3. S.K.Saxena, C. Mathew, Ramu Ram, R.B Manolkar, M.A. Majali, S.A. Balakrishnan, M.R.A.Pillai and G.L Goswami, "A Laser Beam Welding Facility for sealing of miniature Radiation Sources" - Poster presented in "DAE-BRNS symposium on Applications of Plasma, Laser and Electron Beams in Material Processing", held during September 25-28, 2002 at BARC, Mumbai.
4. M.A Majali, S.K.Saxena, C.Mathew, and A. Shanta, "Production and Quality control of ^{125}I Brachytherapy sources for eye cancer", J. Med. Phy 273, 2002.

BARC MANUFACTURES 6.65m SPECTROMETER

Centre for Design and Manufacture and Spectroscopy Division of BARC. have designed and developed a 6.65metre long Off-Plane Eagle Mount Spectrometer for high resolution V.U.V. Beamline. This will be the third instrument of its kind in the world.

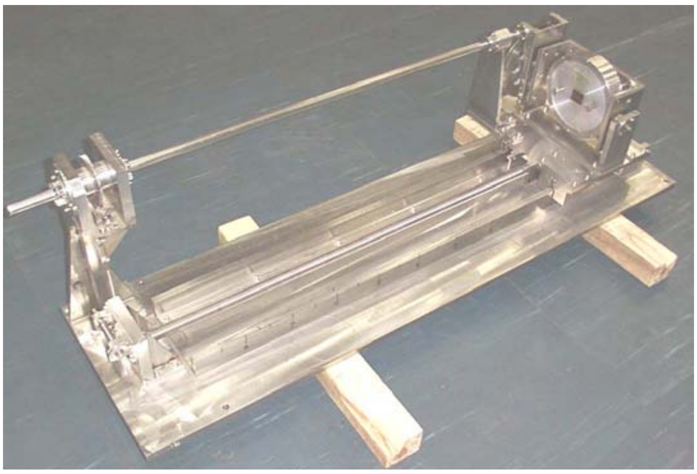
Grating end of spectrometer



Scanning mechanism end of spectrometer

This spectrometer will cover the spectral region of 400 A^o to 2000 A^o with a resolution of about 0.005 A^o. A concave grating having a groove density of 4800 g/mm and a radius of curvature of 3.325 metre will be used as the dispersing and focusing element. The spectrometer will be used in the high resolution V.U.V. beamline using synchrotron source of radiation as a source of excitation. The instrument will be useful in the study of absorption spectra of atomic and molecular vapours using a 450 MeV synchrotron radiation source (Indus-I).

The instrument consists of a 600 mm dia. and 7 metre long high vacuum chamber with entrance slit and scanning mechanism at one end and grating with its drive at the other end at a distance of 6.65 metre. The focused synchrotron beam falls on the sample and then passes through the entrance slit and goes to the grating which diffracts and focuses the circumference of 6.65 metre dia. circle called as “Rowland Circle”. The scanning mechanism, consisting of exit slit and photo multiplier tube, moves along the circumference of the Rolland Circle. For one position of grating, the scanning mechanism can scan a few wavelengths of beam which are focusing on an arc of 300 mm length. To scan other wavelengths focusing on different positions of the Rolland Circle, the Grating and the Guide (on which photo-multiplier tube moves) need to be moved and rotated accordingly. Resolution of mechanical system is 5 microns (linear) and 1 arc sec. (rotational).



Grating Drive

Following movements are required to be given to meet the optical requirements inside the high vacuum chamber (with 10^{-6} torr vacuum level) with high resolution and repeatability. Control panel will display position of all the optical components.

1. Grating movement : 800 mm.
2. Grating rotation : 0^{o} to 30^{o}.
3. Linear movement of photo multiplier tube : 300 mm.
4. Rotation of scanning mechanism : 0^{o} to 30^{o}.

Design and development of various sub-systems of this instrument was a challenging task. Assembly and all types of tests on the job are now completed. The spectrometer is being dispatched to Centre for Advanced Technology, Indore.

“नाभिकीय पदार्थ” पुस्तक का प्रकाशन

भाभा परमाणु अनुसंघान केंद्र में राजभाषा हिंदी के प्रयोग कोबल प्रदान करने तथा विश्वविघ्यालय स्तर पर सहज भाषा में नाभिकीय पदार्था एंव परमाणु ऊर्जा से संबंधित साहित्य उपब्ध कराने हेतु “केंद्रीय सचिवालय हिंदी परिषद” तथा “पुस्तकालय एंव सूचना सेवाएँ प्रभाग “के संयुक्त सौजन्य से हिंदी में अनूदित की गयी पुस्तक नाभिकीय पदार्थ का विमोचन 12 दिसंबर, 2003 को केंद्रीय सभागृह में किया गया । पूर्व वर्ग निदेशक, डॉ. डी.डी. सूद द्वारा लिखित मूल अंग्रेजी पुस्तक न्यूक्लियर मैटेरियल्स् का प्रकाशन ईआनकास द्वारा किया था । डॉ. श्रीकुमार बॅनर्जी, निदेशक, पदार्थ वर्ग के मार्गदर्शन में किये गए । इस उत्कृष्ट राजभाषा कार्य के लिए रेडियोभेषज प्रभाग में वैज्ञानिक अधिकारी के पद पर कार्यरत श्री संजय सक्सेना को केंद्र की राजभाषा कार्यान्वयन समिति के अनुमोदन पर 2500/- रुपए का मानदेय भी प्रदान किया गया । इस पुस्तक को केंद्र के पुस्तकालय एवं सूचना सेवाएँ प्रभाग द्वारा विभिन्न कॉलेजों/विश्वविघ्यालयों एवं राजभाषा संबंधी संस्थाओं को भेजने का तथा जनजागरूकता प्रभग द्वारा इसे परमाणु ऊर्जा विभाग की वेबसाइट पर उपलब्ध कराये जाने का प्रावधान किया जा रहा है ।

FIRST LADY SHIFT ENGINEER IN INDIAN NUCLEAR REACTORS

Miss Renuka Bhabra , a chemical engineer and BARC Training School graduate (43rd batch), joined Reactor Operations Division in September 2000. After undergoing extensive in-plant training in research reactor Dhruva, she successfully completed the three-stage qualification procedure to become the first lady shift engineer in Indian nuclear reactors in the history of Indian Nuclear Programme. She achieved this distinction in the non-traditional field of Nuclear Reactor Operation, despite several personal and professional challenges. Her example can be a stimulant to young women to take up challenging jobs in unconventional fields.

TRAINING PROGRAMME ON DATA INTERPRETATION USING MODERN ANALYTICAL TECHNIQUES

Analytical Chemistry Division (ACD) of BARC and Neutron Activation Analysis Unit of Central Forensic Science Laboratory, Hyderabad jointly organised the Training Programme on "Use and interpretation of data based on NAA & other modern analytical techniques with respect to case exhibits/samples" at ACD, BARC, Mumbai during November 17-19, 2003. The objective of the course was mainly to expose the forensic scientists to recent advances in the use and interpretation of data based on Neutron Activation Analysis and other modern analytical techniques for elemental analysis of evidentiary materials, which has proved to be of immense value in forensic investigations.

The Inaugural function was held at 'C' Block Auditorium, Modular Laboratories, BARC, on November 17, 2003. Dr. N. Chattopadhyay, Deputy Director, NAA Unit of CFSL, Hyderabad (at ACD, BARC) who is the Course Director, welcomed the participants who had come from different places to attend the course. He also introduced to the gathering the course contents focussing the necessary objective to conduct such type of courses inside BARC premises.

Dr T. Mukherjee, Associate Director, Chemistry Group, BARC, inaugurated the Training Programme by stating the objective and utility of the course . Delivering the Inaugural Address, he stressed the potentiality of nuclear technology in helping to solve criminal cases. He also appreciated the sustained team effort and competence of the scientists to take up challenges and opportunities. Compiled lecture notes in the form of books were released by Dr Mukherjee after the inaugural address. They were prepared to enhance information contents and for the benefit of the participants.

During the inaugural function of the Training Programme (seated from right to left) : Dr A.K.Basu, Astt. Director, NAA Unit of CFSL, Hyderabad at ACD, Dr M. Sudersanan, Head, Analytical Chemistry Division, BARC, Dr T. Mukherjee, Associate Director, Chemistry Group, BARC, Dr (Ms) R. Krishnamurthy, Director, Forensic Science Laboratory, Mumbai, Govt. of Maharashtra, Dr N. Chattopadhyay, Deputy Director & Course Director, NAA unit of CFSL, Hyderabad at ACD, Mr C.A. Bhadkambekar and Dr A.B.R. Tripathi of NAA Unit of CFSL(H) at ACD

Dr M. S. Rao, Director-cum-Chief Forensic Scientist, DFS, MHA, New Delhi, by a message, conveyed that a good response from all corners is an indication that the interest in this specialised branch of analytical chemistry is sustaining and quite challenging problems are being pursued. He conveyed his good wishes for the success of the course.

Dr M. Sudersanan, Head, ACD, BARC, delivered introductory address by reiterating the utility of the course. He stated the importance of this unique work programme utilising reactor irradiation and other facilities existing in BARC to carry out nuclear analytical techniques, in the pursuit of truth.

Dr (Ms) R. Krishnamurthy, Director, Forensic Science Laboratory, Mumbai, in her remarks highlighted the scenario with respect to forensic context and advised the participants to take the best advantage of the opportunity of exposure to the scientists of BARC which is a premier research centre.

Dr A. K. Basu, Asstt Director, NAA Unit of CFSL, Hyderabad (at ACD, BARC) proposed the vote of thanks. He was also the curtain raiser of the inaugural function.

The programme consisted of a series of lectures on different aspects of Neutron Activation Analysis technique. Lectures on X-Ray fluorescence, electroanalytical techniques and role of other modem analytical techniques in forensic science were also covered. In addition, a lecture on the recent bomb blast cases in Mumbai was kept. Hand on practical as well as demonstration in Radiochemical and Instrumental Neutron Activation Analysis with associated gamma-ray spectrometry were also arranged for the benefit of the participants. The practicals emphasised the methodologies which are adopted towards analysis of case exhibits/ samples.

Faculty members were drawn from among CFSL scientists stationed at BARC, State FSL, Mumbai, ACD & RCD of BARC.

The 3-day training course was meant to create the awareness among the scientists of various state and central forensic science laboratories to take advantage of the Nuclear Analytical Technique, specially in those circumstances where other normal analytical techniques do not yield satisfactory information to reach to a conclusion. A total of 19 participants (12 Forensic scientists and 7 BARC scientists) attended the Course. Objective type questions for technical feed back in the form of 4 possible options to arrive at the most appropriate answers were conducted for the participants .

Dr M. S. Rao, Director-cum-Chief Forensic Scientist, Directorate of Forensic Science, MHA, New Delhi and Dr C. N. Bhattacharyya, Director, CFSL, Hyderabad, rendered their full valuable administrative and financial support, guidance with constructive suggestions to make all arrangements in a smooth and efficient manner.

On the final day, Dr M. Sudersanan, Head, ACD, BARC, reviewed the feed backs (response sheets) received from the participants. In his valedictory address, Dr M. Sudersanan, mentioned that the impact of interactive deliberations will be fruitful from both sides, i.e. end users as well as providers of facilities. He then presented the certificates to the participants. Dr A.B.R. Tripathi of NAA Unit extended the vote of thanks.

Overall the programme was thought provoking and the lively discussions during/ after presentations were highly appreciated by the participants.

IAEA/RCA REGIONAL TRAINING COURSE

An IAEA/RCA Training Course on “Assessment of Occupational Exposure due to Intakes of Radionuclides” was sponsored by International Atomic Energy Agency and organised by Internal Dosimetry Division of BARC during October 20-31, 2003. The course was attended by 19 participants from 11 RCA Member States in the Asian region, namely, Bangladesh, P.R. China, India, Indonesia, Malaysia, Mongolia, Myanmar, Republic of Korea, Srilanka, Thailand and Vietnam.

The main purpose of the course was to provide training in the principal concepts, methods and equipment used for assessment of internal exposure to ionizing radiation, with emphasis on application to occupational radiation protection. The course was targetted to developing countries, particularly those in the model project, with the dosimetry services responsible for assessment of internal exposure of workers occupationally exposed to ionizing radiation.

Mr H. S. Kamath, Director, Nuclear Fuels and Radiochemistry & Isotope Groups, BARC, delivering the inaugural address. Others on the dais are (from left to right) : Dr A.S. Pradhan, Head, IDD and the Course Director, Dr A. Andrasi, IAEA Expert , Mr H. S. Kushwaha, Director, H, S & E Group, Dr R. V. Griffith, IAEA Expert and Dr Castellani, IAEA Expert

The training course was inaugurated by Mr H.S. Kamath, Director, Nuclear Fuels and Radiochemistry & Isotope Groups, BARC, at the Hotel Sea Princess, Juhu, on October 20,2003. In his inaugural address, Mr Kamath mentioned the importance of internal dosimetry programmes and the effective implementation of these programmes in our country. Mr H.S. Kushwaha, Director, Health, Safety & Environment Group, BARC, welcomed the participants and the invitees. In his address, Mr Kushwaha emphasised the importance of RCA programmes in radiation protection and the effective role played by Department of Atomic Energy to support the RCA programmes by organising several workshops and training courses. The inaugural session concluded with a vote of thanks from Dr A.S. Pradhan, Head, IDD and the Course Director.

The training course consisted of lectures, demonstrations, practical work sessions and exercise with discussion sessions. The lectures included principles of designing a programme for monitoring occupational exposure, criteria for the need for monitoring, individual dose assessment, direct monitoring methods, indirect monitoring methods, uncertainties and performance criteria, interpretation of direct and indirect measurements, internal dosimetry software, assessment of internal exposure following accidents or incidents, quality assurance and quality control and records and record keeping. The practical exercise included four practicals on direct and indirect methods of internal dosimetry and the interpretation of the doses from the measured results. The desktop exercises and the practical experiments were conducted by the experts of the Internal Dosimetry Division.

In the validatory function held on the last day of the training course, a feedback session from the participants was arranged. The feedback received from the participants was highly encouraging. IAEA experts and the foreign participants expressed their profound appreciation for the laboratory facilities and the equipment which was made available for the hands on training and also for the quality of the arrangements and the conduct of the course. It was expected that the knowledge and the experiences gained by the participants would be beneficial to them in their professional career.

BI-ANNUAL NATIONAL SYMPOSIUM ON RADIATION PHYSICS (NSRP-15)

In collaboration with its Mumbai chapter, Indian Society for Radiation Physics (ISRP) organised its 15th bi-annual National Symposium on Radiation Physics, NSRP-15, with its focal theme "Nuclear Radiation Detectors Present Scenario and Future Trends" during November 12-14, 2003 in the Multipurpose Hall of BARC Training School Hostel, Anushaktinagar. The symposium was inaugurated by Dr V. Venkat Raj, former Director, Health, Safety and Environment Group, BARC and Chairman BARC Safety Council (BSC). In his keynote address, Dr Beldev Raj, Director, MCRG IGCAR, Kalpakkam, presented the role of detectors in nuclear reactor safety and control and emerging trends in this area. Dr R.C. Sethi, Head, APPD and President, ISRP-Mumbai Chapter, welcomed the delegates. Mr A. R. Sundararajan, President, ISRP and former Head, Radiation Safety Division, AERB, in his Presidential address stressed the need for more participation of colleges and universities in primary research in this important area of Radiation Physics.

Dr D.N. Sharma, Head, Radiation Standard Safety Division addressing the gathering at the symposium

Around 250 participants, including scientists from National laboratories, University professors, Research Scholars and University students attended the symposium. The scientific programme was divided into 10 sessions, with 10 invited talks, 30 oral and around 100 poster presentations. During the symposium an exhibition of various nuclear instruments and systems was organised in which detector manufacturers and radiation safety and monitoring system suppliers exhibited their products.

DAE-BRNS SYMPOSIUM AND WORKSHOP ON "THERMAL ANALYSIS" (THERMANS-2004)

The DAE-BRNS Fourteenth National Symposium and Workshop on "Thermal Analysis" (THERMANS-2004), organised by the Indian Thermal Analysis Society, Mumbai, and sponsored by Board of Research in Nuclear Sciences, Department of Atomic Energy, was held at the Applied Physics Department, Faculty of Technology and Engineering, M.S. University of Baroda, Baroda, during January 20-24, 2004. Dr Anil Kakodkar, Chairman, Atomic Energy Commission & Secretary, Department of Atomic Energy, Government of India, inaugurated the Symposium and Dr (Ms) Mrinalini Devi Puar, Chancellor, M.S. University of Baroda presided over the inaugural function. Prof. S.M. Joshi, Dean, Faculty of Technology and Engineering, M.S. University of Baroda, welcomed the delegates and other invitees. Dr K.D. Singh Mudher, Fuel Chemistry Division, BARC and Convener of the Symposium and Workshop, highlighted the focal theme of the symposium.

Inaugural function of THERMANS 2004. Seated on dais from left to right are: Dr Shyamala Bharadwaj, Secretary, ITAS, Dr Mrunalini Devi Puar, Chancellor, M.S. University Baroda, Dr. Anil Kakodkar, Chairman, AEC & Secretary, DAE, Govt. of India, Dr V. Venugopal, Associate Director, Radiochemistry and Isotope Group, Dr K.D. Singh Mudher, Convener, THERMANS 2004, Prof. V.N. Potbhare, M.S. University, Baroda, Dr S.K. Sali, Secretary, THERMANS 2004

The Role of Thermal Analysis in Materials Research related to Nuclear and other High Technology Areas". Dr V. Venugopal, Chairman, National Organizing Committee and Associate Director, Radiochemistry and Isotope Group, BARC, in his opening remarks, paid rich tributes to the founder members of the Indian Thermal Analysis Society (ITAS) and spoke about the significant contributions made by ITAS and the various units of DAE to the development of the science of Thermal Analysis in India. He made a special mention about the applications of Thermal Analysis in the development of various fuels for the nuclear reactors, especially the Thoria-based fuels, the carbides, the nitrides and the metallic fuels. Dr Anil Kakodkar, in his inaugural speech, complimented the efforts of BRNS and the Indian Thermal Analysis Society for holding such symposia and workshops which are very useful to the scientific community at large. He was happy to note that THERMANS-2004 symposium coincided with the 50th glorious year of service of the Department of Atomic Energy to the nation and that it is one of the many symposia being organised to commemorate the Golden Jubilee Year of DAE. He also mentioned about the interactions between the University Grants Commission, Inter University Consortium and the Department of Atomic Energy which enable the University students and researchers to participate in the DAE research projects by mutual collaborations. He remarked that collaborative research gets nourished by symposia such as THERMANS 2004 which are held in universities like M.S. University of Baroda.

Dr (Ms) Mrunalini Devi, in her presidential address, recounted the contribution of Maharaja Sayajirao Gaikwad to promote science for the benefit of common man and noted that symposia like THERMANS 2004 are the stepping stones to achieve the bigger vision of our President, Dr Abdul Kalam, i.e., to make our nation a developed one by the year 2020. Dr (Ms) Shyamala Bharadwaj, Hon. Secretary, ITAS, announced the names of the winners of the Awards for the year 2004. The Netzsch-ITAS Award for outstanding contributions in the field of thermal analysis and the TA Instruments and ITAS Young Scientist Award were presented, during the inaugural function, to Dr Gurdip Singh of Chemistry Department, DDU Gorakhpur University and Dr. R. Mishra, Applied Chemistry Division, BARC, respectively. Mr Amol Naik of Institute of Science, Mumbai was the winner of 'Dr M.D. Karkhanavala Memorial Essay Competition 2004'. Dr Arun Pratap, Applied Physics Department, Faculty of Technology and Engineering, M.S. University of Baroda, proposed the vote of thanks.

Dr Anil Kakodkar, Chairman, AEC, and Secretary, DAE, Govt. of India, delivering inaugural address at the 14th National Symposium and Workshop on Thermal Analysis (THERMANS 2004)

The symposium was conducted over the first three days and covered papers on "Fuel Systems", "Glass, Ceramics and Catalysts", "Instrumentation", "Solid State Kinetics", "Polymers, "Biomaterials", "Inorganic Chemistry" etc. A total of 162 delegates attended the Symposium. Nine invited lectures on the various topics of the symposium were presented by experts in the field. Best papers presented in both oral and poster sessions were awarded. A special session devoted to presentations by students was also organized and the best papers presented in the session were awarded separately. A preprint volume incorporating the papers accepted for presentation and the invited lectures was brought out and distributed to the delegates at the time of registration. A total of 109 papers were accepted for presentation in both oral and poster sessions.

A panel discussion was conducted at the end of the symposium and the panelists were Dr V. Venugopal, Associate Director, Radiochemistry & Isotope Group, BARC, Dr S.K. Handoo, General Manager, R & D, National Council for Cement and Building Materials, Ballabgarh, Dr P.V. Ravindran, Analytical Chemistry Division, BARC, and Prof. N.S. Saxena, Department of Physics, University of Rajasthan. The panelists recommended advanced research in the field of nanotechnology, biomaterials and catalysts as well as improvement in instrumentations. The panelists appreciated the efforts of the organisers to attract young talent for participation in such symposia.

A two-day workshop on the "Role of Thermal Analysis in Research and Industry" held after the symposium during January 23-24, 2004, was attended by 62 participants from different parts of the country. Nine invited lectures on 'Thermoanalytical techniques an overview', 'Kinetic equations in thermal analysis', 'Processing of functional ceramics by thermal techniques', 'Calorimetric techniques', 'Vapour pressure measurements', 'High temperature-XRD', 'Applications of Differential Scanning Calorimetry in Food Industry', 'Thermal conductivity of solids: modes of heat conduction and methods of measurement' and 'Application of thermal analysis in catalysis' were delivered during the workshop by eminent scientists in the respective fields. Experimental demonstrations were also arranged during the workshop. The texts of the invited lectures were brought out in printed form and distributed to the delegates of the workshop. A feed back session was conducted at the end of the workshop. The participants appreciated the programme and wanted to have similar interactions more frequently.

DAE-BRNS SYMPOSIUM ON NUCLEAR PHYSICS

The annual DAE - BRNS Symposium on Nuclear Physics was held at the Multipurpose Hall BARC Training School Hostel, Anushaktinagar, during December 8-12, 2003. Since inception, the symposium has traditionally served as an annual meeting ground for active nuclear physicists and technologists and has provided a forum to present their research and developmental work. About 300 scientists, both from India and abroad, participated in the symposium this year.

Dr Anil Kakodkar, Chairman, AEC and Secretary, DAE, inaugurating the DAE-BRNS symposium on Nuclear Physics. Seated on the dais from right to left are : Dr S. Kailas, Associate Director, Physics Group, BARC, Dr V.C. Sahni, Director, Physics Group, BARC & CAT, Indore, Prof V.S. Ramamurthy, Secretary, DST, Mr B. Bhattacharjee, Director, BARC, and Dr P. Singh, Convenor of the symposium

Dr S. Kailas, Associate Director, Physics Group, BARC, and Chairman, Organising Committee, welcomed the delegates to the symposium, the 46th in the series. In his introductory remarks, Dr V.C. Sahni, Director, Physics Group, BARC and CAT, Indore, traced the growth of this symposium over the years. Mr B. Bhattacharjee, Director, BARC, in his Presidential speech remarked that Nuclear Physics research is a thrust area of DAE and scientists from DAE have set the tradition in this exciting field. The symposium was inaugurated by Dr. Anil Kakodkar, Chairman, Atomic Energy Commission, and Secretary, Department of Atomic Energy. He pointed out the various accelerator-based nuclear physics research being performed using both national and international facilities. He also stressed the need to develop technologies of interest to society starting from basic research. Prof. V.S. Ramamurthy, Secretary, DST, gave the keynote address. He observed that large investments are being made in nuclear physics research by both DAE and DST. He also remarked that as a result of our strength in nuclear sciences and rapid progress in related technologies made in the last several years, international community is looking to India for money, manpower and software/ hardware support. Dr P. Singh, Convener of the symposium and Dr Bency John, Secretary, Organising Committee, proposed the vote of thanks during the inaugural and the concluding sessions of the symposium respectively.

In addition to the 16 invited talks, 280 contributed papers were also presented. The invited talks on ‘Halo Structure of Exotic Nuclei’ by P. Egelhof (GSI, Germany), ‘Fission and Properties of Neutron-rich Nuclei’ (A.V. Ramayya, USA), ‘Shell Effects near the r-Process Path and Implications on Nucleosynthesis of Heavy Nuclei’ (M.M. Sharma, Kuwait), ‘Role of Breakup/Transfer on the Fusion Process’ (A. Mukherjee, VECC), ‘Exotic Nuclei: Decay, Direct Reactions and Structure’ (A.K. Jain, BARC), ‘Nuclei, Random Matrices and Chaos’ (K. Kar, SINP), ‘Lasers in Nuclear Physics’ (B.N. Jagtap, BARC), ‘T = 0 and T = 1 Collective Bands in Heavy N = Z Nuclei’ (R. Sahu, Berhampur) and ‘Hadrons in Nuclear Medium’ (R. Varma, IITB) were well received.

One of the highlights of the symposium was seminar-sessions summarising significant contributions made in the areas of Super Heavy Elements (A. Saxena, BARC, G. Gangopadhyay, Calcutta University) and Quark-Gluon Plasma (B. K. Nandi, VECC, C. Gale, Canada). A seminar was devoted to capture the status of accelerator programmes at major facilities in TIFR, Mumbai (M.B. Kurup), NSC, Delhi (A. Roy), and VECC, Kolkata (R.K. Bhandari). These seminars were coordinated by Prof. S.S. Kapoor, Prof. B.C. Sinha, and Dr V.C. Sahni respectively.

Papers dealing with the ADS program, accelerator design, development and related instrumentation from the major accelerator centres in Mumbai, Kolkata and Delhi were also presented. About 220 papers were presented as posters and three posters were selected for best poster presentation prizes.

Thesis-presentations form an important platform for the young researchers to present and discuss their work. This year, nine theses were received and three were short-listed for oral presentations by a panel of well-known experts. The thesis entitled "Study of High Energy Gamma Rays in Nuclear Reactions" by Dr Sarla Rathi, DAE Fellow at NPD, was selected for the best presentation award of the Indian Physics Association.

An absorbing evening lecture, "India's Technology Needs: Nuclear to Rural", was delivered by Prof. R. Chidambaram, Homi Bhabha Chair Professor and Principal Scientific Advisor to the Government of India. A delightful santoor recital by Pandit Rahul Sharma was another highlight of the symposium.

SYMPOSIUM ON RADIATION AND PHOTOCHEMISTRY (TSRP-2004)

The seventh biennial "Trombay Symposium on Radiation & Photochemistry (TSRP-2004)" was organised by Radiation Chemistry & Chemical Dynamics Division, BARC, under the auspices of Board of Nuclear Sciences (BRNS), Department of Atomic Energy (DAB), in collaboration with Indian Society for Radiation & Photochemical Sciences (ISRAPS), during January 8-12, 2004, at the Multipurpose Hall, BARC Guest House, Anushaktinagar, Mumbai. TSRP is a unique symposium series, started in 1992, dealing with both the radiation and photochemistry and their complimentary role in solving problems. Dr Anil Kakodkar, Chairman AEC and Secretary, DAE, inaugurated the symposium. In his inaugural address, Dr Kakodkar stressed the areas of next generation Indian nuclear power programme where inputs from fundamental research, especially the radiation research, are required. Dr B. Bhattacharjee, Director, BARC, presided over the function. In his Presidential address, he dwelt upon several areas of basic and applied research in which BARC has made significant contributions. While congratulating the BARC scientists for the excellent work carried out, Dr Bhattacharjee advised the delegates to utilize the knowledge they have gained for the benefit of the society. Dr Bhattacharjee emphasised the need to produce hydrogen, the fuel of the 21st century, at lower cost, using solar radiation, and development of technologies with minimum pollution. Dr A.C. Bhasikuttan compered the inaugural function. Dr P.D. Naik, Convener, TSRP-2004, welcomed the dignitaries, invitees and delegates. Dr Tulsi Mukherjee, Associate Director, Chemistry Group and Chairman TSRP-2004, gave introductory remarks, and Dr Ms S. Dhanya proposed a vote of thanks.

More than one hundred and fifty poster papers were presented, and forty-six invited talks were delivered in the symposium. Thirty five overseas delegates from countries like USA, Germany, Japan, China, Austria, France, Taiwan, Hong Kong, Poland, and about two hundred and fifty Indian delegates attended the symposium. Amongst them were several leading Indian and foreign scientists. Some of the areas of current radiation research of interest covered in TSRP-2004 were: radiation chemistry at high temperatures, radiation chemistry of sulfur compounds, pulse radiolytic studies on antioxidants, heavy ion radiolysis of polymers, use of laser based electron accelerators giving femtosecond electron pulses for understanding faster phenomena, radiation treatment of dyes and its implication in waste water treatment, radiation induced synthesis of hydrogels, radiolytic generation of nanoparticles, radiation enhanced extractability of soluble products from herbal powders, radiation induced damage to solvents and ion exchangers used in nuclear fuel

Mr B. Bhattacharjee, Director, BARC, delivering the Presidential address during TSRP-2004

reprocessing and separation of nuclear waste, and radiation induced degradation of organic nuclear waste.

Use of femtosecond lasers to understand ultrafast processes, such as inter - and intramolecular energy, electron and proton transfers, and their technological implications, dynamics of solvation and hydrogen bond formation are some of the topics in chemical dynamics which were discussed in TSRP-2004. Study of photochemical reactions at molecular level to understand their dynamics, with a view to control and produce selective products, generation and characterisation of metal and molecular clusters, studies on lasers dyes, photodynamic action of certain molecules for cancer therapy, efficacy of photo-catalytic technique for purification of drinking water, the combined might of photocatalysis and sono-chemistry for remediation of the environment polluted by modem civilization, photochemical studies on semiconductors, photocatalysis and photovoltaic cells, and their potential in solar energy harnessing and degradation of organic compounds, laser ablation studies on polymer films, MARY (magnetic field effect on reaction yield) spectroscopy and time resolved SNOM (scanning near-field optical microscopy) were discussed at length.

Dr S. Adhikari conducted the concluding session, where several delegates expressed their views about TSRP -2004. Fifteen awards, six cash awards and nine only certificates, were given to the young investigators below the age of 32 years, for poster presentations. The best two posters were given Dr. P.K. Bhattacharyya Memorial Award, instituted in the name of the founder secretary of SRAPS.

WORKSHOP ON RADIATION & PHOTOCHEMISIRY

A three-day workshop on Radiation & Photochemistry was organised by Indian Society for Radiation & Photochemical Sciences (ISRAPS) in collaboration wtth Radiation Chemistry & Chemical Dynamics Division of BARC during January 5-7, 2004, at the Homi Bhabha Centre for Science Education, Anushaktinagar, just prior to the seventh Trombay Symposium on Radiation and Photochemistry , which was held during January 8-12, 2004. ISRAPS is devoted to promote education, advancement and applications of radiation and photochemical sciences in India and has headquarters at BARC. It is involved in various activities like publication of ISRAPS Bulletin, organising symposia, seminars and discussion meetings. It is also collaborating with BRNS in organising biennial Trombay Symposium on Radiation & Photochemistry since 1992. The TSRP series has become quite popular due to the high quality of papers presented and participation of national and international experts. In earlier TSRPs, young participants expressed views that to appreciate talks and posters on work with the advanced techniques, a short course on thrust areas of radiation & photochemistry would be useful. To cater to these aspirations, the above workshop was arranged. The response was overwhelming. Dr A.V. Sapre (ex-BARC), Vice-President, ISRAPS, acted as the workshop convener. About

35 participants from various universities and research establishments participated in the workshop which consisted of 10 talks by experts in the field from BARC (Drs D.B. Naik, Kamal Kishore, K. Indira Priyadarsini, H. Pal, S. Sabharwal, S.K. Sarkar and A. V. Sapre (retd.)), TIFR (Prof. N. Periasamy), IIT Bombay (Prof S.S. Talwar) and SINP, Kolkata (Dr Samita Basu). A laboratory visit to different facilities in the field of radiation & photochemistry, at RC&CD Division, BARC, was also arranged to conclude the workshop. A valedictory function was held in which Dr S. Banerjee, Director, Materials Group, BARC, was the chief guest. Prof Balu Venkataraman (ex-TIFR) presided over the function, Dr Tulsi Mukherjee, Associate Director, Chemistry Group, BARC and Vice-President, ISRAPS, addressed the participants. Dr Banerjee gave away certificates to all the participants. A few participants speaking on the occasion expressed great satisfaction about the workshop.

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

• श्री वी. एच. पाटंकर, वैज्ञानिक अधिकारी अल्ट्रासोनिक इन्सट्रूमेन्टेशन विभाग, इलेक्ट्रानिक्स प्रभाग, भा.प.अ.केंद्र को "सिस्टम इनोवेशन्ज़ एन्ड डेवलोप्मेंट " वर्ग का नेशनल NDT 2003 पुरस्कार" से सम्मानित किया गया है। यह पुरस्कार उन्हें दिसंबर 11-13, 2003 के दौरान विक्रम साराभाई स्पेस सेन्टर (VSSC) के द्वारा आयोजित राष्ट्रीय गोष्ठी "NDE 2003" बैंगलोर में डॉ. आर.वी. पेरुमल, निदेशक (ISRO) के द्वारा प्रदान किया गया।

वर्ष 1991 से श्री पाटंकर पदार्थों के NDT अल्ट्रासेनिक सी-स्केन इमेजिंग सिस्टमस् के रूपरेरवा तथा विकास के लिए काम कर रहे हैं। परमाणु ईंधन प्रभाग के सहयोग से उनके द्वारा प्रथम प्रणाली विकास से पूर्व भा.प.अ. केंद्र पृथक अंश के रुप में तारापुर फीड वाटर नोज़ल ऑफ बोइलिंग वाटर न्युक्लियर रियक्टरस के लिए इन-सर्विस इन्सपेक्शन के काम में लाया जाता था। क्रमशः इन्होंने इन्डस्ट्रियल PC बेस्ड "ULTIMA 100+" सिंगल चैनल अल्ट्रासोनिक इमेजिज़ सिस्टम 100 MSPS RF डिजिटाइज़र का रुपांकन किया। यह ULTIMA 100+ प्रणाली भा.प.अ.केंद्र की कई प्रयोगशालाओं के लिये उपयोगी सिद्ध हुई तथा इसी प्रकार की चार प्रणालियां परमाणु ईंधन प्रभाग, रेडियो धातुकी प्रभाग, पश्च किरणन परीक्षण प्रभाग, तथा पदार्थ विज्ञान प्रभाग में भेजी गई तथा एक समरुप गैस टरबाइन रोटरस के निरीक्षण के लिए हैदराबाद में BHEL, R&D को बेची गयी ।

हाल ही में इन्होंने मल्टीचैनल अल्ट्रासोनिक इमेजिंग सिस्टम " ULTIMA 100M" आटोमेटेड, वोल्युमीट्रिक इनसपेक्शन ऑफ लार्ज ओबजक्टस् सिलेंड्रिकल फोरजिंगस् एन्ड टयूब्स् जैसी उपयुक्त प्रणाली का सफलतापूर्वक रूपरेरण तथा विकास किया। एक वैसा ही ULTIMA 4 प्रणाली, रेखांकन तथा उत्पादन केंद्र (CDM) को स्टेंनलेस स्टील फोरजिंगस् (जिनका 190mm व्यास, 2.5m लम्बाई, तथा 700 किग्रा वज़न है) को सौ प्रतिशत परीक्षण के लिए प्रदान किया गया। इसी प्रकार के 200 से अधिक स्टेंनलेस स्टील फोरजिंगस् (जो 500MWe PHWRs की अवयव हैं) का सफलतापूर्वक परीक्षण किया गया।

इन्डियन सोसाइटी फॉर नॉन-डेसट्रक्टिव टेस्टिंग (ISNT) के द्वारा उपरोक्त राष्ट्रीय पुरस्कार प्रदान करने के समय श्री वी.एच. पाटंकर के इस काम की सराहना की गई।

प्रारम्भ में इन्होंने माइक्रोप्रोसेसर बेस्ड-इलेक्ट्रोमयोग्राफ, एक यन्त्र जो कि तंत्रकीय अव्यवथा में उपयोगी है, के विकास एवं रूपरेखा पर काम किया।

श्री पाटंकर, ISNT के आजीवन सदस्य, अल्ट्रासोनिक सोसाइटी ऑफ इन्डिया, नई दिल्ली के सदस्य, एवं कम्प्यूटर सोसाइटी ऑफ इन्डिया, मुंबई के सदस्य भी हैं। इन्होंने 18 से अधिक तकनीकी शोध-पत्र व बी ए आर सी रिपोर्टस् सभाओं में प्रकाशित किए हैं।

हाल में वे मुंबई युनिवर्सिटी में शोध कार्य में व्यस्त हैं तथा उनके कार्य में Ultrasonic Instrumentation for NDT of Tubular Objects का विकास भी शामिल है।

Mr V. H. Patankar of Ultrasonic Instrumentation Section, Electronics Division, BARC, has been awarded the “National NDT Award 2003” under the category “System Innovations and Development”. The award has been conferred upon him by Dr. R. V. Perumal, Director (Projects), ISRO, Bangalore on December 11, 2003, during the National Seminar "NDE2003", organised by Vikram Sarabhai Space Centre (VSSC), during December 11-13, 2003.

Since 1991, Mr Patankar has been working on the design and development of an Ultrasonic C-Scan imaging systems for NDT of materials. The first system developed by him in collaboration with Atomic Fuels Division, BARC, was a standalone type unit and had been used for In-Service-Inspection of Feed Water Nozzle of Boiling Water Nuclear Reactors at Tarapur. Subsequently, he designed an Industrial PC based, "ULTIMA 100+" – Single channel Ultrasonic Imaging system with 100 MSPS RF Digitizer. This ULTIMA 100+ system was found to be very much useful at many labs in BARC and four such systems were supplied to Atomic Fuel Division, Radiometallurgy Division, Post-Irradiation Examination Division and Materials Science Division of BARC and one such system was sold to BHEL, R&D, Hyderabad, for inspection of Gas Turbine Rotors.

Recently, he has successfully designed and developed a Multichannel Ultrasonic Imaging System "ULTIMA 100M", suitable for automated, volumetric inspection of large objects, such as cylindrical forgings and tubes. One such 4-channel ULTIMA 100M4 system has been supplied to Centre for Design and Manufacture (CDM), BARC for 100% inspection of Stainless Steel forgings (each having 190mm diameter, 2.5 metres length and weighing approximately 700Kg). More than 200 such SS forgings (which are constituents of 500 MWe PHWRs) have been successfully inspected with this ULTIMA 100M4 system at CDM, BARC.

This work has been appreciated by the Indian Society for Non-Destructive Testing (ISNT) while honoring Mr. V. H. Patankar by giving him the above national award.

Initially, on joining BARC, he worked on the design and development of microprocessor based – Electromyograph, an instrument used for studies of neuro disorders.

Mr Patankar is a Life member of ISNT, a member of Ultrasonics Society of India, New Delhi, and a member of Computer Society of India, Mumbai. He has published over 18 technical papers/reports in Journals, Seminars and BARC reports.

He is currently working towards his Ph.D. work at Mumbai University and his work involves the development of Ultrasonic Instrumentation for NDT of Tubular Objects.

- श्री पी. पी. नानेकर तथा श्री बी. के. शाह, परमाणु ईंधन प्रभाग, भा.प.अ.केंद्र ने इन्डियन सोसाइटी फॉर नॉन-डेस्ट्रेक्टिव टेस्टिंग (ISNT) के द्वारा आयोजित National Seminar NDE-2003, के दौरान 'Characterization of Material Properties by Ultrasonics' नामक शोध-पत्र के लिए Best Paper Award पुरस्कार प्राप्त किया है। यह शोध-पत्र दिसंबर 11-14 के दौरान थिरूवनन्दपुरम में प्रस्तुत किया गया था।

पी. पी. नानेकर
P.P. Nanekar

बी. के. शाह
B.K. Shah

A technical paper titled 'Characterization of Material Properties by Ultrasonics', authored by Mr P.P. Nanekar and Mr B.K. Shah of Atomic Fuels Division, BARC, has won the Best Paper Award during the National Seminar NDE-2003, organised by Indian Society for Non-destructive Testing (ISNT). The paper was presented in the seminar during December 11-14, 2003 at Thiruvananthapuram.

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