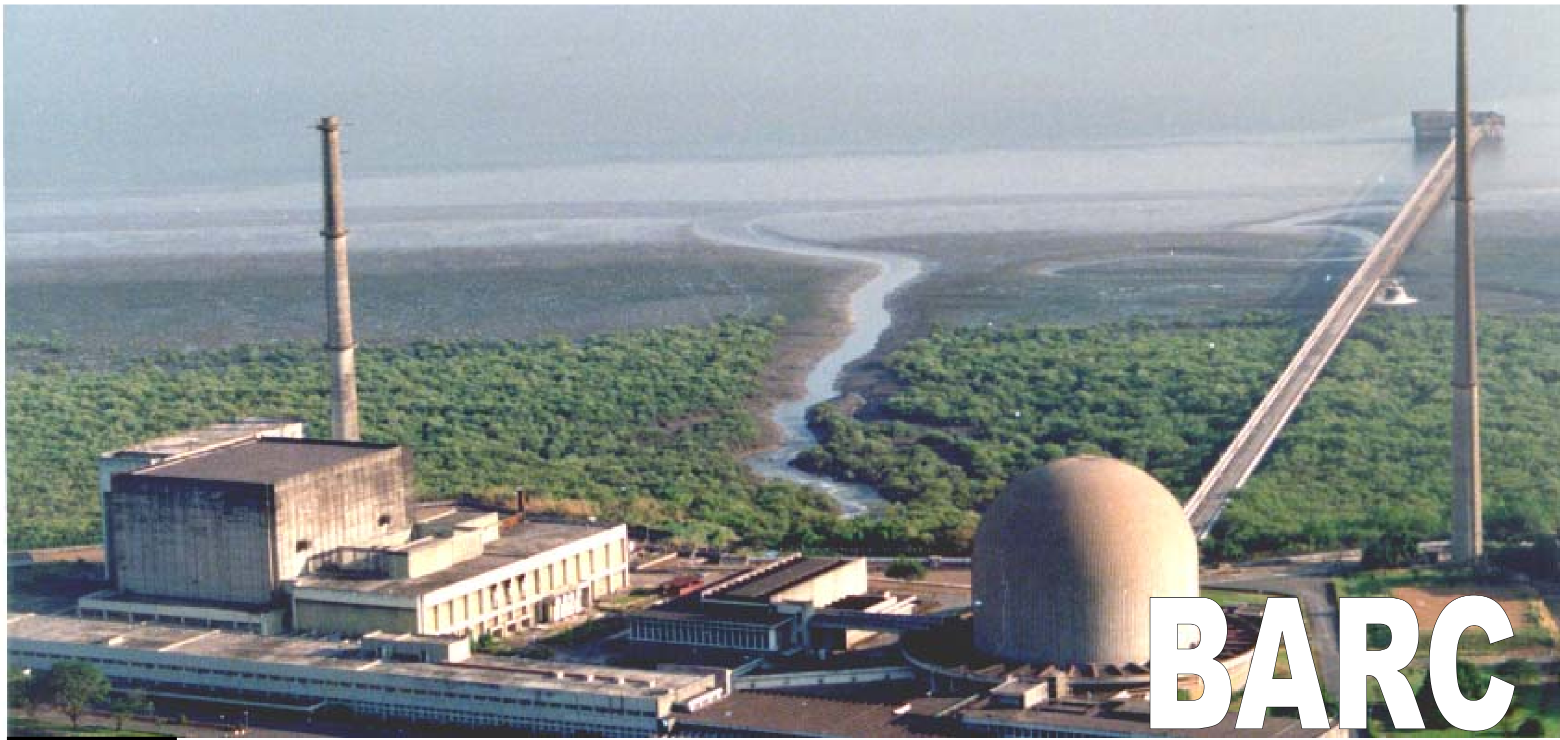


No. 233
June
2003

NEWSLETTER

Contents

POOL SITE INSPECTION FACILITY (PSIF) AT DHRUVA

J. Subba Raju, S. Duraisamy, A.K. Saha and A.C. Tikku
Reactor Group

and

M.G. Andhansare
Formerly in Reactor Group

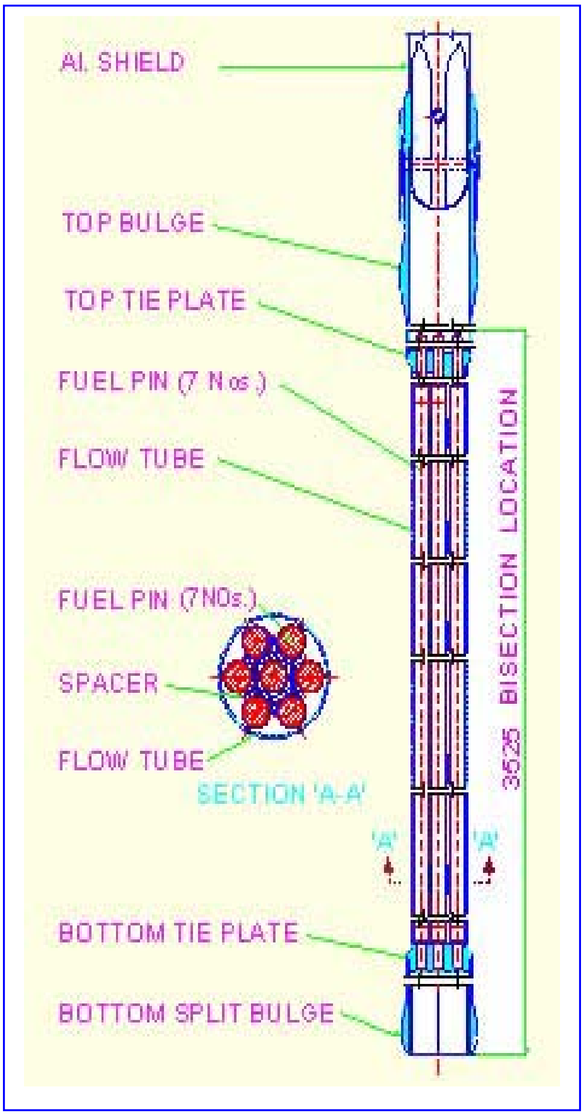
Introduction

Dhruva is a 100 MW (Th.) research reactor using heavy water as moderator as well as coolant and natural metallic uranium as fuel. The fuel cluster is an assembly of seven fuel pins located inside a flow tube (Fig.1). The fuel pins are welded to a bottom tie plate and are guided in the top tie plate for free expansion or contraction. The fuel cluster is pinned to an aluminum shield, which in turn is pinned to a seal and shield plug to form a complete fuel assembly. The loading of a fresh fuel and unloading of an irradiated fuel from the reactor is done by a heavy water cooled fuelling machine. The irradiated fuel discharged into fuel discharge port by the fuelling machine is sent to Spent Fuel Storage Bay (SFSB) by an underwater buggy. After sufficient cooling in SFSB the irradiated fuel is sent to fuel reprocessing plant for further processing.

Objective

The objective of designing a Pool Site Inspection Facility (PSIF) is to have a facility where the irradiated fuel can be inspected for any defects immediately after

Fig.1 Dhruva fuel cluster



unloading from the reactor. In order to inspect the irradiated fuel assembly immediately after unloading from the reactor, wet transportation of fuel and an underwater inspection facility would be required if the inspection is carried out at a remotely located inspection laboratory. Alternatively, the irradiated fuel could be stored in a pool of water at reactor site and after sufficient cooling, it could be transported in dry condition to the remote inspection laboratory.

Any inspection at a remotely located laboratory involves a long under water storage of irradiated fuel, which would result in shadowing of the primary defects thereby loosing vital information on the root cause responsible for initiating the primary defect and will also result in loss of time to acquire the useful data for any remedial action. Hence, it was decided to have an under-water inspection facility in the spent fuel storage bay of Dhruva Reactor for inspection of irradiated fuel assemblies.

Guidelines for Design of PSIF

The following guidelines were followed while designing the pool site inspection facility.

- The design should be simple and reliable for under water operation and inspection of irradiated fuel assembly at a water depth of 4100 mm.
- The radiation exposure of the operation and maintenance personnel should meet the principle of ALARA (as low as reasonably achievable)
- The disturbance in fuel storage bay water should be minimum so as to minimise air borne activity.
- The bay water should not get contaminated with impurities like oil, grease, corrosion products, etc. while performing underwater operations.
- Fuel pins should not get damaged during under water longitudinal slitting and end cutting of fuel cluster.
- The design should facilitate separation of irradiated fuel pins manually using remotely operated tools.
- The radioactive metallic dust generated during fuel assembly cutting operations should be contained in the tank.
- Decontamination of facility should be possible by proper selection of material.
- Easy maintenance and quick replacement of equipment and component should be possible.
- Maintenance and repair activities should be kept to a bare minimum.
- Remote handling tools should be rugged and simple to operate.
- Safe transportation of fuel pins after inspection should be possible.

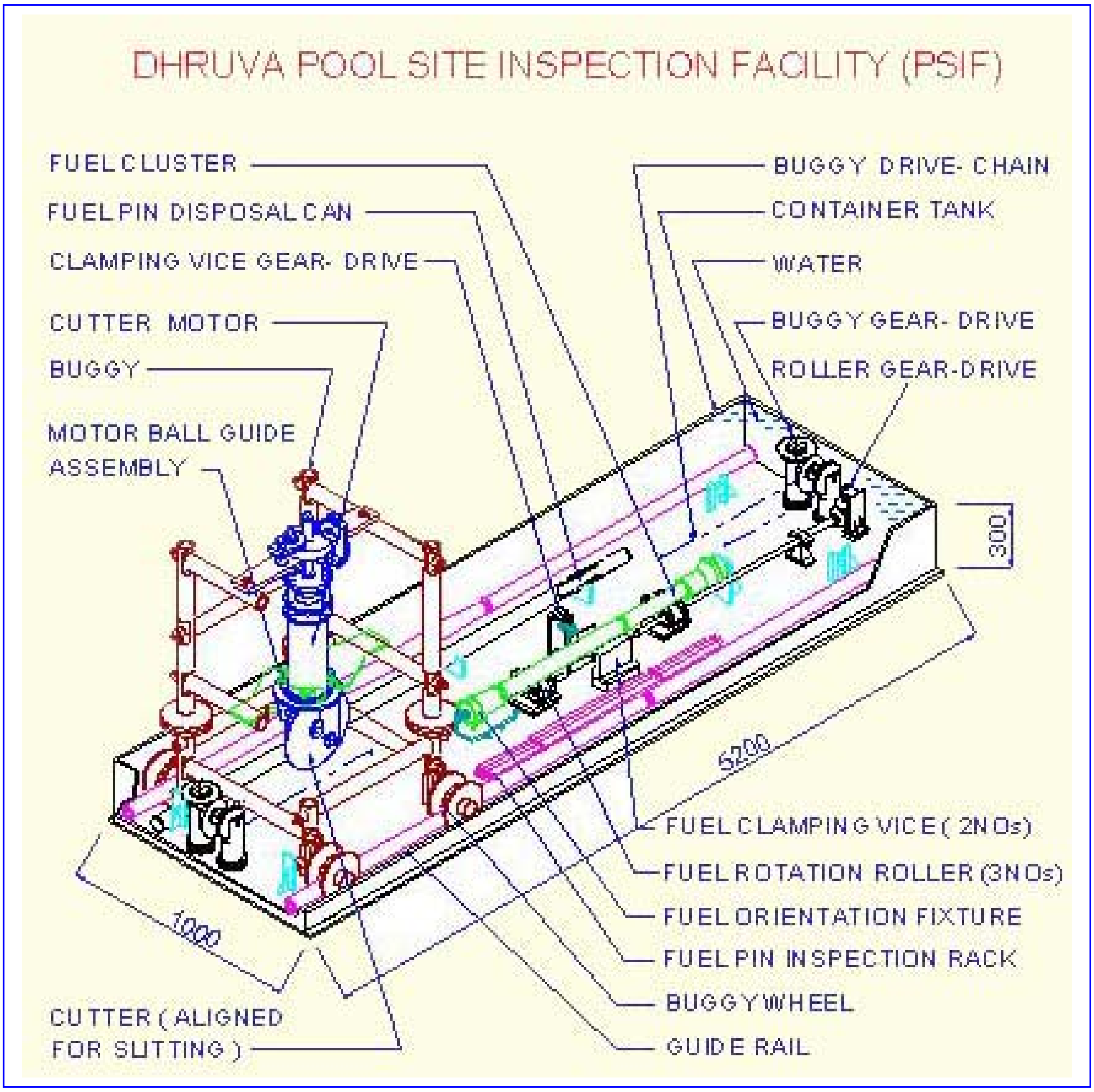


Fig.2 General layout

Based on the above guidelines a pool Site Inspection Facility (PSIF) was designed, fabricated and installed in SFSB of Dhruva Reactor.

Major Components of PSIF

The description of some of the major components of PSIF (Fig. 2) are as follows:

Container tank

A container tank of overall dimensions 5200 mm (length) x 1000 mm (width) x 300 mm (height) houses all the equipments and components required for PSIF. The tank is fabricated out of SS-304 L plates. Stiffeners are provided at the tank bottom for strengthening it so as to minimise deflection of the tank while handling. Drain hole fitted with a removable type fine filter is provided at the bottom of the tank for collection of radioactive metallic dust generated during cutting operations.

Guide rails

Stainless steel guide rails for longitudinal movement of the cutting mechanism mounted on a buggy are provided at a span of 850 $\pm$ 0. 5 mm. The guide rails are fixed to the container tank.

Buggy and buggy drive

A buggy of overall size 850 mm X 660 mm X 1065 mm (height) (Fig. 3) is fabricated from SS material and has four corner wheels for longitudinal movement. The buggy provides support for the cutter motor and the cutting mechanism for longitudinal slitting and end cutting of fuel cluster. SS roller chain and sprocket drive are provided for buggy movement in longitudinal direction. The drive sprockets are located at both the ends of guide rails and manually operated through a bevel gear drive

Fig.3 Buggy with cutting mechanism

arrangement.

Roller assembly

Irradiated fuel cluster of 3525 mm length rests horizontally on three sets of roller assemblies so that the fuel cluster can be rotated for underwater longitudinal slitting. A common shaft connects the drive roller of each roller assembly. The drive roller shaft is rotated manually through a bevel gear arrangement.

Clamping vice

The fuel cluster is clamped by 2 vices during slitting operation. Each vice has a fixed and a moving jaw. The moving jaw of vice is moved in

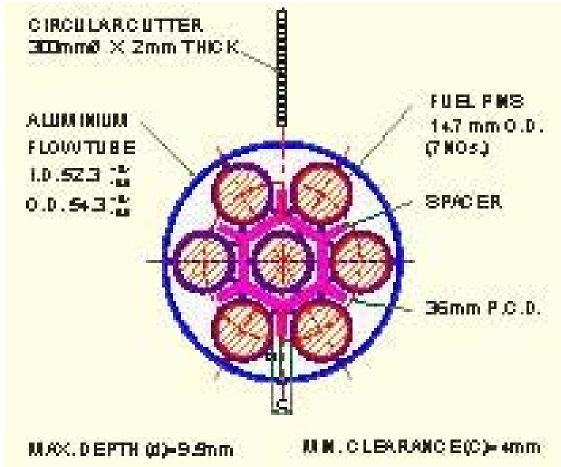


Fig.4 Dhruva fuel cluster cross section (with cutter location)

Orientation-cum-guiding fixture

As the seven fuel pins of the fuel cluster are located inside a flow tube, it is difficult to know their orientation from outside of flow tube. An orientation-cum-guiding fixture has been designed to orient the fuel cluster so as to ensure safe longitudinal slitting operation of the flow tube without causing any damage to the uranium fuel pins (Fig.4). The orientation of the guiding fixture is carried out by taking reference of top end plugs of fuel pins projecting above the top tie plate. The orientation fixture is engaged to the fuel end plugs through seven internal holes (Fig. 5). Two sets of guide plates are provided 180º apart on external surface of the fixture to guide the cutting saw for longitudinal slitting operation. The guide plates are separated by 3.5 mm by which the cutting saw gets located automatically in between the adjacent fuel pins, thereby achieving safe longitudinal slitting of the fuel cluster.

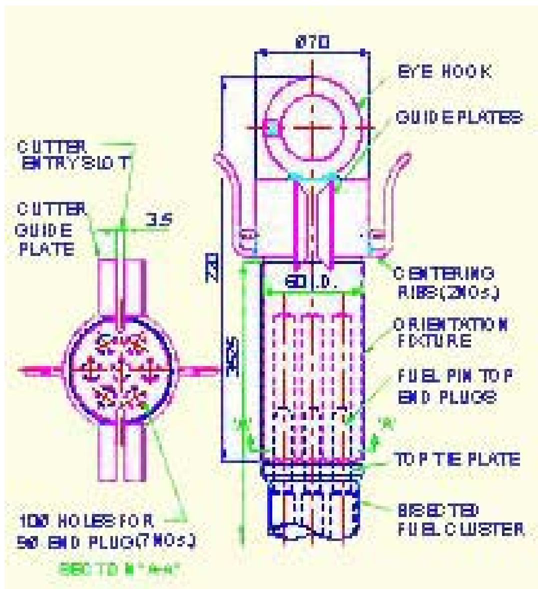


Fig. 5 Orientation-cum- guiding fixture (engaged to fuel

or out by a lead screw mechanism rotated manually through bevel gear arrangement.

Longitudinal slitting and end cutting drive

A circular cutting saw of 300 mm diameter and 2 mm thickness is fixed to a canned motor through reduction bevel gear arrangement and the complete assembly is mounted on the buggy for longitudinal slitting and end cutting operation of fuel cluster. Canned motor of 3 kW capacity, supplied by Control Instrumentation Division, BARC, is assembled with the cutting saw which can be rotated by a lead screw mechanism and indexed by 90^0 for change over from longitudinal slitting to end cutting operation and vice versa. Mechanical stoppers are provided for controlling the depth of cutting for longitudinal slitting and end cutting operations. Guide rods and ball guide bearings are provided to guide the motor and the cutting saw during vertical feeding for slitting and end cutting operation. Underwater feeding, indexing and clamping of the motor along with the cutter assembly are carried out manually, by remotely operated tools.

Inspection rack

The fuel pins are stored underwater in a rack provided on one side of the container tank after separation from the fuel cluster. The fuel pins can be handled underwater with remotely operated tools for various inspections to check for any defects.

Tools for underwater operations

As the underwater operations for PSIF are to be carried out remotely in manual mode, different types of tools, each 6 meters long, have been designed to carry out various underwater operations like:

Fig. 6 Underwater PIE of Dhruva fuel cluster at PSIF

- Roller drive to align the fuel cluster along with orientation fixture for longitudinal slitting.
- Vice drive for fuel assembly clamping.
- Feed drive of cutting saw for longitudinal slitting and end cutting.
- Buggy drive for longitudinal movement of the cutting saw.
- Unlocking of cutting saw clamps and release of anti-rotation latch.
- Rotation & Indexing of cutting saw for longitudinal slitting & end cutting operation and vice versa.
- Separation and storage of fuel pins in the rack for inspection.
- Loading of separated fuel pins in a can for disposal.

Under-water Post Irradiation Examination (PIE) at PSIF

After extensive trials, the PSIF was installed and commissioned in SFSB and visual inspection of an irradiated fuel assembly was carried out.

Visual inspection

An irradiated fuel assembly having confirmed clad failure was longitudinally slit and ends were cut underwater at PSIF and the fuel pins were separated for visual inspection. The visual inspection revealed a defect of around 50 mm length on one of the fuel pin (Fig.6). Uranium and aluminum clad material was found missing from the defect location and this observation was recorded by an underwater video camera. The root cause for clad failure is under investigation.

Non-destructive testing

In order to extend the scope of underwater inspection, various other non-destructive tests like Eddy Current Testing and Ultrasonic testing etc. are planned in future at Dhruva Pool Site Inspection Facility for underwater inspection of irradiated fuel assemblies.

The successful design, fabrication and testing of Dhruva PSIF was done by Research Reactor Services Division (RRSD) and the satisfactory installation and commissioning of PSIF was done by Reactor Operation Division (ROD) & RRSD of Reactor Group, BARC.

ULTRASONIC C-SCAN IMAGING OF END FITTING FORGING FOR 500 MWe PHWR USING AUTOMATED SCANNER AND ULTIMA-100M4 SYSTEM

S.P.Srivastava, B.N.Lahiri and A.Manjunatha
Centre for Design & Manufacture

and

V.H.Patankar, V.M.Joshi and S.K.Kataria
Electronics Division

Introduction

End Fitting forgings for 500 MWe Pressurised Heavy Water Reactor (PHWR) are manufactured at Centre for Design & Manufacture (CDM), BARC, under rigorous quality control. In the PHWR, these forgings are used as end fittings for high pressure coolant channel, so as to (i) facilitate on-line fuelling, (ii) provide a transition joint between Zirconium Niobium pressure tube and the carbon steel primary circuit piping, and (iii) provide support for coolant channel assembly. The End Fitting forging is machined out of modified AISI 403 grade stainless steel

(Martensitic) single piece cylindrical forging to obtain a hollow cylindrical piece (ID- 137.1mm, OD- 163.5mm, Length- 2516mm) with a side port.

During the manufacturing process, End Fitting forgings are subjected to Ultrasonic Testing (UT) and Magnetic Particle Testing (MT) to ensure defect-free final products. Volumetric defects are detected by UT, and MT is used for detecting surface and sub-surface defects. These tests are carried out manually and suffer from inherent limitations such as poor repeatability, operator dependence and lack of provision for maintaining record, etc.

To overcome these limitations and to ensure 100% volumetric testing of End Fitting forgings, a fully automated Ultrasonic Imaging system has been designed and developed jointly by CDM and Electronics Division, BARC. This system is capable of detecting 1.2mm diameter flat bottom hole (FBH) or bigger flaws at 171mm depth in a 190 mm diameter SS403 forging using ultrasonic normal beam contact test method. It is possible to generate and store on-line C-Scan images along with 'A' Scan waveforms and 'B' Scan images for four channels simultaneously. Data can be retrieved for image reconstruction to enable post examination location and sizing of defects, if present. Excluding the job loading and unloading operations, entire scanning is automatic and fully under the control of host personal computer (PC).

The ULTIMA-100M4 is a four-channel Ultrasonic C-Scan Imaging system which has been designed and developed at Electronics Division, BARC, specially for this requirement. The four-axis stepper motor controlled mechanical scanner has been designed at CDM, BARC, for carrying out inspection of End Fitting forgings, in a contact scanning mode. This article provides an overview of the full system.

Fig. 2 A-Scan waveform and B-Scan image of a Defect Standard showing image of 1.2mm and 2mm diameter FBHs

Fig. 1 An overall view of four-axis Automated Scanner

System Description

The automated End Fitting forging inspection system consists of following assemblies:

- A four-axis stepper motor driven Mechanical Scanner for transducer manipulation and job rotation.
- Probe Assembly consisting of transducers, operating in contact scanning mode.
- Oil feeding arrangement.
- Industrial PC-based four channel Ultrasonic C-Scan Imaging system "ULTIMA-100M4".
- Stepper Motor Driver and Controller unit

Mechanical Scanner

The Scanner provides three to-and-fro translational movements (viz., X, Y and Z) to the probe assembly and one rotational movement (θ), in clockwise or anticlockwise direction to the End Fitting forging under test. Ball screw-nut assemblies and appropriate guide assemblies have been used for precision and repeatability for linear movement for every axis. Each linear motion axis incorporates pairs of (i) limit switches for over-run protection, and (ii) proximity switches for home positions at either ends. The test job along with a defect standard is rotated with the help of rollers mounted on two sets of shafts, fitted inside a base tank. The rollers serve as frictional transmission elements and they are fitted with polyurethane sleeve to avoid any slippage of the job. Roller mounted shafts are coupled to the θ-axis stepper motor through a gearbox and a timing belt for synchronized rotation. A pendant, incorporating controls for X, Y, Z and θ motions, emergency stop and oil pump On/Off operation, has been provided at one end of the scanner for manual mode operations during calibration and loading/ unloading of End Fitting forging.

A two-way valve at the bottom of the base tank is used for maintaining adequate couplant fed from the stationary storage tank. Size of the base tank has been designed so as to carry out the testing in immersion scanning mode also, if required. The overall dimensions of the mechanical scanning assembly are: 5125mm (L) x 1505mm (W) x 1483mm (H).

Probe Assembly

Ultrasonic probes are fitted with in-house fabricated Perspex shoes having curvature matched to the outer diameter of the job. Flexible oil hoses are connected to the shoe through nozzles, which communicate with holes drilled inside the Perspex such that oil continuously spreads between the shoe and the surface of the job at the point of contact. Spring-loaded shoe can be moved up and down with the help of a vertical arm through a hole inside the probe holder. The height of the probe assembly is adjusted in such way that it exerts optimum pressure to maintain the contact between the transducer and the job during scanning. Radial and axial separation between two adjacent probes are fixed considering at least 50% overlap of ultrasonic beam in the bottom half of the forging.

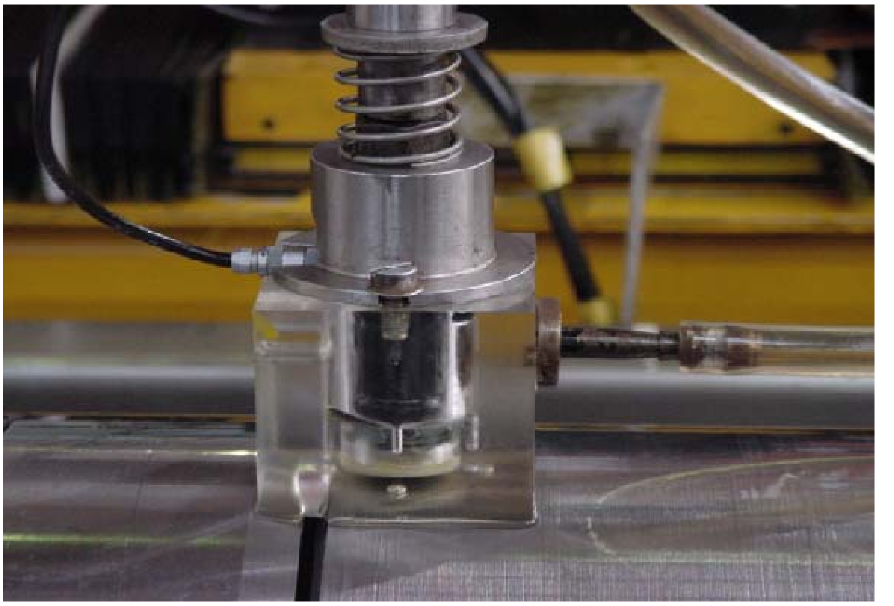


Fig. 3 A close view of Probe Assembly

Oil feeding arrangement

Since the transducers remain in contact with the job during the scanning process, continuous supply of a suitable couplant such as oil is mandatory. An oil feeding arrangement is provided to feed oil between the probe and the job while scanning is being carried out. The oil, which is dispensed on the job, is collected at the bottom in the stationary storage tank through a filter/strainer assembly. This oil is pumped back to a movable storage tank, which is mounted on the carriage plate of X-axis at a sufficient height so that continuous supply of oil to the header is assured. The oil pipeline is distributed by four flexible hoses and connected to the header column by quick release couplings. Magnetic level switch inside the movable storage tank controls the operation of the motor used for pumping the oil.

Ultrasonic C-Scan Imaging System "ULTIMA-100M4"

The ULTIMA-100M4 system has been designed and developed by Electronics Division, BARC, to cater to the specialised need of volumetric inspection of End Fitting forgings in an automated manner. It is based around an Industrial Personal Computer and is capable of operating in the shop floor environment. The block diagram of the ULTIMA-100M4 is as shown in Figure 4. The major constituents of the ULTIMA-100M4 System are as follows

[A] Hardware

1. Square Wave Pulser-Receiver Unit
2. 100 MSPS, 8 Bits Digitizer : ISA compatible PC Add-on board
3. Multichannel Sequencer : ISA compatible PC Add-on board
4. Programmable Gain Amplifier : ISA compatible PC Add-on board
5. Rectifier Board : ISA compatible PC Add-on board

The system provides four-channels for data acquisition. The four transducers are energised in Pulse-Echo (PE) mode in a user defined sequence. This avoids any mixing of the data among the channels. The Multichannel Sequencer Board (MCSB) generates the required sequence of trigger signals. These trigger signals are routed to the four-channel Square Wave Ultrasonic Pulser-Receiver unit. The amplified echo signals (4 nos.) from this unit are brought back to MCSB where they get multiplexed (4:1). Multiplexed echo signal is further amplified with Programmable Gain Amplifier board and then rectified and envelope-detected with the help of the Rectifier Board. This envelope-detected echo signal is fed to the 100 MSPS, 8 Bits Digitizer Board for data acquisition, storage and display purpose. This board has an 8k bytes of record length for storage of an each 'digitized A-Scan waveform'.

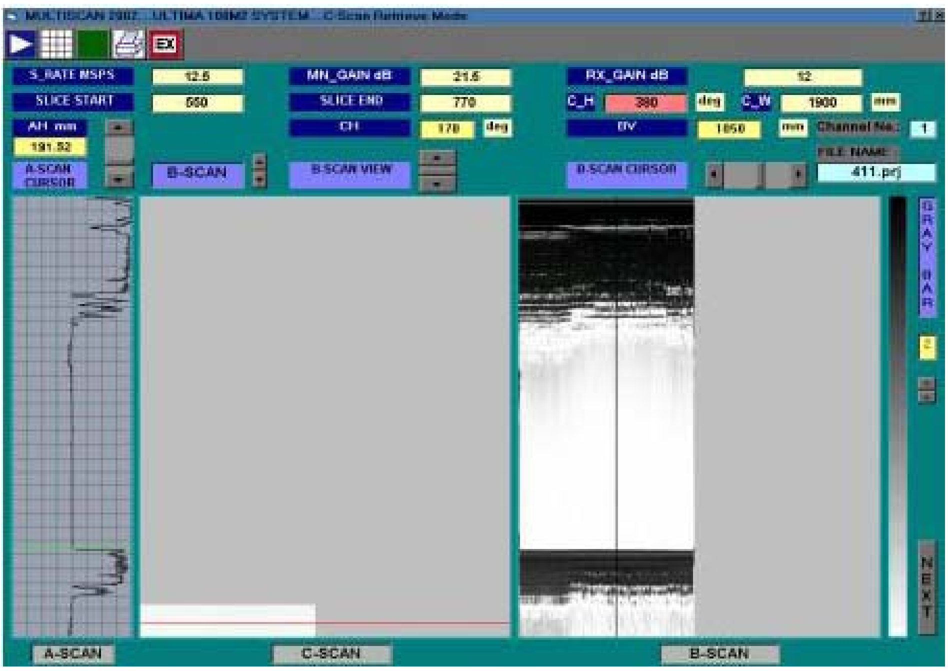


Fig. 5 Retrieved C-scan image of End Fitting forging using ULTIMA-100M4

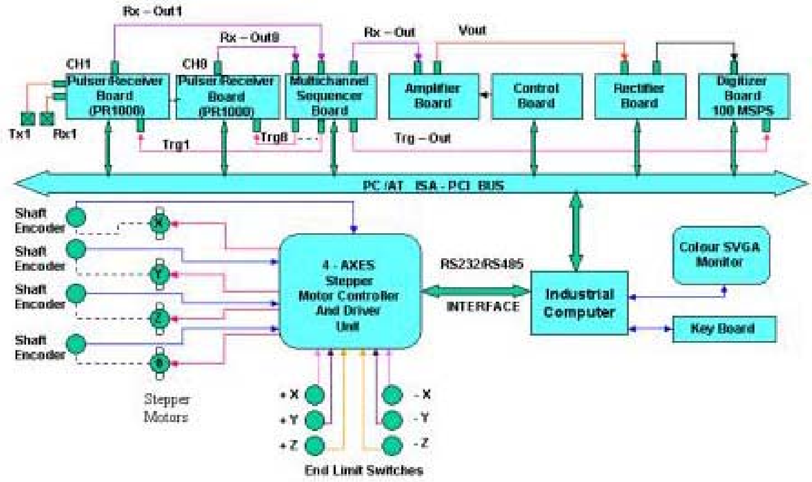


Fig. 4 Schematic block diagram of ULTIMA-100M System

[B] Software

Windows 98 compatible system software has been developed using Visual Basic and Visual C++. Some of the major features of the software are: material and transducer selection and calibration, four-axis mechanical scanner control program, data acquisition-storage and display of information in the form of A-Scan waveforms or B-Scan (cross-sectional front-view) or C-Scan (cross-section plan view) images in gray-scale/pseudo colours. 'Return on Defect' mode for confirmation of defect locations for C-Scan imaging is an added feature.

A Square Wave type Ultrasonic Pulser-Receiver unit has been designed and developed specifically for this 'End Fitting forging' inspection application and the same has been integrated with the four channel ULTIMA-100M4.

Stepper Motor Driver and Controller unit

Rotation of the End Fitting forging (i.e., the θ movement) and the translation of ultrasonic probes (in the X, Y and Z directions) are carried out with the help of four independent stepper motors. The controller and driver units (all Warner, USA, make) are governed by the ULTIMA-100M4 system in the 'Auto' mode and can be controlled with the help of pendant in the 'Manual' mode operations. The Stepper Motor Controllers (Model SS2000 Pci) for all the four axes are interfaced with the host computer of ULTIMA-100M4 system in a daisy-chain manner using the RS 485- "Multidrop Interface" protocol. All the electrical control signals routed to the driver from the controller are optically isolated. The feedback signals derived from the rotary shaft encoders, limit switches and proximity detectors, and control signals for 'manual mode operation' switches from the pendant are connected to the respective controller. Each controller module operates with 240VAC mains and has a built-in regulated DC power supply. The drivers for all the axes are of micro-stepping type and can provide upto 20,000 steps per revolution.

The Controller-Driver assembly is located below

Fig. 6 Scanning of End Fitting forging by four-axis Automated Scanner in progress

the main scanning assembly and operates with 3-phase AC supply equipped with a single phasing preventer. The Controller-Driver assembly is interfaced to the host Industrial PC with the help of RS485 compatible serial communication cable.

Ultrasonic Inspection Technique

Each End Fitting forging, after coarse O.D. turning (190mm diameter x 2533mm long and weighing 600Kg approx.) is subjected to volumetric ultrasonic test using normal beam contact scanning method in order to assess its quality. Ultrasonic system calibration for setting the sensitivity is done with the help of a Defect Scanning is carried out by moving the probe assembly in X-θ sequence, i.e. first, the probe assembly is moved from one end of the job to the other end in the direction parallel to the length of the job, in user defined steps (Δ x) after which the job is given an incremental rotation (Δ θ) in clockwise (CW) direction to ensure 100% planar coverage. Then the probe assembly is moved back to the location from where the inspection was started and again the job is rotated in the same direction. In this fashion, the entire volume of the job is covered. The data acquisition is only performed when the probe assembly is static at

Standard consisting of a 1.2mm diameter, 19mm deep flat bottom reference hole drilled radially in 190mm diameter, 350mm long piece cut from the same forging. Defect Standard and the job are kept on the rotating rollers side by side so that scanning speed, job and probe indexing, contact pressure and couplant flow are identical for the Defect Standard as well as the End Fitting forging under test. Ultrasonic pulser-receiver & data acquisition parameters also remain constant because the defect standard as well as the test job is inspected in the same pass under identical settings. This is a unique feature of the inspection procedure.

each linear incremental position. X and θ increments are selected in such a way that during calibration, a discernible image of the 1.2mm diameter FBH is seen in the C-Scan. Once the calibration is performed, the probe assembly is moved on the job for automatic scanning in the same manner. It may be noted that, in view of the large size of the job, trade off between axial and angular increments and total inspection period is inevitable. In case of on-line validation, total number of X vectors should include the length of the Defect Standard in addition to the job length.

Fig. 7 Close-up of Defect Standard with FBH, End Fitting forging and rotating rollers

Fig. 8 Finished End Fittings ready for dispatch

Full scanning of one job, (with X-increment: 20mm and θ -increment: 20 degrees) with two probes (and the ULTIMA-100M4 system running under PII- 300 MHz Industrial PC) takes roughly one and half-hour. However, during this period operator intervention is generally not required, as all the data gets automatically stored in a file. Subsequently, the image can be reconstructed for the post test evaluation. For verification of any defect indication, the user can position the cursor at the desired location on the C-Scan image and then activate "Return on Defect" command. This action initiates the motor movements so that the probe assembly is aligned w. r. t. the desired region.

During scanning operation, only one C-Scan image for a selected channel is displayed; however, display of 'A' scans for all the active channels are available continuously and the operator can easily identify improper indications, if any.

Conclusion

The need for exhaustive and critical inspection of mechanical components used in fabrication of nuclear reactors is well known. Safety measures amply emphasise the necessity of extensive testing of such parts in pre-fabrication, fabrication, pre-service and in-service stages. Keeping this requirement in mind and as a modest attempt to introduce an advanced and total NDT procedure for inspection of End Fitting forgings, the development of the subject system has been undertaken and successfully completed by joint efforts from engineers in CDM and Electronics Division, BARC. The system so far has been used for testing over one hundred End Fitting forgings at CDM, BARC.

References

1. Patankar V.H., Agashe A.A., P. Jyothi, Joshi V.M. " ULTIMA 100M8 – Multichannel Ultrasonic Imaging System for NDE of Tubes/Pipes ", X^{th} National Conference On Ultrasonics, Osmania University, Hyderabad, March 15-16, 2001.
2. Patankar V.H., Joshi V.M., Kataria S.K. "Multichannel - Ultrasonic C-Scan Imaging System For NDE of Metallic Tubular Objects", National Seminar and Exhibition NDE 2001, Lonavala, December 7-9, 2001.
3. Patankar V.H., Joshi V.M. "Design and Development of an Ultrasonic Pulser-Receiver Unit for Non-Destructing Testing of Materials", BARC Report No. 2002-E-034

BARC CELEBRATES NATIONAL SCIENCE WEEK

The National Science Week (NSW) was celebrated during February 24-28, 2003. The theme of the celebration was, "50 years of DNA (Deoxy Ribonucleic Acid)". On February 28, 1928, Dr C. V. Raman announced the news of his discovery which dealt with the phenomenon of light scattering, later called the "Raman Effect". Coincidentally, on February 28, 1953, Watson and Crick announced to their colleagues in U.K. informally that they had stumbled on the blue-print of life.

National Science Week programme at Multipurpose Hall, Training School Hostel, Anushaktinagar

Bio-Science Group, BARC, and Media Relations & Public Awareness Section (MR&PAS), BARC, evolved the programmes held during NSW. The audiences for the talks and the experiments on DNA fingerprinting were students of 9th and 11th class and teachers from RUIA College, S.I.E.S. College, Atomic Energy Central Schools (AECS) and Marathi Vidnyan Parishad. The history of DNA, the 'master molecule', was traced down in a very lucid manner by BARC scientists from the

DNA Fingerprinting experiment in progress

elucidation of its double helical structure.

On February 27, a programme was held in Training School Hostel, Anushaktinagar, for 600 students of AEC Schools 2 to 5. Dr K. B. Sainis, Associate Director, Bio-Science Group, BARC, was the chief guest. Ms Rani Verma, Head, Academic Unit, Atomic Energy Education Society, gave the inaugural address. Mr R.K. Sharma, Head, MR&PAS, BARC, talked about the significance of science day and programmes conducted during the week.

The spin off areas of DNA research have resulted in commonly used scientific jargon, such as Molecular Biology, Biotechnology, Genetic Engineering, Molecular Genetics, Fingerprinting, Cloning, Genetically Modified (GM) plants, etc. These terms were simplified and presented in different hues for the audience by scientists of the Bio-Science group: Dr N. Jawali, Dr R. Mukopadhyay, Dr S. G. Bhagwat and Dr T. G. Krishna.

The DNA threads of life, which intertwine from across viruses to homo sapiens, were shown to excited students by the demonstration of DNA spooling in the test tube, its visualization and fingerprinting by gel electrophoresis. These experiments were carried out by Dr (Ms) A. Parasnis, Ms J. Boloor, Ms M. Gomes, Ms S. Indurkar, Ms N. Eshwaran – all Ph.D. students from the Bio-science Group. The experiments were projected on the screen by Mr M. Ananda and Mr Ajaykumar using a videocam and multi-media projection. This helped a large number of students to clearly see the experiment.

The lectures and the experiments triggered many interesting questions. A few of them were: "Can a full human genome be synthesized in the test tube?", "If we can find evidence of a Himalayan plant on a suspect in Mumbai, can it lead to the site of crime?" "Can DNA be extracted from perspiration?", etc.

National Science Week programme at Gadhinglas, Dist. Kolhapur

'Meet the Scientists' programme was held in collaboration with Nehru Centre and Nehru Science Centre. 200 students from 50 schools of Mumbai participated in the two events. Dr S. Apte, Head, Molecular Biology Division, BARC, talked about crop improvement and an eco-friendly environment. Dr M. Seshadri, Head, Low Level Radiation Studies Section, BARC, spoke on genetic studies in human populations exposed to low-level background radiation. Ms A. Dabeer, Accelerator & Pulse Power Division, BARC, Dr (Ms) Susan Eapen, Nuclear Agriculture & Biotechnology Division, BARC, and Dr A.Tyagi, Applied Chemistry Division, BARC, unfolded subjects such as accelerators, biotechnology and thermophysics of solids. More than 1000 students took part in the science week activities. Mr R. K. Sharma, Dr (Ms) Uma N. Rao and Mr. Satish Solankurkar from Media Relations and Public Awareness Section coordinated the programme.

Science films on "Genetic Fingerprinting", "Test Tube Bodies" and "Dawn of the Clone Age" (courtesy - British Council), were screened in CC auditorium, BARC.

On the eve of National Science Day, presentations were organised at Doodh Sakhar Mahavidyalaya in Bidri and Sadhana Vidyalaya, Gadhinglas, Dist. Kolhapur. Dr Dingarkar, Radiation Safety Systems Division, BARC, spoke in Marathi on “Atom for Peace”. Mr R. K. Sharma, Head, MR&PAS, spoke in Hindi on “Radioisotopes & Radiation in Healthcare, Industry, Agriculture and Research”.

TRAINING PROGRAMME ON FORENSIC APPLICATIONS OF NEUTRON ACTIVATION ANALYSIS

Neutron Activation Analysis (NAA) Unit of Central Forensic Science Laboratory (CFSL), Hyderabad (BPR&D), and Analytical Chemistry Division, BARC, conducted another week-long Training Programme on "Forensic Application of NAA" at BARC during January 13-17, 2003. This type of meet was 8th of its kind with the objective for awareness percolation about application and appreciation of nuclear analytical techniques in crime investigations. Although the course was meant mainly for the benefit of in-service Forensic Scientists, 5 scientists from ACD, BARC, were also participants. In addition, 2 Research Fellows of the NAA Unit of CFSL, Hyderabad (at ACD, BARC) also attended the technical lectures and practicals. Dr M. Sudersanan, Head, Analytical Chemistry Division, BARC, formally inaugurated the training programme by stating the utility of the course and pointing out the importance of spin-off nuclear technology for various peaceful applications. Dr (Ms) R. Krishnamurthy, Director, Forensic Science Laboratory, Mumbai, Government of Maharashtra, was the guest of honour in the inaugural function.

The course consisted of 21 lectures in total, hands-on practicals as well as demonstration experiments covering various aspects of NAA and other complementary analytical techniques in the field of forensic ballistics, toxicology, source correspondence to decide commonness of origin or otherwise, narcotics, white collar crimes, suspected electrocution, documents, etc. The faculty for the course was drawn from the NAA Unit, ACD, RCD, RC & CDD, NM & SCD of BARC and FSL, Mumbai, Government of Maharashtra. Much stress and emphasis were given on the technique of collecting clue materials from the scene of crime, sample preparation and interpretation of data with illustrative examples to demonstrate application of NAA to real life case samples as helpful evidence in the pursuit of truth. In this context, salient points as given in the laid down guidelines and necessity of preserving integrity of valuable exhibit specimens while referring cases for NAA were highlighted.

Valedictory function of the Training Programme on "Forensic Application of NAA". Seated from left to right are : Mr C.A. Bhadkambekar of NAA Unit (Co-ordinator), Dr N. Chattopadhyay, Deputy Director, NAA Unit of CFSL, Hyderabad at ACD (Course Director), Dr M. Sudersanan, Head, Analytical Chemistry Division, BARC, Dr J.P. Mittal, Director, Chemistry & Isotope Group, BARC, Dr (Ms) R. Krishnamurthy, Director, Forensic Science Laboratory, Mumbai, Government of Maharashtra, Dr A.K. Basu, Assistant Director, NAA Unit of CFSL, Hydrabad at ACD, Dr A.B.R. Tripathi of NAA Unit (Co-ordinator)

Exercise-cum-group discussions (with suggestions) of interactive nature was conducted to evaluate the understanding of each participant. The need for quantitative analytical measurements for definitive inferences in forensic sciences through validation of analytical methodology were reiterated during deliberations which were mutual in nature. Visit to Nuclear Reactor "APSARA", which is regularly utilised by the NAA Unit at ACD, BARC, for examination of forensic case exhibit samples and allied R&D work, was arranged for the participants in the afternoon of January 13, 2003.

On the final day, January 17, 2003, in the valedictory function, Dr J.P. Mittal, Director, Chemistry & Isotope Group, BARC, presented the certificates to the participants. Dr Mittal, in his brief address, pointed out the relevance of Atomic Energy programme for the benefit of the public. He also opined that such type of courses should be encouraged and supported so that nature of this specialised unique national facility can be made known to all concerned for fruitful utilisation.

Dr C.N. Bhattacharyya, Directotor, CFSL, Hyderabad, BPR&D, MHA, Government of India, rendered his full administrative and financial support which enabled successful organisation of the programme.

NATIONAL SAFETY DAY CELEBRATED AT BARC

The National Safety Day was celebrated on March 4, 2003 at BARC with a day-long programme. An exhibition was arranged at the Central Complex Auditorium, BARC. Display of safety posters on different themes as well as safety-related information charts, conducting safety slogan and safety poster competitions, and screening of safety films were the highlights of the programme.

Mr B. Bhattacharjee, Director, BARC, inaugurating the Safety Exhibition organised on National Safety Day at the Central Complex Auditorium. Dr V. Venkat Raj, Director, HS & E Group, BARC, and Dr D.K. Ghosh, Head, IHS Section, RSSD, BARC, look on.

Padmashri Mr B. Bhattacharjee, Director, BARC, inaugurated the safety exhibition. He appreciated the exhibits displayed in the exhibition and the efforts taken towards enhancing and reinforcing safety awareness among the employees.

The annual programme is a part of the educational and motivational activities under the Accident Prevention Programme and is being regularly organised by the Industrial Hygiene and Safety Section, Radiation Safety Systems Division, BARC. A number of employees of the Centre took active part in the celebration.

Fuel Reprocessing Division at BARC, as well as PREFRE and AFFF at Tarapur, conducted similar programmes on the occasion.

FORTHCOMING NATIONAL SYMPOSIUM ON VACUUM SCIENCE AND TECHNOLOGY

Indian Vacuum Society has been organising a symposium every alternate year on various aspects of Vacuum Science & Technology. There has been considerable participation from R&D establishments, universities and Indian industry in this event. This year, the National Symposium on "Vacuum Science & Technology and Vacuum Metallurgy (IVSNS-2003)" is being held at BARC, Mumbai, during October 15-17, 2003. The main areas covered under the symposium will be the production of low, medium, high and ultra high vacuum, measurement techniques, leak detection, vacuum materials and processing inclusive of application of vacuum in industry.

Vacuum melting and refining of metals/alloys have been one of the oldest and strongest applications of this technology. Vacuum evaporation and thin film coating are the most vital processes for electronic and automobile industry. Several new avenues in extraction and processing of advanced materials have been opened by this technology. This is why vacuum metallurgy has been chosen as the focal theme for this year's symposium. The symposium will address various aspects of the science and technology of vacuum and its applications in metallurgy. It will provide an opportunity for interaction to active researchers and scientists to review the current scenario, report recent results, share the expertise and chalk out future research directions in this area.

In addition, the symposium will provide a forum for exchange of information among vacuum scientists, technologists and industrialists on recent advances made in this field.

For further details, contact : Dr K.C. Mittal, Convener, IVSNS 2003, Accelerator and Pulse Power Division, BARC, Mumbai 400 085.
Ph : (O) 022-25595037; (R) 022-25519098
Fax : 022-25505151;
E-mail : kcm@magnum.barc.ernet.in

FORTHCOMING SUMMER SCHOOL

Sensors find wide applications in many fields of technological significance. They form the heart of all detection instruments. Among the various sensors used, e.g., for the detection of toxic gases for environmental monitoring, electro-chemical sensor is the sensor of choice. It is highly specific and sensitive and has a wide linear range. Though a lot of work is presently being done in the country on the electrochemical apects of gas sensing, there is no indigenous manufacture and India imports 20 to 25 different gas sensors.

A Summer School on "Electrochemical Sensors-Theory, Characterization and Fabrication" is being organised by BARC, Department of Science and Technology (DST) and United Phosphorus Limited (UPL), Vapi, during July 14-25, 2003 at Mumbai, to explain the basic principles, properties of materials, methods of fabrication, characterization, etc., of electrochemical sensors. In addition, it will open avenues of promoting collaborative activities between the researchers and the manufacturers of sensors.

For details, contact : Dr R. Sundaresan, Analytical Chemistry Division, BARC, Mumbai 400 085; Email : sundar@apsara.barc.ernet.in

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

- डॉ. नरेंद्र मोहन गुप्ता, अध्यक्ष, अनुप्रयुक्त रसायनिकी प्रभाग को केटलिस्ट सोसाइटी ऑफ इन्डिया द्वारा एस. के. भट्टाचार्या ऐन्डोमेंट विशिष्ट वैज्ञानिक पुरस्कार से सम्मानित किया गया । यह सत्कार एवं पुरस्कार समारोह उत्प्रेरक पर 16वीं राष्ट्रीय संगोष्ठी एवं प्रथम भारत-जर्मन संगोष्ठी के दौरान आयोजित किया गया। यह आयोजन 6 से 8 फरवरी, 2003 के दौरान भारतीय रसायन प्रोद्योगिकी संस्थान, हैदराबाद में किया गया। यह गौरवशाली जीवन-काल उपलब्धि पुरस्कार उत्प्रेरक संस्था द्वारा 12 वर्ष पूर्व आरंभ किया गया तथा डॉ. गुप्ता इसके पांचवें विजेता हैं। डॉ. गुप्ता को यह पुरस्कार विजातीय उत्प्रेरक एवं पृष्ठीय विज्ञान के क्षेत्रों में उनके द्वारा किये गये अनुप्रयुक्त एवं मूलभूत अनुसंधान में प्रमुख योगदान के लिये दिया गया। डॉ. गुप्ता के अनुसंधान विषय निम्न हैं: जियोलाइटिक पदार्थों के कनफाइन्ड स्पेसस् में आण्विक गति विज्ञान पर अध्ययन, टेलरमेड मिश्रित आक्साइड उत्प्रेरकों का विकास एवं अभिलक्षणन, अंतरधात्विकी के उत्प्रेरक गुणधर्म, उत्प्रेरकों में सक्रियता का प्रभाव, उत्प्रेरक विषायण, आदि। डॉ. गुप्ता एवं उनके अनुसंधान सहयोगियों द्वारा परमाणु ऊर्जा विभाग के लिये विकसित किये गये उत्प्रेरकों में गम्भीर दुर्घटना की परिस्थितियों में नाभिकीय ऊर्जा रियक्टरों के कन्टेनमेंट में हाइड्रोजन के न्यूनीकरण हेतु उत्प्रेरक, सील्ड ऑफ CO_2 लेसर से CO_2 की पुनः प्राप्ति के उत्प्रेरक तथा

हाइड्रोजन एवं जल के बीच में आइसोटोपीय आयन विनिमय हेतु उत्प्रेरक शामिल हैं।

डॉ. गुप्ता महाराष्ट्र वैज्ञानिक अकादमी के सदस्य हैं। वे उत्प्रेरकों के क्षेत्र में प्रमुख योगदान के लिये "हरि ओम आश्रम प्रेरित श्री एस.एस. भटनागर अनुसंधान पुरस्कार - 1998 के विजेता भी हैं तथा यूडीसीटी (UDCT), मुम्बई -1998 के डीएमसीसी (DMCC) अभ्यागत सदस्य हैं।

Dr Narendra Mohan Gupta, Head, Applied Chemistry Division, BARC, was honoured by the Catalysis Society of India with the S.K. Bhattacharya Endowment Eminent Scientist Award. This felicitation and award function formed the part of the 16th National Symposium and the First Indo-German Symposium on Catalysis, held at the Indian Institute of Chemical Technology, Hyderabad, during February 6-8, 2003. Dr Gupta is the fifth recipient of this prestigious life-time achievement award instituted by the Catalysis Society about 12 years ago. This honour comes to Dr Gupta for his contributions to the applied as well as the fundamental research in the areas of heterogeneous catalysis and surface science.

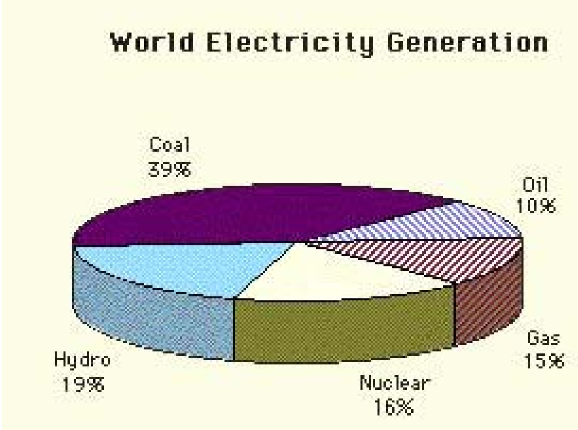
Some of the topics pursued by Dr Gupta relate to: Studies on the dynamics of molecular motions in the confined spaces of zeolitic materials, structure-activity relationship in catalytic processes, development and characterization of tailor-made mixed oxide catalysts, anchoring and encapsulation of nano-size metal oxide crystallites within the channel system of mesoporous materials, catalytic properties of intermetallics, radiation effects in catalysis, catalytic poisoning, and the surface processes occurring during catalytic reactions.

Some of the catalysts developed by Dr Gupta and his research group for the requirements of Department of Atomic Energy include : Catalysts for the mitigation of H_2 in containments of nuclear power reactors during the severe accident conditions, catalysts for recovery of CO_2 in sealed-off CO_2 laser, and the hydrophobic catalysts for isotopic exchange between hydrogen and water.

Dr Gupta is a Fellow of the Maharashtra Academy of Sciences. He is also a recipient of Hari Om Ashram Prerit Shri S.S. Bhatnagar Research Award - 1998 for contributions in Catalysis and a DMCC Visiting Fellowship at UDCT, Mumbai - 1998.

- डॉ. जी.पी. कोठियाल अध्यक्ष, ग्लास एन्ड सिरामिक्स टेक्नोलाजी अनुभाग, TPPED, को फरवरी 11-13, 2003 के दौरान भाभा परमाणु अनुसंधान केंद्र में आयोजित मेटीरियल रिसर्च सोसाइटी आफ इण्डिया (MRSI) की 14वीं वार्षिक सभा में वर्ष 2003 के लिए MRSI मेडल लेक्चर अवार्ड से सम्मानित किया गया। यह पुरस्कार उन्हें पदार्थ विज्ञान तथा अभियांत्रिकी के क्षेत्र में उत्कृष्ट योगदान के लिए दिया गया। यह पुरस्कार एक पदक, प्रशस्तिपत्र, तथा 2000/-रुपये का है जो प्रति वर्ष ऑल इन्डिया आधार पर MRSI के द्वारा दिया जाता है। हाल में ही (2002) भारतीय स्वास्थ्य संस्था, पर्यावरण, शिक्षण तथा अनुसंधान (ISHEER), जोधपुर शाखा ने भी उन्हें सम्मानित किया था। डॉ. कोठियाल पिछले 20 वर्षों से भाभा परमाणु अनुसंधान केंद्र के हिन्दी विज्ञान साहित्य परिषद की त्रैमासिक पत्रिका "वैज्ञानिक" के सम्पादकीय मंडल में हैं तथा अब प्रमुख सम्पादक के पद पर हैं। वर्ष 1999 में हिन्दी में विज्ञान संचार-व्यवस्था के क्षेत्र में मुख्य योगदान के लिए उन्हें विज्ञान परिषद प्रयाग द्वारा "विज्ञान वाचस्पति" का पद दिया गया। इन्होंने भौतिक विज्ञान के क्षेत्र में राष्ट्रीय एवं अंतर्राष्ट्रीय पत्रिकाओं में 100 से अधिक लेख प्रकाशित किए हैं। डॉ. कोठियाल मुम्बई विश्वविद्यालय से एक मान्यता प्राप्त भौतिकी पीएचडी निर्देशक भी हैं।

Dr G.P. Kothiyal, Head, Glass and Ceramics Technology Section of TPPED, BARC, was



honoured by MRSI Medal Lecture award for the year 2003 in 14th Annual General Meeting of Materials Research Society of India (MRSI) held at BARC during February 11-13, 2003. The award has been conferred upon him for his outstanding contributions in the field of materials science and engineering. The award carries a medal, certificate and a cash prize of Rs. 2000/-. The award is given by MRSI every year on an all India basis. He has also been honoured recently (2002) for his remarkable editing ability by Indian Society of Health, Environment, Education and Research (ISHEER), Jodhpur Chapter. Dr Kothiyal has been associated with the editorial board of *Vaigyanik*, a quarterly Journal of Hindi Vigyan Sahitya Parishad, BARC, for the last twenty years and is currently its Chief Editor. Earlier, he was honoured by a title of 'Vigyan Vachaspati' by Vigyan Parishad Prayag in 1999, for his contribution in the field of science communication/popularisation in Hindi. He has published more than 100 papers in International/ national journals/proceedings in the area of materials science. He is a recognised Ph.D. guide in Physics from University of Mumbai.

NUCLEAR POWER IN THE WORLD TODAY

Today, the world produces as much electricity from nuclear energy as it did from all sources combined in 1960. Civil nuclear power can now boast over 10,800 reactor years of experience and supplies 16% of global needs. Many countries also built research reactors to provide a source of neutron beams for scientific research and the production of medical and industrial isotopes.

Today, 56 countries operate civil research reactors, and 31 have 439 commercial nuclear power reactors with a total installed capacity of 3,60,000 MWe (see Table). This is over three times the total generating capacity of France or Germany from all sources. More than 30 further power reactors are under construction, equivalent to 7% of existing capacity, while a similar number are firmly planned, equivalent to 7% of present capacity.

Seventeen countries depend on nuclear power for at least a quarter of their electricity. France and Lithuania get around three quarters of their power from nuclear energy.

Although fewer nuclear power plants are being built now than during the 1970s and 1980s, those now operating are producing more electricity. In 2001, production was 2544 billion kWh, an increase of 4% (97 billion kWh) over the previous year. The increase over the last seven years (414 billion kWh) is equal to the output from 60 large new nuclear plants. Yet, between 1995 and 2001, there was a net increase of only two reactors (3.5% in capacity). The rest of the improvement is due to better performance from existing units.

Three quarters of the world's nuclear reactors (apart from Russia and Ukraine) have load factors of more than 75%, compared with only 39% in 1990. For the past 15 years, Finnish plants have topped the performance tables, with average load factors now around 92%. Reactors in Belgium, Czech Republic, Germany, Japan, South Korea, Spain, Switzerland, Taiwan and the USA achieve at least 80%.

WORLD NUCLEAR POWER STATUS

Country	Reactors operable June 2003		Reactors under construction June 2003		Nuclear electricity Generation 2002	
	No of Units	Capacity MW(e)	No of Units	Capacity MW(e)	billion kWh	Nuclear Share (%)
Argentina	2	935			5.4	7.2
Armenia	1	376			2.1	41
Belgium	7	5728			44.7	57
Brazil	2	1855			13.8	4.0
Bulgaria	6	3538			20.2	47
Canada	14	9998	6	3598	71.0	12
China	8	6002	3	2535	23.5	1.4
Czech Republic	6	3472			18.7	25
Finland	4	2656			21.4	30
France	59	63293			415.5	78
Germany	19	21141			162.3	30
Hungary	4	1755			12.8	36
India	14	2503	8	3728	17.8	3.7
Iran			1	950		
Japan	53	44153	3	3696	313.8	39
Korea, North			1	950		
Korea, Republic of	18	14870	2	1900	113.1	39
Lithuania	2	2370			12.9	80
Mexico	2	1310			9.4	4.1
Netherlands	1	452			3.7	4.0
Pakistan	2	425			1.8	2.5
Romania	1	655	1	655	5.1	11
Russia	30	20793	6	5575	130	15
Slovak Republic	6	2472			18	65
Slovenia	1	679			5.1	41
South Africa	2	1842			12	5.9
Spain	9	7405			60.3	26
Sweden	11	9460			65.6	46
Switzerland	5	3170			25.7	40
Taiwan	6	4884	2	2600	33.9	21
UK	27	12082			81.1	22
Ukraine	13	11195	2	1900	73.4	46
USA	104	98523			780.1	20
Total	439	359,992	35	28,087	2574	16%

Sources : ANSTO and IAEA

Edited and published by Dr Vijai Kumar, Head, Library & Information Services Division, Bhabha Atomic Research Centre, Trombay, Mumbai 400 085.

Editorial Management : T.C. Balan; Computer graphics & layout : P.A.S. Warrier

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