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BARC DEVELOPS GAMMA SCANNER

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Introduction

The core of a nuclear reactor consists of fuel in the form of pins or bundles. The power of a pin/bundle can be estimated by measuring its gamma radiation. The scanners consist of gamma ray detectors for the purpose. Development of two types of gamma scanners, one for fuel



pin and the other for fuel bundle, for use in a classified nuclear facility in BARC, was taken up in Reactor Control Division (RCnD). The technical specifications for the design of these scanners were based on the fuel pins/bundles used in the facility. After evolving a design of the scanners, the prototypes were made and tested. Based on the trials taken on the prototypes, the designs were finalised. Two scanners, one for fuel pin and the other for fuel bundle were manufactured. The design aspects of the prototypes and the actual scanners are described here.

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Design Criteria

- *Fuel dimensions:* The size of the scanners is based on the size (diameter and length) of the fuel pin or bundle.
- *Fuel holding:* The fuel is held in horizontal position in the scanner.
- *Scanning method :* The fuel is rotated about its longitudinal axis and the detector is moved from one end of the fuel to the other with collimator of the detector facing the fuel.
- *Scan time :* A combination of rotary speed of the fuel and linear speed of the detector can be selected to acquire scan data in required time.

Table-1: Technical specifications of fuel pin scanner

| Sr. No. | Parameter | Description |
|---------|--|---------------------------------|
| 1 | Rotational speed of pin gripping collet | 10-30 rpm |
| 2 | Linear speed of detector | 1-10 mm / sec. |
| 3 | Collimator window size | 10 mm W x 60 mm L |
| 4 | Lead collimator thickness | 50 mm |
| 5 | Collet I.D. | 3-4 mm |
| 6 | Stroke length | 1400 mm |
| 7 | Gap between collimator face and fuel pin | 10 mm |
| 8 | Detector type | Nal(Tl) |
| 9 | Detector Lead shield thickness | 75 mm |
| 10 | Drive Mechanism | Ball screw drive |
| 11 | Steps / revolution of the stepper motors | 200 steps / rev. |
| 12 | Control panel | PC based, size : 600x647x1700 h |
| 13 | Approximate Size of scanner | 2000 x 600 x 1500 h |
| 14 | Total weight | 500 kg appx. |

Design Features

General design layout of the scanners for fuel pin and fuel bundle is shown in Fig. 1. The fuel is held in horizontal position and the detector moves just below the fuel from one end of the fuel pin / bundle to the other. The scanner mainly consists of a linear motion drive having guided rollers, a rotary drive, detector assembly, motor controller unit and data acquisition system. The linear drive imparts linear motion to detector assembly. The fuel pin/bundle is held horizontally by teflon rollers. One end of the fuel is connected to a motor. Both linear and rotary motions can be varied independently as per the requirements.

The detector is mounted in vertical orientation just below the fuel. The collimator window of the detector faces the fuel. While the fuel pin rotates about its axis, the detector moves from one end of the pin to the other. A control panel accommodates the electrical and electronic units such as the stepper motor controller, data acquisition system, PC, power supplies etc. The technical specifications of gamma scanners for fuel pin are given in Table-1.

Features for Operational Safety

General safety features provided in the design are as follows :

- Duplicated sensors are provided to stop motion in case of overrun due to any reason.
- The fuel bundle is gripped by a nylon collet to avoid any scratch on the fuel bundle in the event of any slip.
- The ball screw assembly is completely covered with bellows / metallic sheets to avoid any loose parts / foreign particles from falling on to the ball screw.
- The fuel pin / bundle is supported by nylon rollers in order to avoid any scratch on fuel surface during fuel rotation.

- i) The fuel pin / bundle is held by friction grip in order to allow a slip in the event of high torque due to any reason.
- ii) The detector is supported by rubber 'O' rings in the detector housing to avoid any jerk to the detector.
- iii) Full short circuit protection is provided for electronic parts in the control panel.
- iv) An independent manual control panel is provided which may be used in the event of failure of auto mode.

The scanners for fuel bundle are also based on the similar design. The technical specifications of gamma scanners for fuel bundle are given in Table-2.

Table-2 : Technical specifications of fuel bundle scanner

| Sr. no. | Parameter | Description |
|---------|---|----------------------------------|
| 1 | Rotational speed of fuel bundle gripper | 10-30 rpm |
| 2 | Linear speed of detector | 1-10 mm / sec. |
| 3 | Collimator window size | 10 mm W x 60 mm L |
| 4 | Lead collimator thickness | 50 mm |
| 5 | Gripper I.D. | 45-50 mm |
| 6 | Stroke length | 1500 mm |
| 7 | Gap between collimator face & fuel bundle | 10 mm |
| 8 | Detector type | Nal(Tl) |
| 9 | Detector Lead shield thickness | 75 mm |
| 10 | Drive Mechanism | Ball screw drive |
| 11 | Steps / revolution of the stepper motors | 200 steps / rev. |
| 12 | Control panel | PC based, size- : 600x647x1700 h |
| 13 | Approximate size of scanner | 3200 x 600 x 1500 H |
| 14 | Total weight | 600 kg appx. |

Operation and Control

The scanners can be operated in auto or manual mode. However, auto mode is the normal mode of operation. The auto mode is controlled by PC, whereas, the manual start – stop buttons are provided right on the machine. In manual mode also, the speeds can be varied, however, the positional repeatability will not be as accurate as in case of auto mode. The manual mode should be selected only when auto mode is not working due to some failure. As the scanners are PC based, the manual start – stop features are bypassed during the normal operation. The parameters such as the scan speed, total stroke, retrieval speed, homing speed, etc. can be set as desired. A display of position, and time for each scan stroke is continuously displayed online. The data related to the fuel power, acquired and processed by the computer, are also displayed online. As mentioned earlier, the scanners have two independent modes of operation two independent drives for auto and manual modes are provided. In auto mode operation, the stepper motor drive is automatically selected, whereas in manual mode, induction motor drive is selected.

Data Acquisition

Radiochemistry Division (RCD), BARC, provided the Nal(Tl) detector and the data acquisition unit for testing the prototypes as well as for the actual scanners. The motion control and data acquisition programs can be triggered simultaneously on a single click to avoid time lag between the start of detector movement and the start of acquisition of scan data. However, independent manual start of detector movement and acquisition of scan data are also possible.

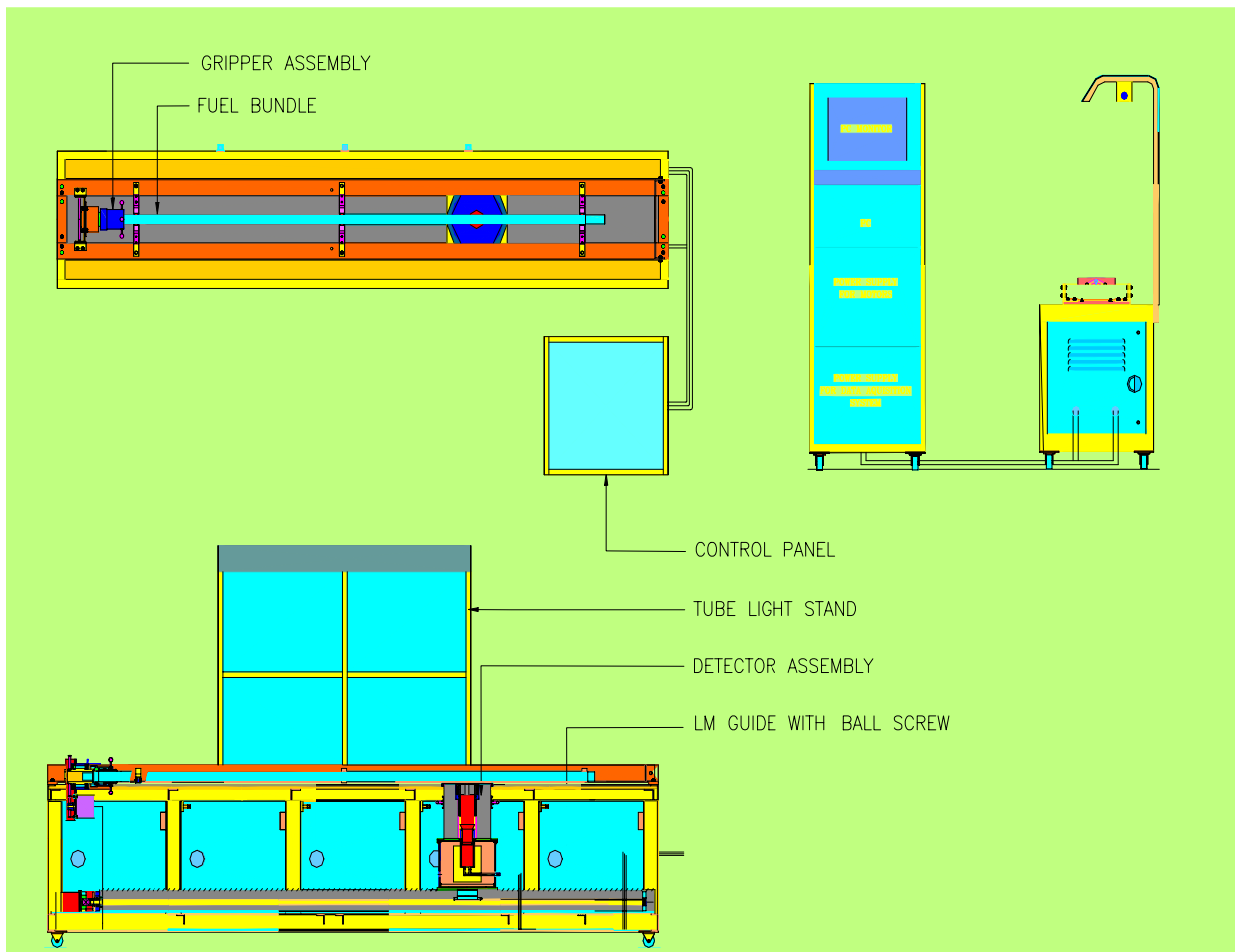


Fig. 1 Schematic layout of the gamma scanner

Development of Prototypes

A schematic layout of a typical gamma scanner shown in Fig. 1 showing various units/assemblies are as follows :

1. Frame assembly
2. LM guide with ball screw
3. Detector assembly
4. Fuel Gripper assembly
5. Control Panel

Frame assembly provides structural support to all other units. The structure is provided with castor wheels for easy manoeuring and fixed legs for firm support. LM guides with ball screw is used to impart linear motion to the detector assembly. The details of the detector assembly is shown in Fig. 2. Fig. 3 shows the location of the detector assembly in the scanner. The detector is of NaI(Tl) type

which is housed in an aluminium casing. The detector casing is mounted on two rubber 'O' rings to avoid any damage to the detector during the operation. The aluminium casing is

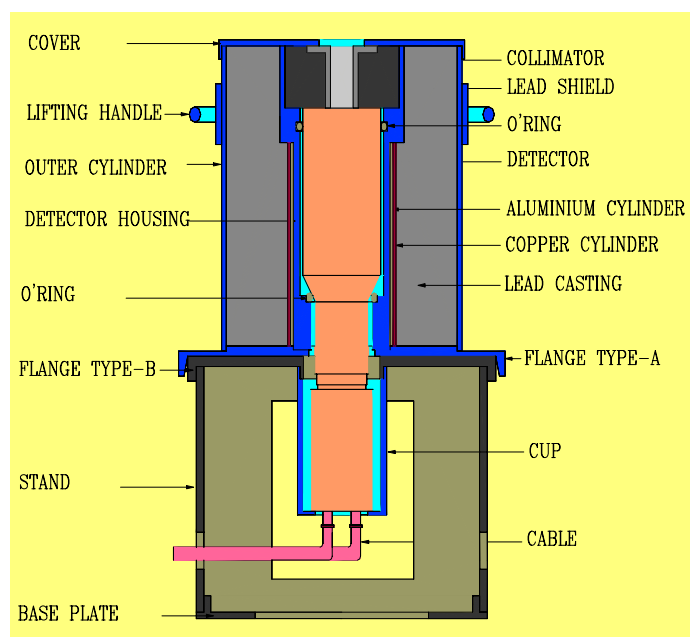


Fig. 2 Details of the detector assembly

surrounded by thick lead shield made by casting the lead in between two concentric cylinders. Top side of the detector is provided with a collimator which is also made of lead. The detector can be taken out or assembled back in the shielding without disturbing the lead shielding. The electrical cables can also be connected / disconnected from the detector without disturbing the detector.

Fuel gripper unit consists of a collet which can be opened or closed manually for gripping one end of the fuel pin / bundle. The gripper assemblies for fuel pin and fuel bundle scanners are shown Fig. 3 and 4 respectively. The collet in bundle gripper assembly is opened or closed manually by sliding cone and cup surfaces against each other. The cup is formed by a cup shaped special nut, whereas, the collet is of cone shape.

The gripper assemblies for fuel bundle and fuel pin are shown in Fig. 4 and 5, respectively.



Fig. 3 Detector assembly location in the scanner

The collet in the fuel pin gripper assembly is spring loaded. The force of the spring is just sufficient to grip the pin. The compression and expansion of the spring is provided with a spring loaded cam which is manually rotated. The control panel houses all electrical and electronic equipments such as the data acquisition unit, power supply, motor controls and a PC.

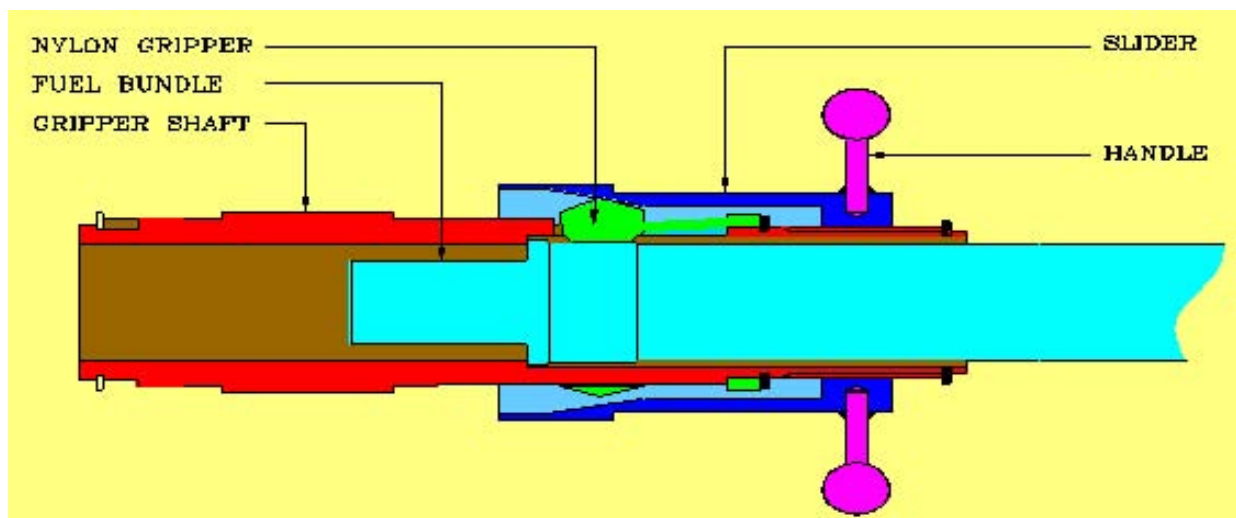


Fig. 4 Gripper assembly for fuel bundle

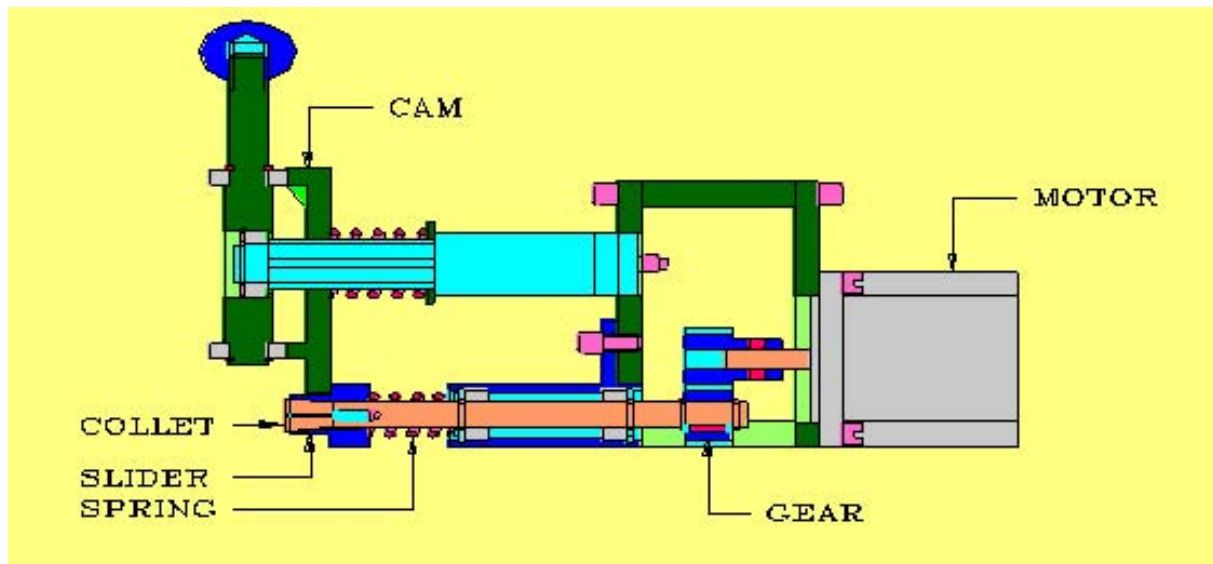


Fig. 5 Gripper assembly for fuel pin



Fig. 6 Prototype of fuel pin scanner

All the operations of the scanner are PC based. Prototypes of fuel pin and fuel bundle scanners were developed and tested in RCnD. A prototype of the fuel pin scanner is shown in Fig. 6.

The prototype was PLC controlled having provision for both linear as well as rotary motions of the fuel pin. All the initial trials for fuel pin scanning were taken on the prototype with point sources of gamma radiation and all parameters were finalised for final design.

Similarly, a prototype of fuel bundle scanner was also developed. A photograph of the prototype along with the test set-up is shown in Fig. 7. All the trials for fuel bundle scanning were taken with point sources as well as with fuel bundles having few fuel pins inside as source of gamma radiation. The final design of the bundle scanner was decided on the basis of trials taken on prototype.



Fig. 7 Test set-up for prototype fuel bundle scanner

The testing set-up of the fuel bundle prototype scanner shown in Fig. 7 was PLC controlled. The trials were taken with a dummy fuel bundle to check the functionality of the prototype. Later, tests were also conducted with gamma sources mounted on the dummy fuel bundle. The data acquisition system was integrated with the scanner to record the count rates. The variation of linear and rotary speeds were also checked to see the effect of speed on the positional accuracy of the detector. It was found that the specified linear speeds of the detector ranging from 1-10 mm/sec and the rotary speed of the fuel bundle ranging from 10-30 rpm can be used with the specified positional accuracies.

The scanner is designed to accommodate full length of the fuel bundle. The fuel bundle is supported at 3 points. The supports are rollers made of teflon to avoid any damage to the bundle during the rotation. Two supports are located at two ends of the fuel portion of the bundle. The third support is just near the collet. The loading procedure of the fuel bundle is quite simple.

First the bundle is gently rested on the support rollers and then pulled manually so that the gripping end of the bundle enters into the collet as shown in Fig. 8. The collet is then closed by rotating a nut. The linear motion of the nut shall result in closing the collet. The total time for loading and unloading of the bundle is only 2-3 minutes. The bundle is held in the collet only by friction grip.

Actual Scanners

After testing of prototypes, the design of the scanners was finalised. Actual fuel pin and fuel bundle scanners were fabricated. The detailed drawings, operating manual, etc. may be referred for more details. A photograph of the actual fuel pin scanner is shown in Fig. 9.



Fig. 8 Loading procedure of the fuel bundle

As mentioned earlier, all electrical and electronic items including the data acquisition system and PC, are housed in the control panel shown by the side of the scanner. A back side view of the control panel showing the electrical and electronic components is shown in Fig. 10. The



Fig. 9 Fuel pin scanner



Fig. 10 A view of electronic board

fuel bundle scanner also (not shown here) has similar features as the fuel pin scanner except the size. The testing and commissioning of fuel pin scanners were completed in RCnD.

The scanner can be operated in manual as well as in auto mode. In auto mode, the operation is PC controlled and motion is provided with stepper motors in steps finer than 0.01 mm. However, if stepper motors or any electronic component suddenly goes bad during the operation, fuel scanning can still be performed by switching on the manual mode switch. In manual mode, the motion is provide by induction motors directly by on/off manual push buttons. Thus, the scanners have two independent drives. The positional repeatability of stepper motor drive is of the order of 0.1mm which is much better than the specified value of 0.5 mm.

As mentioned earlier, the scanner is PC based. A typical PC screen showing scanning parameters is depicted in Fig. 11. The scanner software is window based and the program is user friendly. The scan data as

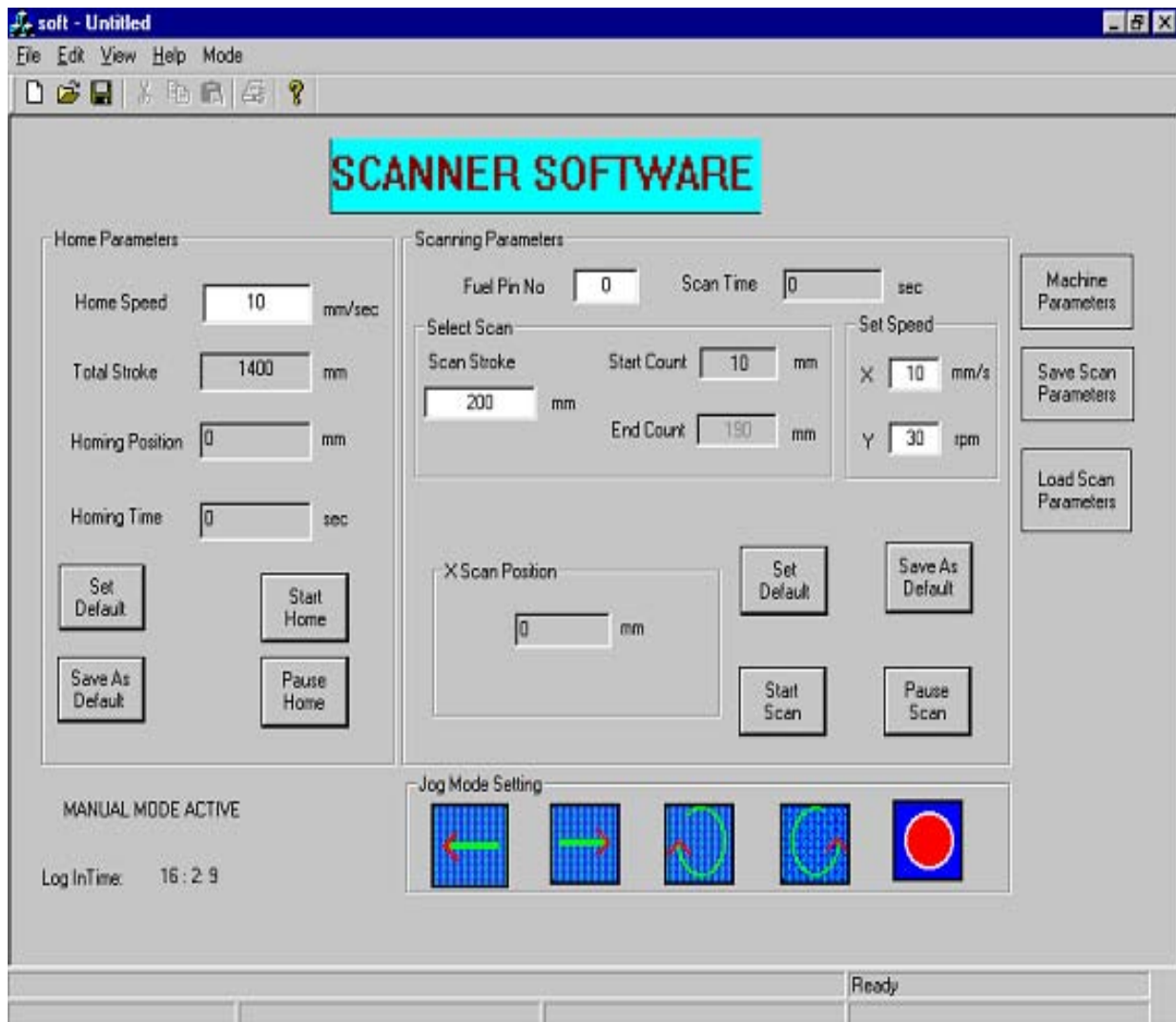


Fig. 11 PC screen showing online display of scanning parameters

well as the acquired data is displayed online through respective windows.

Conclusion

The gamma scanners for fuel pin and fuel bundle described here are horizontal type, i.e. the fuel pin/bundle is held in horizontal position during the scanning operation. The fuel scanning involves linear movement of the gamma detector along the length of the fuel pin / bundle while the fuel pin / bundle rotates around its longitudinal axis. The scanning speed can be varied. Each scanner is provided with two independent drives, namely the stepper motor drive and the induction motor drive. Normally, the stepper motor drive is used. The other is provided as stand-by and can be switched on if the stepper motor drive

suddenly goes out of order during the scanning operation.

The loading and unloading of the fuel is a simple operation which can be performed quickly. Scanning time for a pin or bundle depends on the selected speed of the detector movement. It takes less than 3 minutes to complete full scanning stroke for a pin or bundle at a scanning speed of 10 mm/sec which is a normally preferred scanning speed. The positional repeatability is much better than required (within 0.1 mm compared to acceptable specified value of 0.5 mm). The stepper motors are used with half step and gearing, which provides a linear movement of the detector in steps finer than 0.01 mm.

BARC DEVELOPS COBALT-60 TELETHERAPY MACHINE FOR CANCER TREATMENT

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Introduction

Human cancer is probably as old as the human race. For normal cells, the growth, division and death of cells occur in a controlled manner. Cancer cells on the other hand multiply in an uncontrolled way creating tumors. Tumors may replace healthy tissues and often start spreading to other parts of the body, leading to a life-threatening situation. If untreated, most cancers lead to protracted sufferings and eventual death. As per IAEA estimate, almost 13% of all deaths worldwide are caused by cancer and more than 10 million persons are diagnosed with cancer each year [1]. Once considered a western disease, cancer now affects and kills more people in the developing world than in industrialised nations [2].

There are three well established arms in the management of cancer: Surgery, chemotherapy and radiation therapy [3]. The discovery of X-rays by Roentgen in 1895, radioactivity by Becquerel in the following year, and isolation of radium by Curies in 1898 revolutionised the medical diagnosis and treatment. Ionizing radiation damages the genetic material in the cells of target tissue and prevents the cell growth. Although radiation destroys healthy cells as well, healthy cells recover from the effects of radiation more easily than cancer cells. Ionising radiation is generally used for treating localised solid tumors, such as cancers of the skin, tongue, larynx, brain, breast or uterine cervix.

Radiation Oncology is the art and science of directing a cancericidal dose of ionising radiation to the tumor while giving minimum dose to the adjacent normal structure. Ionising radiations

used for cancer treatment are mainly, γ -rays from radioactive isotopes and X-rays from accelerators. Internal radiation therapy, also known as *brachytherapy*, is typically used to deliver a high dose of radiation to a small area. Such treatments involve placing radioactive materials encased in wires, seeds or small rod implants adjacent to or inside of a tumor. The treatment where the radiation source is kept outside the body and the beam is directed on the cancer site is called external beam radiation therapy or *teletherapy*.

Teletherapy Machines

Linear accelerators (LINAC) use high energy electrons or high-energy X-rays for treatment of deep-seated tumors. High energy γ -emitting radioisotopes, such as Cobalt-60, Cesium-137 and Europium-152 are also used for cancer treatment. Radiation source is kept at a distance of 80-100 cm from the tumor to be treated. Among various radioisotopes, Cobalt-60 is the most widely used in teletherapy machines, considering the energy of emitted photons, half-life, specific activity, and means of production. Cobalt-60 has a half-life of 5.3 years and emits high energy (1.17 and 1.33 MeV) γ -rays. Sources of very high specific activity (~ 250 curie/gm) and high source strength (~10 kilo curie) are used in teletherapy machine. Although linear accelerators offer superior beam characteristics and faster treatments, these units are expensive and complex. In developing countries like India, Cobalt-60 machines are more suitable than LINAC, considering the cost and maintenance issues. More than 50% of all human cancers are amenable to Cobalt-60 teletherapy.



Fig. 1 Indigenous Teletherapy Machine installed at ACTREC, Navi Mumbai

As the radiation is harmful to healthy cells as well, it is required to have a mechanism which can deliver specific amounts of radiation only to the designated area of the body, while keeping the exposure to the adjacent areas limited to the extent possible. It is also essential to ensure the safety of radiation workers, patients, public and the environment. Concern for radiation protection and regulations is growing significantly because of rapid increase in use of radiation and better understanding of the risks and benefits attributable to it. ICRP Publication No. 33 [4] gives recommendations regarding protection design, operation and quality assurance for radiological equipments used in medicine. Basic requirements for mechanical and electrical safety for radiotherapy equipments should conform to International Electro-technical Commission (IEC) Standards 60601-1 (1977) [5]. Particular requirements for the safety of gamma beam therapy equipment are as per IEC-60601-2-

11(1997) [6]. At present, the permissible limits for leakage radiation are: at 5 cm from the head surface: 20 mR/h, at 1 m from the source: 1 mR/h, at 1 m from the source (jaw closed): 0.1% of m/c capacity (RMM), collimator transmission within the collimator zone at 1 m from the source: 2% of m/c capacity (RMM). In India, Radiological Physics & Advisory Division (RP&AD), BARC, evaluates and approves the siting, planning and layout of radiation installations from radiation safety point of view. AERB issues necessary type approval certificate on receipt of technical evaluation and recommendations from RP&AD.

Cancer Treatment: Indian Scenario

In India, it is estimated that over 7 lakh new cancer cases are detected every year and 3 lakh deaths occur due to cancer. Tobacco related cancers account for almost a third of cancers diagnosed in India. Cancers of cervix and breast

account for half the cancer burden among Indian women. A majority of the patients require radiotherapy at one time or the other during the course of treatment.

The first Cobalt-60 teletherapy unit was installed in 1957 in Madras. The current yearly commissioning rate is 12-15 Cobalt-60 units and there are only about 250 Cobalt-60 machines operating in the country [7]. The existing radiotherapy centers are mostly located in metropolitan and large cities and there are many states that do not have a single teletherapy machine. This slow growth is primarily attributed to the high landed cost of imported machines, combined with lack of indigenous technology in our country. The present availability of teletherapy machine in India is only about 0.3 per one million population, whereas, in developed nations like USA and UK, the availability is 8.2 and 3.4 per million respectively. Considering the fact that, in a developing country, the requirement of teletherapy machine is 1 machine per million population, India should have at least 1000 operating machines. Also, the treatment facilities should be distributed so that there should be at least one hospital in each district with full-fledged cancer treatment facility.

Indigenous Development

Considering the growing demand and need for affordable machines, BARC had taken up the development of indigenous Cobalt-60 Teletherapy Machine. Manufacture of the first machine is completed and it is installed at Advanced Centre for Treatment, Research and Education on Cancer (ACTREC), Navi Mumbai. Ministry of Health and Family Welfare has approved funding of two machines for supply to cancer hospitals. Some of the technical aspects of the machine are discussed here.

The indigenous machine has state-of-the-art features in safety, controls and user interface. Fully closable collimator for improved radiation safety is a unique feature of the machine. The

machine incorporates world-class features, like minimum couch height, and noise free movements, at par with any imported machine of similar category. In addition, the machine has lower penumbra for better beam quality, total digital controls with self-calibration of motors and controls, single cable communication between machine and control console, computer controlled couch and total treatment data acquisition and data analysis. In the machine, Cobalt source is mounted isocentrically allowing the beam to rotate about the patient at a fixed source-axis distance. The main components of the machine are radioactive source, source head, source drawer, collimator, gantry, base housing, patient support system, and control console.

Cobalt Source : The Cobalt-60 source is contained inside a cylindrical stainless-steel capsule and sealed by welding. 20 mm diameter cobalt-60 source will be used for treatment. The machine has capacity to load 200 RMM source. Indigenously produced Cobalt sources are the cheapest in the world [8] and are effectively being used in most of the teletherapy units in India.

Source Head : It is a shielded container that houses the radioactive source. Uranium is the major shielding material used in the machine, because of its high density and high mass number. The processing of uranium requires special precautions because of its radioactivity, chemical toxicity and pyrophoricity. The surfaces of the uranium parts are protected by specialised electroplating to prevent it from oxidising in air. Wherever, space is not a major constraint, lead is used as the shielding material. The machine has source-to-skin distance of 80 cm, which is an important parameter of the machine. It is achieved by the compact design of source head and collimator. The source drawer and collimator are mounted on the source head. Optical Distance Indicator mounted on the source head displays the distance between the source and skin.

Collimator : The size and orientation of the radiation beam is controlled by the collimator assembly. Two pairs of motorised jaws generate rectangular field of desired size. The collimator can also be rotated around the radiation beam axis. The radiation field can be visualised by a high intensity light during patient positioning. The centre of the radiation field is indicated by the collimator cross hairs. Two sets of trimmers are provided to decrease the penumbra of the beam. The lower pad of the collimator is prepared to receive wedge filters and shadow tray for the beam shaping lead blocks. Collimator and trimmers are made of uranium to reduce size.

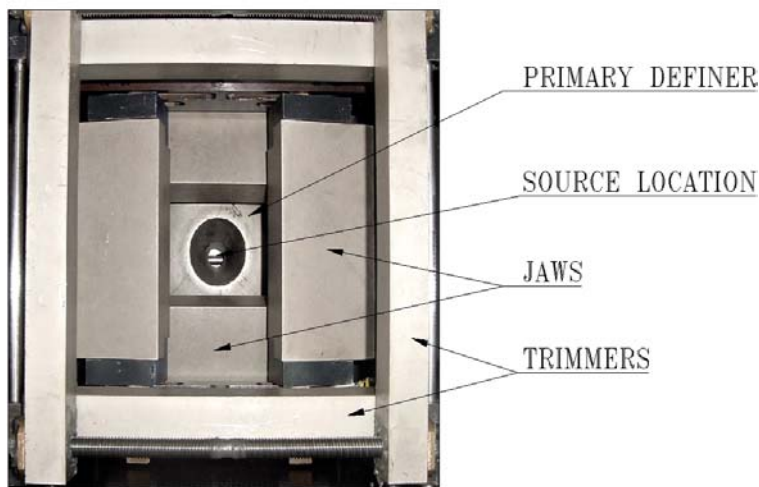


Fig. 2 Collimator

Fully closable collimator is a unique feature of the machine. It is an improvement over the traditional designs using intermeshing leaves. In case of any emergency, the collimator gets closed automatically. This ensures improved safety against leakage radiation during accidental situations. Using this machine, it is possible to deliver radiation beam on a field smaller than the typical 5cmx5cm field size.

Source Drawer : A pneumatically driven source drawer is used for moving the source between shielded position and treatment position. The pneumatic cylinder will return the source automatically to radiation-off position in case of any failure. As a safety measure, the source is allowed to move to treatment position, only if

there is sufficient compressed air in the tank to withdraw the source.

Gantry : Gantry is the part of the unit that holds the source head and counter weights. It can rotate around the patient about a horizontal axis by $\pm 180^\circ$. The gantry is mounted on the base housing.

Patient Support System or Couch : The unit has a sophisticated Patient Support System on which the patient has to lie down during treatment. It consists of a turntable mounted eccentrically with the isocenter to support another system of tables providing required motions for positioning the tumour site at the isocenter. All the motions are motorised and the couch is under fully computerised control. The indexed patient positioning system enables quick, accurate and reproducible patient positioning.

Controller : The controller is fully computerised and the interaction between the operator and the unit is achieved through a computer monitor, keyboard and mouse. Data on every treatment are registered on the computer's hard disk and may be retrieved for control purposes. Separate unit mounted control panels are provided on both the sides of the couch.

The necessary interlocks and corrective actions for radiation safety are also provided by the control system. Numerous safety interlocks are installed to ensure that, under no circumstances, the patient is exposed to a radiation other than the planned value. Some of these are: treatment room door interlock to prevent any treatment when the room door is open, gantry fault interlock to terminate treatment in case any error in gantry motion, source drawer movement interlock to prevent treatment when the drawer fails to move in desired manner, etc.

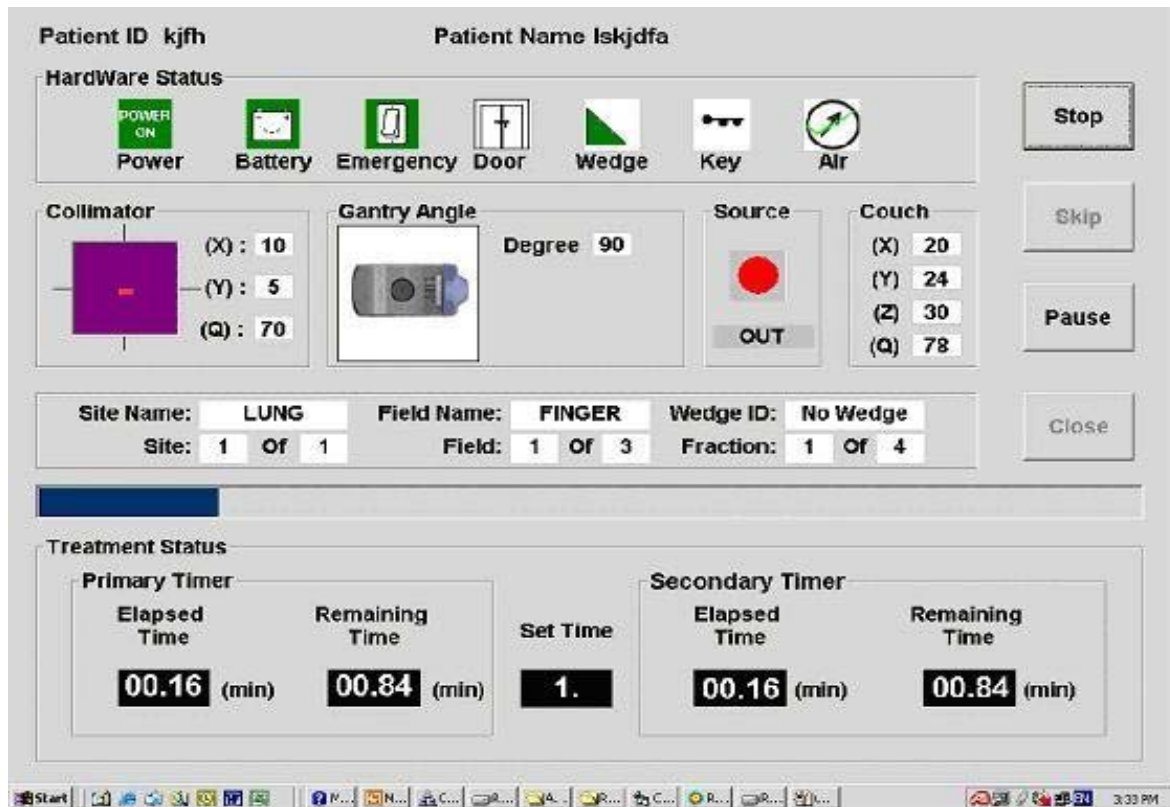


Fig.3 Graphical user interface of the machine

Specification

| | |
|-----------------------------------|--|
| Source Strength | Up to 250 RMM |
| Source to Isocentre Distance | 80 cm |
| Floor to Isocentre Distance | 128 cm |
| Collimator | Field size min: 0 x 0 cm at 80 cm Field size max: 30 x 30 cm at 80 cm Rotation: $\pm 90^\circ$ from its central axis Field size indicator: digital display Field size adjustment: motorized |
| Source to Skin Distance Indicator | Optically projected over the field under treatment (60-100 cm) |
| Patient Support Assembly Motions | Vertical: 67 cm to 167 cm from floor Longitudinal: 100 cm Lateral: ± 18 cm Couch rotation: $\pm 95^\circ$ |
| Control Console | Machine health status of AC power, Battery, Door, Wedge, Key and Air Displays exposed time and set time Source position indicator Emergency stop switch Patient and treatment database Treatment data interlock Gantry, Collimator and Couch motions |
| Hand Control | Gantry, Collimator and Couch positions Room lights, Laser Lights Emergency Stop switch |
| Automatic Collimator Closure | Will close the Collimator jaws to Zero Field size in case of source movement irregularities |
| Technology Standards | IEC 60601-2-11 |

Conclusion

Indigenous development of Cobalt-60 Teletherapy Machine is completed and the first unit is installed at ACTREC, Navi Mumbai. Ministry of Health and Family Welfare has approved funding of two machines for supply to cancer hospitals. The cost of the indigenous machine is significantly lower than imported machines of similar capacity. This will result in more treatment facilities as smaller hospitals can afford Cobalt teletherapy machine. Also, this development is expected to result in reduction in treatment cost and reduction in travel and waiting time, especially for rural patients.

References

1. Programme of Action for Cancer Therapy, Report by the Director General, IAEA, May 2004.
url:http://www.iaea.org/NewsCenter/Feature/Radiotherapy/gov2004-39_derestict.pdf
2. A Silent Crisis: Cancer Treatment in Developing Countries. IAEA Booklet, 2004.
url:<http://www.iaea.org/Publications/Booklets/TreatingCancer/treatingcancer.pdf>
3. Shrivastava S. K., Radiation Therapy: Procedure and Treatment in the Management of Cancer, Proceedings of the Fifteenth Annual Conference of Indian Nuclear Society (INSAC-2004), Mumbai
4. ICRP, 1982. Protection against ionizing radiation from external sources used in medicine. International Commission on Radiological Protection, Publication no.33, Pergamon, New York.
5. International Electro-technical Commission Standards for Medical Electrical Equipment-Part-1: General requirements for safety. (IEC-60601-1), 1988.
6. International Electro-technical Commission Standards for Medical Electrical Equipment-Part-2: Particular requirements for the safety of gamma beam therapy equipment. (IEC-60601-2-11), 1997.
7. Bhatt B.C., Role of BARC in quality assurance and safety in medical applications of ionizing radiation, In 50 years of Cancer Control in India, Ministry of Health and Family Welfare, pp. 105-121, url: <http://mohfw.nic.in/pg105to121.pdf>
8. Piet-Hein van der Giessen, Jose Alert *et. al.* (2004), Multinational assessment of some operational costs of teletherapy. Radiotherapy and Oncology, vol.71, pp.347-355.

NOBEL LAUREATE PROF. K. WUTHRICH VISITS BARC

Prof K. Wuthrich, a Nobel Laureate of 2002 in Chemistry from Institute of Molecular Biology and Biophysics, Zurich, Switzerland visited Bhabha Atomic Research Centre on January 11, 2005 along with his wife, Ms Mariane. Currently, Prof Wuthrich is a Professor of Biophysics at ETH, Zurich and Ceil H. and Ida M.Green Visiting Professor of Structural Biology at The Scripps Research Institute, La Jolla, USA. Prof Wuthrich has been a recipient of several prestigious awards before getting the Nobel Prize and most

notable among them was the prestigious Kyoto Prize in Advanced Technology.

Prof Wuthrich delivered a talk in Trombay Colloquium which was titled Chemistry at the interface with biology in protein structure determination using NMR in solution which was attended by a large number of scientists and engineers of the Centre. The talk covered the basic principle, methodology and applications of NMR related to transverse relaxation optimized



Dr Srikumar Banerjee, Director, BARC, welcoming Nobel Laureate Prof. Wuthrich

spectroscopy (TROSY), which was discovered and developed by him. This technique has made enormous impact in determination of a number of macromolecular structures of significance to biology and medicine. Prof Wuthrich presented examples of some proteins and nucleic acids whose three dimensional structure has been solved by his research group using NMR methods. It may be noted that Prof Wuthrich and his research team have solved structures of more than 50 proteins and nucleic acids by NMR.

Prof Wuthrich also participated in the Interaction Meeting with the scientists and engineers of BARC. The purpose of organizing this interaction meeting was to provide a forum for informal discussions on scientific issues, exchange of ideas and to stimulate research of especially younger investigators. Prof Wuthrich gave several motivational and inspirational remarks related to scientific research and academic

pursuits. He urged young investigators and doctoral students to work hard and pursue career in frontline areas of research.

THEME MEETING ON RADIATION PROTECTION ACTIVITIES AND PRACTICES IN THE INDIAN ATOMIC ENERGY PROGRAMME

Health Safety & Environment Group, BARC, organised a three-day theme meeting of health physics professionals in BARC during August 18-20, 2004. The objective of the meet was to harmonise Radiation Protection activities and practices in the Indian Atomic Energy Programme. In the key note address



On the dais from left to right are : Dr R.K. Kher, RPAD, BARC, Prof. S.P. Sukhatme, Chairman, AERB, Mr H.S. Kushwaha, Director, HS&E Group, BARC and Mr M.L. Joshi, Head, HPD, BARC

Mr H.S. Kushwaha, Director, HS&E Group, BARC, stressed the need for exchange of information among the health physics professionals and harmonisation of practices at various nuclear facilities. The meeting was attended by 87 delegates including observers from NPCIL, AERB and 30 participants from out-station health physics units. There were 21 papers on various facets of radiation protection presented in the meeting which was organised into the following seven sessions;

- I. Front-end of Fuel Cycle
- II. Research Reactors and Accelerators
- III. Power Reactors
- IV. Personnel Monitoring-External
- V. Personnel Monitoring-Internal
- VI. Reprocessing and Waste Management
- VII. Environmental Monitoring

Senior Health Physicists with vast experience in their respective fields presented the papers which were followed by lively discussions among the participants. During the dialogue, several areas for improvement in operational radiation protection were proposed. The major areas identified are:

- (i) Need for R&D efforts to develop sturdy, durable and reliable radiation monitoring

instruments and calibration facility for high range survey meters.

- (ii) Harmonisation of work procedures at different facilities
- (iii) Standardisation of computer software used in operational radiation protection.
- (iv) Development of suitable monitoring system for accelerator facilities.
- (v) Centralised Dose Registry.
- (vi) Quality Assurance in Internal Dosimetry.
- (vii) Lack of prescribed action levels for radioactivity in certain matrices.
- (viii) Documentation requirements at different nuclear facilities.

The meeting provided an excellent forum for information exchange, sharing of operating experience and updating of professional knowledge among the operational health physicists.

The meeting was concluded with a discussion and summing up session chaired by Mr H.S. Khushwaha, Director, HS&E Group, BARC. An action plan was prepared to resolve the deficiencies and harmonisation issues in the operational HP laboratories and the out-station Health Physics Units.

MAT LAB AT BARC INAUGURATED

MAT Lab facility for preparation of high purity materials was inaugurated by Dr Anil Kakodkar, Chairman, Atomic Energy Commission and Secretary to the Government of India, on July 9, 2004. The lab is an outcome of a long journey



Inauguration of MAT Lab by Dr Anil Kakodkar, Chairman, AEC

on high purity materials in the Chemistry Group, BARC. Relevance of high purity materials in nuclear power plants and semiconductor industry is very well known. Over a period, methods to purify a wide range of materials, required in electronic industry, have been developed. These methods are comprised of physical (e.g., distillation, zone refining), chemical or electro-chemical (e.g. electro winning) routes. Electronic technology has undergone drastic changes with time. These changes have not only lead to produce materials with increasing purity, but

have also resulted in the development of new growth processes which employ metallo-organic compounds. To meet these demands, indigeneous methods for the preparation of high purity gallium and arsenic and their organometallic compounds was undertaken under this program.

To commemorate inauguration of MAT Lab, a one-day seminar on "High purity materials for advanced electronics" was arranged. Eight invited talks covering various aspects of high purity materials were delivered. The seminar was

attended by more than ninety participants.



Dr Srikumar Banerjee, Director, BARC, addressing the one day seminar on "High purity materials for advanced electronics"

NISARGRUNA PLANT AT INS KUNJALI INAUGURATED

A One tonne capacity NISARGRUNA plant for disposal of biodegradable waste has been successfully installed in Indian Naval Station, Kunjali, Colaba, Mumbai, in June 2004. The improved design of the plant is functioning well and treating the biodegradable waste generated in the naval canteens in this area. The methane generated in this plant is being used in one of the

canteens saving daily 1.5 to 2 cylinder equivalent of liquid petroleum gas.

The plant was inaugurated on August 13, 2004 by Vice Admiral Mr S.K.K. Krishnan, Admiral Superintendent, Dock-yard. Dr R.B. Grover, Director, Knowledge Management Group, BARC, Dr K.B. Sainis, Associate Director, Bioscience

Group, Dr S.F. D'Souza, Head, NABTD, BARC, Mr A.K. Vechalekar, Executive Director (Technical), Heavy Water Board, Mr V.K. Khilnaney, Manager (EM&C), Heavy Water Board, Commander at Arms Mr C.V. Vasudevan and Lt. at Arms Mr Arjun Singh Sisodiya from Naval Police were present at this function. Mr S.K.K. Krishnan took keen interest in understanding the mechanism of NISARGRUNA concept and plant functioning, and expressed his appreciation for the NISARGRUNA technology. Dr Grover and Dr Sainis emphasised BARC's commitment to societal needs.



Inaugural function of NISARGRUNA plant at INS Kunjali



NISARGRUNA biogas plant at INS Kunjali

TRAINING COURSE ON “RADIOIMMUNOASSAY AND ITS APPLICATIONS”

The 50th Training Course on “Radioimmunoassay and its Applications” organised by the Radiopharmaceuticals Division, BARC, was held during October 11-30, 2004, at the Board of Radiation and Isotope Technology, Vashi, Navi Mumbai. 24 medical personnel, most of whom were pathologists and endocrinologists from various parts of the country, participated in this

course. Radioimmunoassay is an analytical technique based on immune reaction between the analyte and its antibody which is highly specific, and radioisotopes are used to trace a reaction imparting high sensitivity. This technique can measure substances such as hormones without any extraction at nano/pico mole concentrations in complex biological fluids.



At the inaugural function, seen on the dais from left to right are : Dr (Ms) Meera Venkatesh, Head, Radiopharmaceuticals Division, BARC, Dr V. Venugopal, Director, Radiochemistry & Isotope Group, BARC, Dr Anil Kakodkar, Chairman, Atomic Energy Commission & Secy. to Govt. of India, Dr S. Banerjee, Director, BARC, Mr J.K. Gosh, Chief Executive, BRIT, and Dr Grace Samuel, Course Coordinator

Dr Rosalyn Yalow, who along with Dr Solomon Berson, invented this technique in 1959 was awarded the Nobel Prize in 1975. Work on RIAs was started in BARC in the early seventies and RIA kits for several important hormones were developed and supplied to users in hospitals. This led to the need for training persons from hospitals in this technique, which in the course of time became a well formulated training course. The aim of the training course is to train prospective users of radioimmunoassay kits with all the basic aspects of the methodology and its quality control. It enables the trained person to do the assay in a meticulous and correct way, report the values with accuracy and tackle any problem in an intelligent manner. Radiopharmaceuticals Division has been conducting this training course since 1980 and the demand has necessitated two courses a year. The faculty members are drawn from BARC as well as BRIT, which is the supplier of RIA & IRMA kits now. In the past 25 years, 50 courses have been held and over 1200 medical and para-medical professionals have been trained. One exclusive Radioimmunoassay course was held for IAEA sponsored candidates in 1986. Because of the keen interest and request, a few courses were held outside Mumbai, viz. at Bangalore, Surat, Tirupati, Kolkata and Thiruvananthapuram, which mainly catered to the local candidates.



Dr Anil Kakodkar, Chairman, AEC, delivering the inaugural address at the 50th RIA Training Course

The 50th RIA Training Course was inaugurated by Dr Anil Kakodkar, Chairman, Atomic Energy Commission & Secretary, Department of Atomic Energy, Government of India, on October 12, 2004. At this inauguration, Dr Kakodkar emphasised that the use of radioisotopes in healthcare was becoming increasingly important and that BARC's mandate was to reach the benefit of the peaceful uses of radioisotopes to the Indian people. He said that the true fulfillment comes when the simple but important techniques such as RIA is available to the poor man in remote corners of our country at an affordable price, which is to a large extent achieved in the case of RIAs. One reason for this outreach is the RIA training course where a large number of professionals have been trained.



Dr S. Banerjee, Director, BARC, presiding over the function at the 50th RIA Training Course

Dr Srikumar Banerjee, Director, BARC, presided over the function and addressed the gathering. Dr Banerjee highlighted the importance of immunoassays, outlined the principle underlying the technique and the possibility of using immunoassays for non-clinical purposes. He pointed out the valuable benefits such simple techniques can yield.

Dr V. Venugopal, Director, Radiochemistry & Isotope Group, BARC, and Mr J.K. Ghosh, Chief Executive, BRIT, addressed the participants and the guests. Dr Venugopal mentioned about the merits of a formal training course in imparting

complete knowledge in the subject, particularly in reporting statistically valid results, which will then enable correct diagnosis. Mr Ghosh said that such training helps in spreading awareness in the professionals as well as institutes. He also mentioned about the expanding utility of such assays in veterinary field and the initiatives taken at BRIT in that line.

Dr Meera Venkatesh, Head, Radio-pharmaceuticals Division, BARC, welcomed the participants and the invitees to the inaugural function. On the occasion of the 50th training course, she gave a comprehensive account of the course right from its genesis in 1981 and acknowledged all the persons who have strived hard to formulate the course to this present extent. Dr Grace Samuel, Course Coordinator, proposed the vote of thanks.

All the participants successfully cleared the appraisal tests conducted at the end of the training. A valedictory function was held on October 30, 2004 when the completion certificate was given away by the eminent endocrinologist, Prof. S.D. Bhandarkar, who also addressed the participants.

AWARNNESS PROGRAMME ON "RADIOACTIVE SOLID WASTE MINIMISATION"

As a follow up of "Workshop on Minimisation of Radioactive Solid Waste", held at BARC during August 23-24, 2004, a one-day Awareness Programme on "Radioacative Solid Waste Minimisation" for various waste generators was conducted on October 11, 2004. A total of 19 participants from various Divisions of BARC attended this programme, which was inaugurated by Head, Waste Management Division, BARC, This was followed by four lectures, delivered in Hindi/English.

A visit to the RSMS site was planned and the participants were shown the various engineered facilities, viz. Stone Lined Trenches, RCC Trenches, Tile Holes, Waste Compaction, Assaying and Imaging Units, their functions and the disposal methods followed. Enthused with the opportunity to be able to see the quantum of work involved in waste management and the large area consumed for disposal, the participants appreciated the need for minimisation of radioactive solid waste. It was rightly emphasised on them to be ambassadors in their respective Divisions and carry the message on minimisation of radioactive solid waste for effective implementation. At the end, an interactive feed back session was organized.

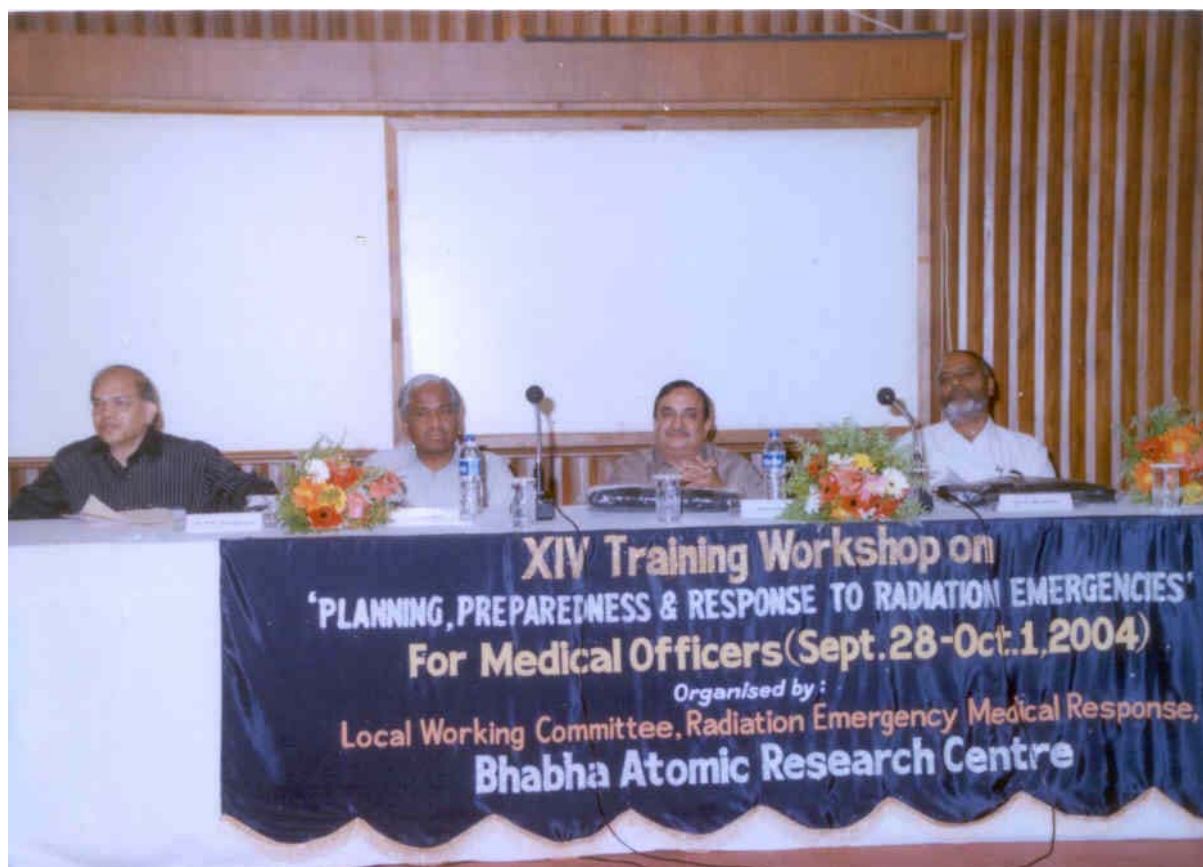
TRAINING WORKSHOP ON RADIATION EMERGENCY PREPAREDNESS FOR MEDICAL OFFICERS

The XIV Training Workshop on “Planning, Preparedness and Response to Radiation Emergencies for Medical Officers” was held under the aegis of Local Working Committee for Radiation Emergency Medical Response (REMR) of BARC at Niyamak Bhavan, AERB, from September 28 to October 1, 2004 and was inaugurated by Prof. S.P. Sukhatme, Chairman, AERB.

At the outset, Dr P.R. Bongirwar, Medical Officer-in-Charge of Trombay Dispensary and Chief Coordinator of the workshop, welcomed the distinguished invitees, guests and delegates and said that though it was the fourteenth workshop in the series, it was on the third occasion that it was being held under the auspices of the Local Working Committee for REMR, BARC. The total

number of delegates registered for the workshop were 43 and included specialists from Mumbai's top four major teaching hospitals, doctors from Armed Forces Hospitals and medical officers from different constituent units of DAE.

Dr P. T.V. Nair, Head, Medical Division, BARC, and Chairman of Local Working Committee of Radiation Emergency Medical Response (REMR), greeted the delegates and said, in his introductory address, that ionising radiation was being used in diverse fields in an ever increasing manner and hence it was very crucial for doctors to know how to handle radiation emergencies and injuries. He also spoke of the crucial need to include this subject in medical curriculum as there was hardly any teaching done on this topic either at undergraduate or postgraduate level.



At the valedictory function of the workshop, seen on the dais from left to right are : Dr Bongirwar, Medical Officer-in-Charge, Trombay Dispensary, BARC, Dr P.T.V. Nair, Head, Medical Division, BARC, Mr S.K. Jain, CMD, NPCIL, and Mr K. Muralidhar, Secy., AEC, & Head, MSG, DAE

DAE being the nodal authority for all aspects of radiation emergencies, it becomes imperative to host such workshops for creating awareness among doctors from different units and cross-section of society. This would certainly help in filling the knowledge gap by dissemination of information and bringing clinical awareness about handling radiation injuries among the physicians. He also added that this workshop would help in developing further the integrated medical network system among different medical institutions as a matter of radiation emergency medical preparedness.

Dr D.N. Sharma, Head, Radiation Safety Systems Division, BARC, gave an overview of the set up and functioning of the Emergency Response Centres (ERCs) under DAE, based in different parts of the country. He also stressed the need to train First Responders by organising training workshops and conducting regular emergency exercises.

Prof S.P. Sukhatme in his inaugural speech, described various peaceful applications of ionising radiation and the regulatory role that AERB plays in the control and protection of all activities related to use of ionising radiation all over the country. He also referred to an excellent safety track record of Indian nuclear power plants which was second to none at global level. He said that, in this context, there was no need to be alarmed about radiation accidents and emergencies. Nevertheless, inadvertent misuse of orphan radioactive sources or threat of nuclear terrorism are some of the issues which need to be looked at. Therefore there is a need to sensitise and train medical professionals in handling radiation injuries and emergencies so as to create a pool of trained doctors.

The training workshop spread over a period of 4 days comprehensively covered all topics pertaining to radiation injuries/emergencies/accidents including assessment of psychological impact of radiation accidents and an overview of overall preparedness in dealing with medical management of radiation emergencies as it exists

in different units of DAE. This was achieved through series of lectures by faculty members drawn from AERB, BARC and DAE, practical demonstrations on methods of decontamination and how to handle radiation injuries, and by visits of delegates to RMC, Tata Memorial Hospital and BARC.

Mr S.K. Jain, Chairman and Managing Director, NPCIL, was the Chief Guest for the valedictory function which was held on October 1, 2004. Dr H.M. Haldavnekar welcomed the Chief Guest and invitees. Dr P.R. Bongirwar gave a brief summary of the training workshop inclusive of feedbacks from the participant delegates. In his valedictory address, Mr Jain gave an account of outstanding safety record of operating nuclear power plants in our country. He further stressed the crucial need for training our doctors in this field to be prepared to handle any untoward incidents or situations should they ever happen and also keeping in view the potential possibilities of acts of nuclear terrorism. He also offered to give NPCIL help in conducting training workshops elsewhere as well in future. He later distributed certificates of participation to attending delegates. Dr Ravi Jarnmihal proposed a vote of thanks on behalf of the Local Working Committee, REMR, BARC.

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



डॉ. ए. के. त्यागी, ठोस अवस्था एवं पृष्ठीय रसायनिकी अनुभाग, अनुप्रयुक्त रसायनिकी प्रभाग को हाल ही में विभिन्न पुरस्कारों से सम्मानित किया गया। उन्हें नेशनल एकेडमी ऑफ साइन्सेज, इंडिया (एन ए एस आई) की फेलोशिप और महाराष्ट्र एकेडमी ऑफ साइंस की फेलोशिप प्रदान की गयी। उन्हें इंडियन न्युक्लियर सोसाइटी

(आई एन एस) के वार्षिक सम्मेलन में दिनांक 15 नवंबर 2004 को महानिदेशक, अंतर्राष्ट्रीय परमाणु ऊर्जा एजेंसी (आई ए ई ए), विएना द्वारा इंडियन न्युक्लियर सोसाइटी (आई एन एस) के स्वर्ण पदक से अलंकृत किया गया। उन्हे वर्ष 2005 के मेटेरियल रिसर्च सोसाइटी ऑफ इंडिया (एम आर एस आई) के पदक से भी अलंकृत किया गया। डॉ. त्यागी को सभी पुरस्कार पदार्थ रसायनिकी के अग्रणी क्षेत्रों में उनके विस्तृत अनुसंधान कार्यों को मान्यता स्वरूप दिए गए। उनके द्वारा नाभिकीय पदार्थों (प्रगत भारी पानी रिएक्टरों हेतु थोरिया ईंधन और प्लुटोनियम उपयोग हेतु भविष्य कालिक मैट्रिक्स ईंधन) में किए जा रहे कई महत्वपूर्ण अनुसंधान कार्य इस प्रकार हैं :- प्रौद्योगिक रूप से महत्वपूर्ण नेनो-सिरेमिक तैयार करना, असामान्य तापीय प्रसार व्यवहार सहित फेमवर्क ठोस, विरल-मृदा आधारित फ्लोराइड एवं अपारिवेशी स्थितियों के अंतर्गत ठोस अवस्था रसायनिकी इत्यादि. अंतर्राष्ट्रीय पत्रिकाओं में उनके कई प्रकाशन हैं। उन्होनें देश-विदेश में अनेक वार्ताएं प्रस्तुत की हैं। वे मुंबई विश्वविद्यालय के मान्यता प्राप्त पीएच.डी. गाइड हैं, व अनेक विद्यार्थी उनकी देखरेख में पीएच.डी. कर रहे हैं।

Dr A.K. Tyagi, Head, Solid State & Surface Chemistry Section, Applied Chemistry Division, has recently been honoured with several awards and recognitions. He was conferred the Fellowship of the National Academy of Sciences, India (NASI), and the Fellowship of the Maharashtra Academy of Sciences.

He was awarded the Gold Medal of the Indian Nuclear Society (INS), which was given away by the Director General, International Atomic Energy Agency (IAEA), Vienna, on November 15, 2004, during the Annual Conference of INS.

Dr Tyagi has also been awarded for the Materials Research Society of India (MRSI)'s Medal for the year 2005.

All these honours to Dr Tyagi are in recognition of his wide ranging research activities in the frontline areas of Materials Chemistry. Some of the important research activities pursued by him are in the field of Nuclear Materials (thoria based fuels for Advanced Heavy Water Reactors, and

futuristic Inert Matrix Fuels for plutonium utilisation), preparation of technologically important nano-ceramics by soft-chemical routes, Framework solids with unusual thermal expansion behaviour, Rare-earth based inorganic fluorides and Solid State Chemistry under non-ambient conditions, etc. He has to his credit a large number of publications in international journals. He has delivered a number of invited talks in India and abroad. He is a recognised Ph.D guide of Mumbai University, and several students are doing Ph.D. under his supervision.

रसायन इंजीनियरी (CRYS-2004) में अनुसंधान कर्ताओं एवं युवा वैज्ञानिकों का प्रथम राष्ट्रीय सम्मेलन दिनांक 25 से 27 सितंबर, 2004 के दौरान भारतीय प्रौद्योगिकी संस्थान, खड़गपुर में हुआ। यह संगोष्ठी इंडियन इंस्टिट्यूट ऑफ केमिकल इंजीनियरिंग एवं भारतीय प्रौद्योगिकी संस्थान, खड़गपुर द्वारा संयुक्त रूप से आयोजित की गई। श्री निलय जे.जसु एवं श्री केयुर सी. पंचोली, अपशिष्ट प्रबंधन प्रभाग, भा.प.अ. केंद्र द्वारा प्रस्तुत उच्च स्तरीय रेडियोसक्रिय द्रव अपशिष्ट के प्रबंधन हेतु कॉचीकरण नामक लेख को संगोष्ठी में सर्वश्रेष्ठ लेख का पुरस्कार



N.J. Jasu



K.C. Pancholi

प्राप्त हुआ।

The 1st National Conference of Research Scholars and Young Scientists in Chemical Engineering, (CRSYS-2004), was held at IIT Kharagpur during September 25-27, 2004. The Conference was jointly organised by Indian Institute of Chemical Engineers and IIT, Kharagpur. A paper titled "Vitrification technology for the management of high level radioactive liquid waste" presented by Mr Nilay J. Jasu and Mr Keyur C. Pancholi of Waste Management Division, BARC, was judged as the best paper award in the Conference.

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