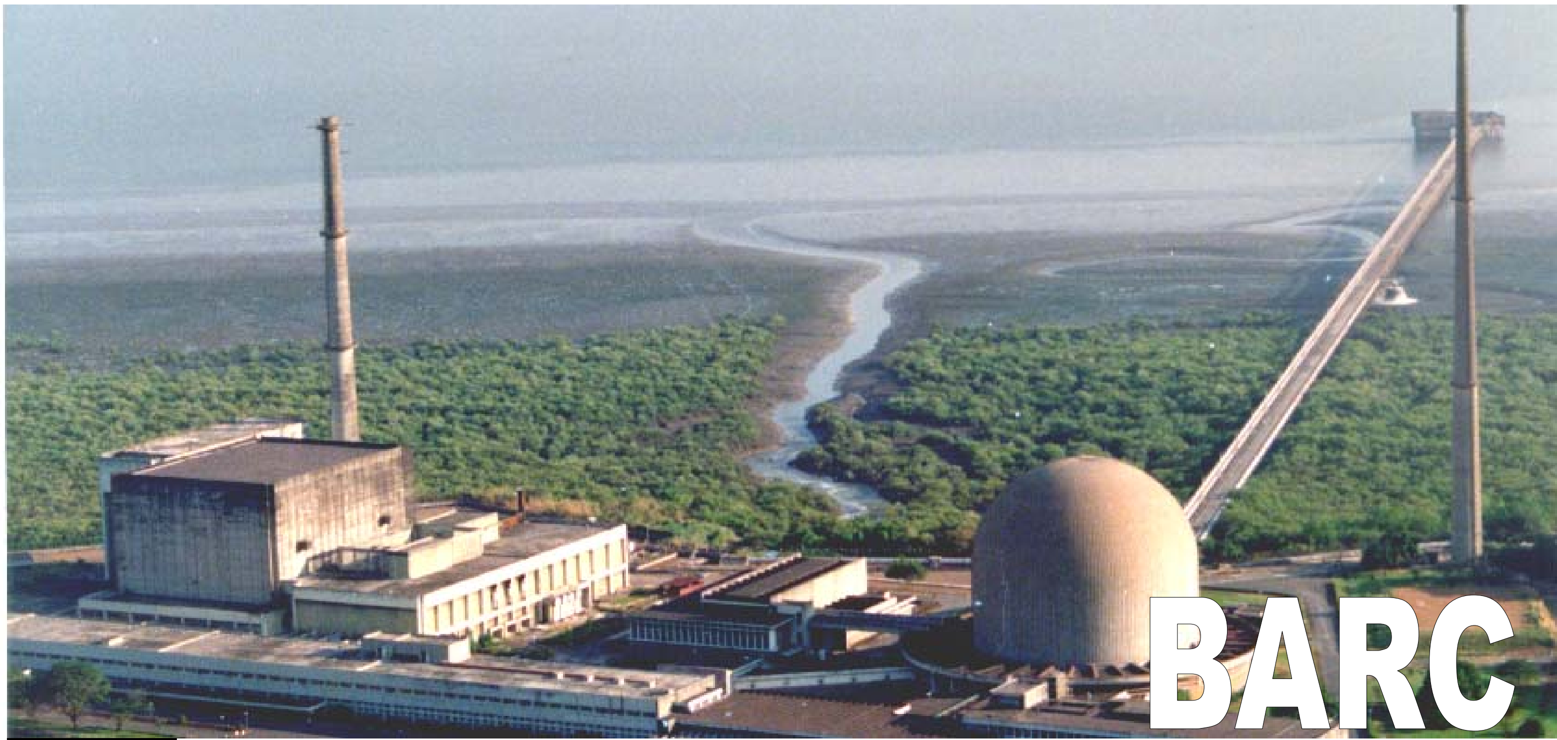

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Department of Atomic Energy
Golden Jubilee Year
August 2003 - August 2004

From the Director ...

Dear Colleagues,

With a deep sense of pride and privilege, let me share my feelings and thoughts with you all, the Scientific fraternity of our nation's prestigious research establishment –BARC - for the first time after assuming the charge as Director. I am overwhelmed with the multitude of messages of good wishes received expressing your affection, faith and confidence. At the outset, I would like to convey my sincere gratitude to all of you. This is a very special moment in my professional carreer that has taken shape and got nurtured all through the last three and a half decades here in BARC amidst you. I have grown with you and lived with you all these years here and all of you were in one way or other involved in my professional accomplishments. Let us further join our hands in collective efforts to keep the BARC flag fly high. At this juncture, I feel it is appropriate to share with you all – my colleagues – my personal feelings and thought-streams about our programmes, in general, through the BARC Newsletter *columns.*

Contents

BARC is our nation's pride standing tall as a leading centre for scientific and technical excellence. As a multifaceted research and development institute, the contribution from our centre to the mainstream national development programme has been phenomenal. Thanks to the astute planning and efforts of visionaries, the greatest among them, Dr. Homi J. Bhabha, a post independent resurgent India has given adequate stress to the Indian Atomic Energy Programme leading to the birth of BARC. Over these years, BARC has grown to attain a stature of a consortium of cognoscenti from all fields of science and technology. While saluting the pioneers of Indian Atomic Energy programme, we have to carry on the mission with more and more object-oriented research activities bounded by a well defined time domain, focusing on the national priority issues and intensely pursuing frontline research activities, thereby, making significant contribution to the progress of our nation. With the translation of our research activities through development, demonstration and finally deployment for the tangible benefit of the nation and its people, we are taking science and technology to the masses. Exploration of the peaceful uses of Atomic Energy and extending its benefits to the needy being one of the major institutional mandate, BARC has, all through the past, lived up to the expectations. Innovative technological and scientific programmes and products were indigenously made available to the nation in many areas as a spin off from its main stream research activities. BARC has etched an enviable track record in the international forum by giving the much needed fillip to the ambitious national atomic energy programme by making it self reliant. We also have made significant impression in the front line areas spanning the whole gamut of science and technology specializations through quality research and research publications, thereby, attaining the status of global cynosure. Needless to stress, the massive quantum of efforts put in by the human elements behind the success story of our institution through world class research activities being pursued by all of us is remembered with due gratitude here.

Being a multidisciplinary research speciality institution, practice of effective and pragmatic communication among the scientists and engineers of the institute is absolutely essential for the successful implementation of any programme. All of you will agree with the fact that modern science is highly interwoven and sometimes some degree of overlapping fields of interests and intra-collaboration within the institute will yield a lot of innovative and challenging ideas that could be pursued with collective efforts. Adaptability to the new and changing scenario is the need of the hour and I am sure, all of us are capable of rising to the occasion to meet the future challenges in a manner consistent with the tradition of BARC.

Friends, once again, let me thank you all and wish you and your near and dear ones very healthy and prosperous years ahead.

Dr S. Banerjee
Director

THE VIBRATION SIGNAL ANALYSER USING FOURIER TRANSFORMATION AND ANN (ViSFoTA) PACKAGE

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and

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Introduction

A software package, named ViSFoTA, has been developed for analysing vibration signal using Fourier Transformation and Artificial Neural Network (ANN). The package has been developed primarily for applications in seismology. It can also be used to perform analysis of time series generated by any vibration signals in different frequency bands. The package is therefore equally useful in bio-medical sciences, non-destructive testing of samples by ultrasonic and reactor control system diagnosis. The package consists of two major parts – the pre-processor for the vibration signal and the ANN module.

A vibration signal carries the signature of the event that caused it and the path through which it travels before getting detected. For example, seismic waves travelling from the source of a seismic event such as an earthquake or an underground nuclear explosion to different seismic stations installed throughout the world contain the signatures of the path and the source. From the seismograms recorded at these seismic stations, seismologists infer about the seismic event, like its location, type of source, and its magnitude. The seismic signal is generally embedded in noise. The problem of the analysis of seismogram is complicated because of overlap of the noise and the seismic signal in frequency spectra. ANNs have been used in solving complex problems like speech recognition, pattern matching, classification, optimisation, control and noise filtering[1-3]. Because of the difficulties mentioned in following section, a raw seismogram cannot be fed directly to the ANN. Pre-processing of a raw seismogram is required before feeding it to an ANN. Post-processing of the output of the ANN is also necessary for correct interpretation of results. The pre- and post-processing of seismic data consists of Binary to ASCII conversion, Fast Fourier Transformation (FFT), Inverse FFT (IFFT), Low-Pass, High-Pass, Band-Pass, and Band-Stop digital filters, DC Filter, calculation of autocorrelation, generation of training and test patterns for the ANN and majority voting in case of multiple results on the analysis of the same event.

ANN's have been used in analysing seismograms[4-5]. In these works, the emphasis was on the analysis of seismograms using ANN and other tools available off-the-shelf. The focus of the present work is on providing an integrated package containing all the tools necessary for the analysis of a vibration signal in general and seismograms in particular. In addition, it offers synthesis of vibration signals. In case of underground explosion signals, often, only a limited number of seismograms are available for analysis. Therefore, a large number of seismograms are required to be synthesised for training and testing the performance of the ANN.

ANN Module

A Neural Network is a powerful calculation tool. It consists of many ordinary processors, called neurons, arranged in one or more layers as shown in Fig. 1. Each connection is assigned a number called weight. The ANN does not follow

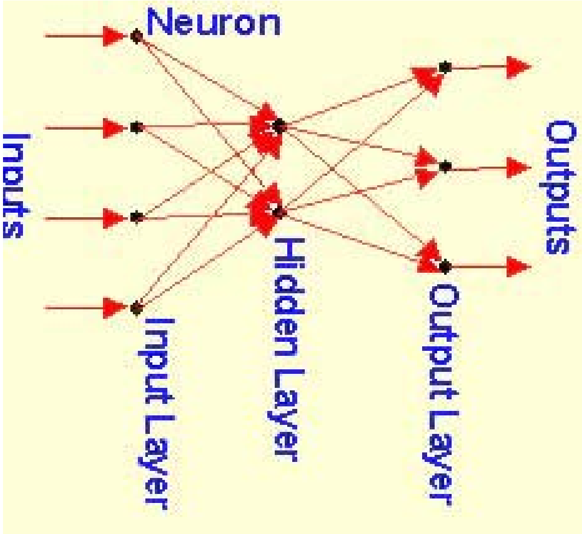

Fig. 1 Schematic diagram of a typical ANN

the traditional algorithmic approach for solving a problem. It has to be trained first for solving a specific problem. During the training, the ANN is supplied with the inputs and the corresponding desired outputs from the problem domain several times. From the given inputs and the corresponding desired outputs, the ANN extracts the knowledge of the problem domain and adjusts its weights accordingly. After the training, if an input is given to the ANN, it can produce an estimate of the output from the knowledge stored in its weights.

Most of the applications of ANN are based on simulated model of Neural Network in software. The ANN module of ViSFoTA was developed earlier in Reactor Control Division as an independent ANN package. It is referred to here as the ANN Package. It is based on resilient back-propagation algorithm[6-7]. This algorithm was chosen for its ease of implementation and good speed of convergence. It can simulate any number of layers and any number of neurons in each layer. The numbers of layers and neurons in each layer are limited only by the memory available in the computer. The package is simple and easy to use. This package runs on all versions of Microsoft Windows operating system.

The number of neurons in the input and the output layer is determined by the problem for which the ANN is being used. The number of hidden layers and the number of neurons in each of these hidden layers is adjusted by trial and error. An ANN with an input layer, an output layer and one hidden layer is found to be sufficient for majority of applications.

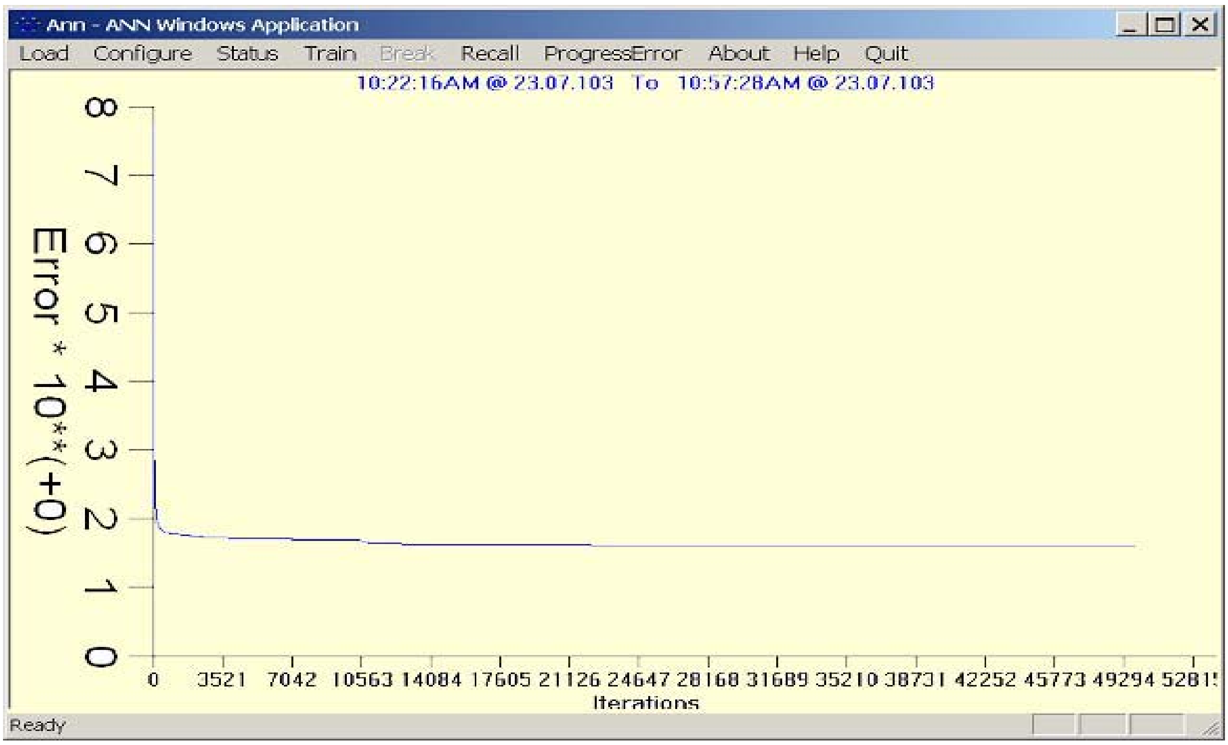

Fig. 2 GUI of the ANN package

When the ANN package is started, it displays a Graphical User Interface (GUI), similar to the one shown in Fig. 2, except for the curve shown in client area of the window. As soon as the package is started, a default ANN with 3 layer having 3, 5 and 3 neurons in its input, middle and the output layer respectively is setup in the memory. Such an ANN is designated as 3-5-3 ANN. This ANN configuration may or may not match with the requirement of the user. If it does, the user may go ahead and supply other parameters. In case the default ANN configuration does not match with the desired configuration, the user can either load a previously trained ANN or can change the existing ANN configuration loaded in its memory.

The user stores the training pattern data in a file called training pattern data file. A training pattern consists of all the inputs followed by all the desired outputs from the ANN. For example, to detect the seismic signal in a given seismogram, one uses autocorrelations for training. A typical training pattern may contain 22 points from autocorrelation function as inputs and a 1 or 0 (i.e. presence or absence of the seismic signal) as output. Thus, a typical training pattern consists of about 23 numbers. Typically, there are 3000 to 4000 training patterns in a training pattern data file. The size of such a training pattern data file is about 1.5MB.

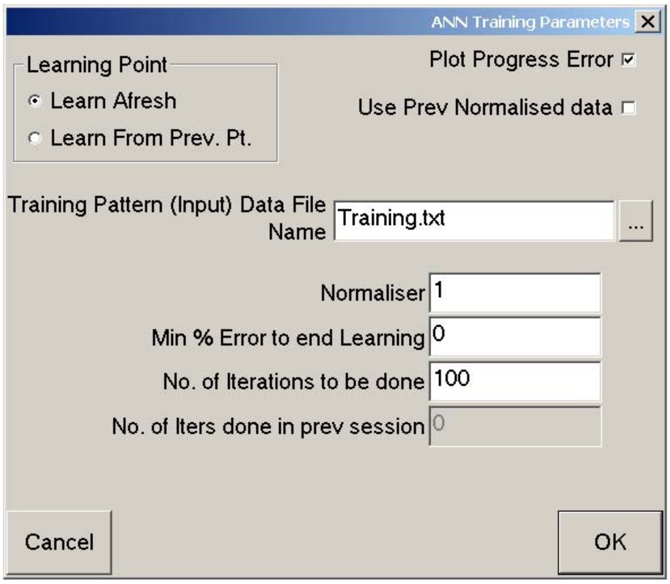

Fig. 3 The Training Parameter Dialog Box

Before starting the training, the user specifies the training parameters through a dialog box shown in Fig. 3. From these parameters the ANN does 10 iterations and finds out the expected time required for doing the specified number of iterations. The estimated time is displayed on the computer screen. At this point, the user may opt to go ahead with the training or abandon the operation. If the user opts to train the ANN, the training starts and the number of iterations vs. the training error curve is displayed on-line as shown in Fig. 2. The ANN training is supposed to be completed when the training error does not reduce further by doing more iterations. It depends upon the specific application. In a typical case, one stops training when the RMS error is less than 0.1%.

While the training is in the progress, the user can terminate the training operation and can resume it any time later. When the training operation is broken, the package saves partially learnt weights in a file called ANN parameters' file. When the training is resumed later, the weights are taken from this file and the training starts from the point at which it was broken.

Depending upon the topology of the ANN selected, number of iterations specified, the complexity of the problem and the size of the training pattern data file and the computer used, the ANN package may take from a few seconds to a few hours for training. In a typical case of a seismic pattern data file of about 1.5 MB, an ANN configuration of 22-5-1, for 50000 iterations, it takes about 45 minutes to train on a 1 GHz Pentium-III PC running under Windows 2000.

To test the performance of the ANN, the user prepares a test pattern data file, whose format is same as that of the training pattern data file. Using the inputs in the test pattern data file, the ANN calculates outputs, compares it with the desired outputs and calculates the percentage deviation from the desired deviation from the desired outputs. The results are written in a user specified file called result file.

All files handled by the package are in ASCII format so the user can view and/or modify them using any text editor. The training and test pattern data files can have user's comments also. These comments are ignored by the package but are very useful to the user.

Since this ANN module was developed as an independent package, it consists of its own simple pre- and post-processor. The pre-processor of the package consists of determination of normaliser and selection of training and test data from a given master data file. When the ANN is tested, it writes results in a user specified file, called result file. The result file consists of specified inputs, corresponding desired outputs, calculated outputs and percentage error made by the ANN in calculating each output. The post-processor produces error versus frequency histogram table using the error values in result file. This data can then be plotted by any curve drawing package such as Microsoft Excel. This type of pre- and post-processing is general and is applicable to most of the problems using ANN. It is, therefore, part of the ANN package. This pre- and post-processing is different from the one described in the next section. The pre- and post-processor described in the next section is specific to vibration signal analysis and is, therefore, part of the ViSFoTA package.

Pre- and Post-Processor for Vibration Signal

Autocorrelation

Suppose an ANN is trained with an actual (raw) seismic data for detecting the location of seismic signal in a seismogram. This ANN may fail to detect the location of seismic signal in the seismogram, if a slightly time-shifted version of the same seismogram is given to the ANN during its testing. That means the ANN is sensitive to the position of the seismic signal in the window used for analysis. To overcome this problem, autocorrelation function of the seismogram is used for training the ANN. The autocorrelation is calculated by taking 16 to 24 points from a portion of the given seismogram called the "autocorrelation window". The autocorrelation window is then slid by half its width and the autocorrelation is calculated again. This process is repeated for the whole seismogram. Autocorrelation functions for a noise and a signal region of a seismogram are shown in Fig. 4a & 4b respectively. It is observed from these figures that the characteristics of the autocorrelation for the noise and the signal regions differ significantly. ANN makes use of these distinguishing features of the autocorrelation to detect the seismic signal in a seismogram. Normalized values of autocorrelations are used for training and testing the ANN.

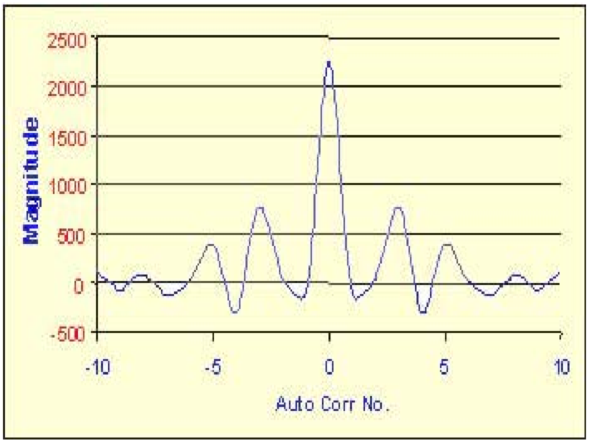

Fig. 4a Autocorrelation of the Noise region of a Waveform

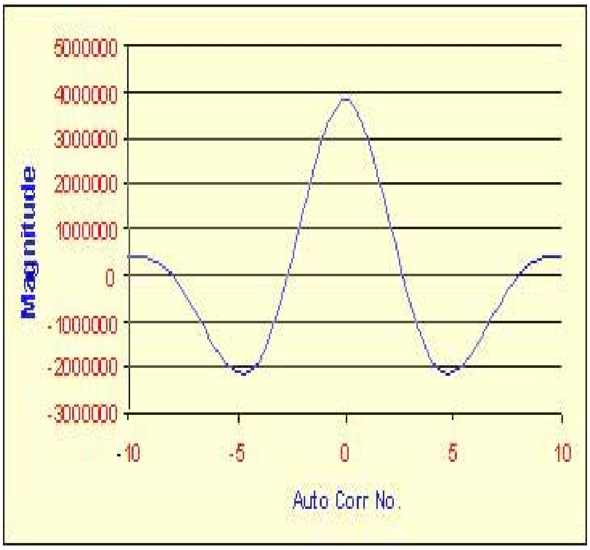

Fig. 4b Autocorrelation of the Signal region of a Waveform

Synthesis of Seismograms

A large number of seismograms are required for training and for testing the performance of an ANN. In case of most of the nuclear explosions, only a few seismograms are available for most of the nuclear test sites. Therefore, a large number of seismograms will have to be synthesised for training and testing the performance of the ANN. The synthesis of a seismogram is done as follows. From a given seismogram, one picks a portion from the noise region of the given seismogram. The FFT of this noise region is obtained which contains the amplitude and the phase part. The phase part, of the FFT consists of two parts, p1 and p2, which are mirror images of each other. The phase part, p1, is replaced by a set of random numbers. A mirror image of these randomly generated numbers are calculated, which replaces the phase part, p2. Keeping the amplitude part unchanged and taking the newly synthesised values of the phase angles, IFFT of the frequency domain noise is calculated. This gives rise to a time domain waveform, which is the synthesised noise. This noise has the same spectrum as that of the noise of the given seismogram. By adding the signal with a scaling factor, into the synthesized noise, one gets a synthesised seismogram of higher or lower Signal to Noise Ratio (SNR).

Features of the Package

The block-diagram of the ViSFoTA package is shown in Fig. 5. It consists of following 6 major blocks :–

1. The Raw Data Handling
2. The Noise Filter
3. The Seismogram Synthesis
4. The Pre- Processor for the Vibration Signal
5. The Post-Processor of the ANN Result
6. Display

Normally, the data flows from the "Raw Data Handling" block to the "Pre-Processor for the Vibration Signal" block in the above-mentioned order. The ANN package, described earlier, uses the training or the test pattern data prepared by the "Pre-Processor for the Vibration Signal" block. The results of the ANN package is given by the user to the "Post-Processor of the ANN Result" block for generating final result. All blocks interact with the Display block.

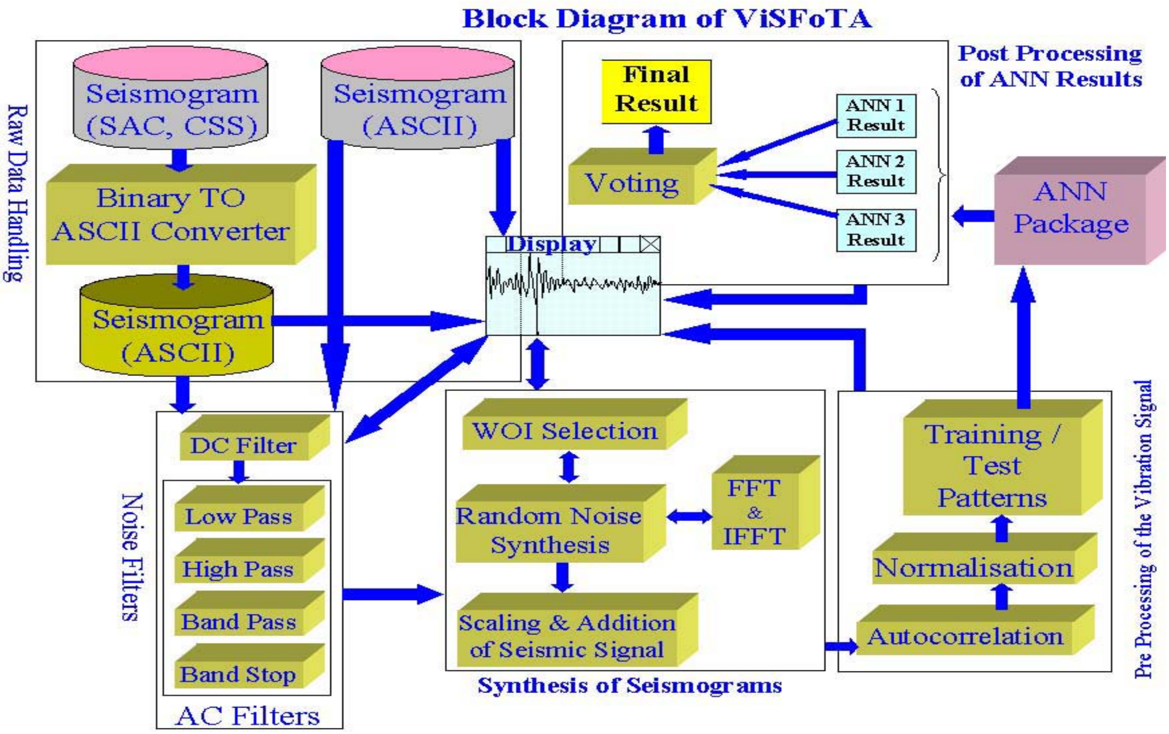

Fig. 5 Block diagram of ViSFoTA

The data available for analysis is generally obtained from the Internet. This data may be in binary or in ASCII format. The “Raw Data Handling” block takes care of both. If the available data is in binary, it is first converted into ASCII. If the available data is already in ASCII, it can be used directly for further processing.

The “Noise Filter” block gets its input from the “Raw Data Handling” block. It consists of DC Filter and Low-Pass, High-Pass, Band-Pass and Band-Stop AC filters. The user can vary the filter parameters displayed on the screen and view the filtered seismogram immediately.

A large number of synthesised seismograms are required for training and testing the performance of the ANN. The “Seismogram Synthesis” block takes the filtered seismogram and synthesizes a large number of seismograms whose spectrum is same as that of the given seismogram. This block consists of Window Of Interest (WOI) Selection, FFT, IFFT and Scaling and Adding the Seismic Signal modules. When the user selects a WOI by mouse, the package selects the number of points to be the nearest integral power of 2, i.e. 32, 64, 128, 256, etc. It does so, because the FFT, IFFT and digital filter modules demand the number of points to be an integral power of 2. However, the user can force the package to accept a number which is not an integral power of 2 by entering the desired number through the computer keyboard. Method of synthesis of seismogram is described in subsequent sections.

Pre-processing of synthesised seismograms is necessary before feeding it to the ANN package for training or testing. The “Pre-Processor for the Vibration Signal” block consists of the Autocorrelation, Normalisation and Training and Test Pattern Generator modules. User intervention is required for feeding training or test pattern data to the ANN package and feeding back the result of the ANN package to the “Post-Processor of the ANN Result” block for getting the final result.

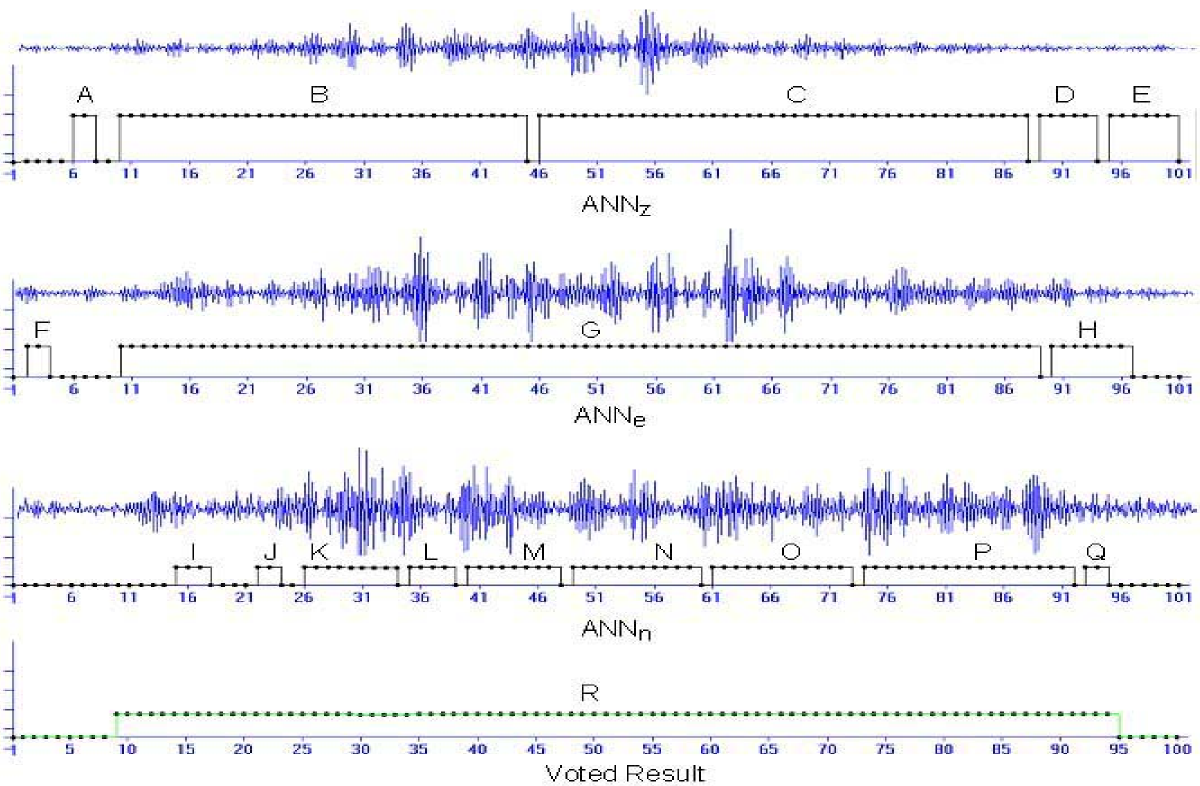

Fig. 6 2 out of 3 majority voting of an ANN result

The Voting Module

When the user tests a trained ANN, it writes its results in a file. The result is a 1 or 0 indicating the presence or absence of seismic signal in a given seismogram. A seismogram contains 3 components - the vertical component (z),the east-west component (e) and the north-south component (n). Noise levels in each of these 3 components are quite different. Three different ANNs may be trained to detect the presence of seismic signal in z, e and n components independently. Because of different noise levels in the 3 components, results of all these 3 ANNs may not match exactly. An ANN may fail to detect a seismic signal or falsely detect a noise peak as seismic signal. However, it is less likely that all the 3 ANNs will have same type of failure simultaneously. A majority voting of detection results of the 3 ANNs is therefore expected to yield more reliable result. The package offers majority voting of 3 ANN results. Fig. 6 illustrates 3 components of a seismogram along with the corresponding ANN result. ANN_z, ANN_e, and ANN_n detect the presence of the seismic signals in the z, e and n components respectively. According to ANN_z, the seismic signal is present in regions A, B, C, D and E. According to ANN_e, the seismic signal is present in regions F, G and H and according to ANN_n, the seismic signal is present in regions I to Q. Each of these ANNs has failed in properly detecting seismic signal at least thrice. Taking a 2 out of 3 voting of these 3 ANN results, one gets region R in the lowest curve marked as "Voted Result". The voted result is more reliable than an individual ANN result.

Synthesis of Seismograms

When the package is started, a screen similar to the one shown in Fig. 7 is displayed on the screen. In the beginning, the client area of the screen contains a flash window which continues to remain on display for about a minute or till the user clicks anywhere on the screen. For analysis and synthesis of seismograms, the user selects a desired seismogram (or a vibration signal) either through an appropriate menu item or through a tool bar button. The package displays following 7 windows in the client area of the main window as shown in Fig. 7 :-

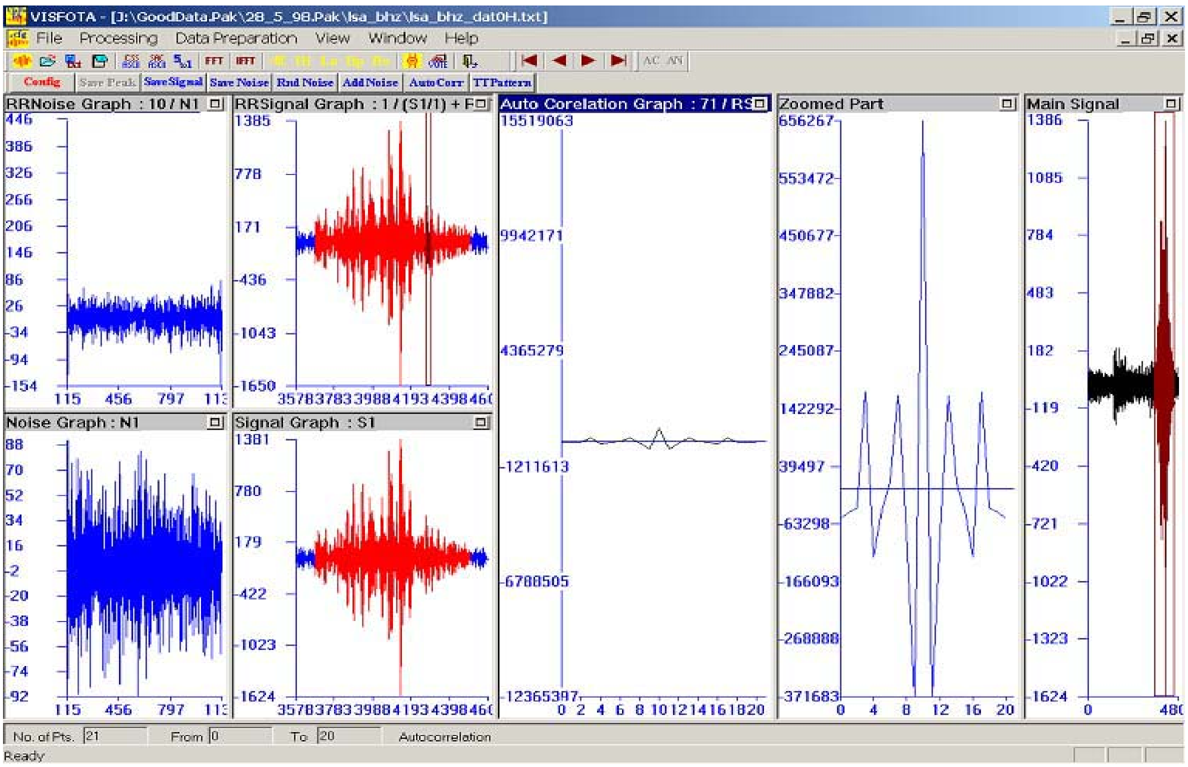

Fig. 7 Various windows of ViSFoTA

1. The “Main Signal” window.
2. The “Zoomed Part” window.
3. The “Auto Correlation Graph” window.
4. The “Signal Graph” window.
5. The “Noise Graph” window.
6. The “RRNoise Graph” window.
7. (RR=Randomly Reconstructed)
8. The “RRSignal Graph” window. (Synthesised Seismogram)

The selected vibration signal is displayed in 2D graphical form in the “Main Signal” window leaving other windows blank. The user can select any part of the main signal by mouse and save it as noise or signal portion (as the case may be) in the “Noise Graph” or “Signal Graph” window. More than one noise or signal portions can be selected and saved in the “Noise Graph” or “Signal Graph” window. Since more than one noise (or signal) is saved in the same noise (or signal) window, the desired noise (or signal) may be displayed by the navigation buttons provided in the tool bar. Any of these 7 windows can be resized or zoomed to occupy most of the available screen space for comfortably viewing minor details of a graph. Selection of items and navigation on the display is most convenient using mouse. Alternatively, most of the functions that user can perform using mouse are also mapped to the keyboard for ease of operation.

So, the user can use either mouse or keyboard or a combination of the two.

To synthesise a seismogram, the user selects a window of interest in the noise region of the “Main Signal” window and saves it in the “Noise Graph” window. The user can select several noise windows of interest and save them all one by one in the “Noise Graph” window. Similarly, the user can select several windows of interest in the seismic signal part of the “Main Signal” window and save them all one by one in the “Signal Graph” window. Now, using *Rnd Noise* button, the user can synthesise several noise windows corresponding to each window of interest saved in the “Noise Graph” window. These synthesised noises are saved in the “RRNoise Graph” window and can be viewed one by one using the navigation buttons of the tool bar of the package. Using the *AddNoise* button of the tool bar, all these synthesized noises can each be added with desired scaling factor in each of the windows of interest of the signal saved in the “Signal Graph” window. This gives rise to several synthesized seismograms. The number of synthesised seismograms equals all possible combinations of the number of noise windows in the “RRNoise Graph” window and number of seismic signal windows saved in the “Signal Graph” window. The synthesised seismograms are saved in the “RRSignal Graph” window and can be viewed one by one using the navigation buttons of the tool bar of the package.

Using the *Autocorr* tool bar button, autocorrelations with desired autocorrelation window size can be calculated for all the synthesised seismograms. The autocorrelations are saved in the internal memory and can be viewed one by one using the navigation buttons of the tool bar of the package. The autocorrelations are displayed in actual as well as in zoomed view in the “Auto Correlation Graph” and the “Zoomed Part” windows respectively. To generate training (or Test) patterns for the ANN, the user uses the *TTPattern* button of the tool bar. Pressing *TTPattern* button causes the package to normalise all the autocorrelations and save these normalised autocorrelations in a file, which is the training pattern data file (or the test pattern data file) for the ANN.

Future Plan

A beginning has been made to provide an integrated environment for analysing vibration signals of various frequency bands. The present version of ViSFoTA, presented here has several limitations. It is planned to add following features in the package.

- Spectral ordinate method of distinguishing signal from noise.
- Prediction error method of distinguishing signal from noise.

- Recursive digital filter.
- Estimation of magnitude of the seismic event.
- Distinction between different kind of seismic events.
- Online detection and estimation of the magnitude of seismic events.

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FABRICATION OF MULTIFILAMENTARY NIOBIUM-TITANIUM SUPERCONDUCTING WIRE AND CABLE : TECHNOLOGICAL CAPABILITIES AVAILABLE AT ATOMIC FUELS DIVISION, BARC

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Atomic Fuels Division

Niobium-titanium superconducting composites have quite a long history in the era of applied superconductivity. Nb-Ti alloys are ductile and can be co-processed with copper into a wide range of composite conductors. Virtually, all the larger superconducting magnet systems onstructed so far have used Nb-Ti conductors. High energy physics has made extensive use of superconductor for the construction of magnets several metres in diameter to produce the large volume of field needed in cyclotrons and fusion reactors.

Important criteria for conductor design and fabrication processes are:

(a) Critical temperature, T_c & Critical magnetic field, H_c

(b) Critical current density, J_c

(c) Magnet size

Fabrication parameters must be in compatibility with electrical and mechanical properties and suitable microstructure in the final composite conductors. To meet the combination of very different demands of superconductive and normal conductive properties for stabilisation and mechanical strength, the superconducting technology is a composite technology.

The steps involved in fabrication of superconducting wire are:

1. Assembly of extrusion billet
2. EB welding of the billet assembly
3. Hot Extrusion
4. Cold drawing with intermediate vacuum ageing treatment
5. Twisting

Atomic Fuels Division has set up a facility for development and fabrication of composite superconductor for various applications under IX plan sub-project "Technology demonstration of fabricating LTSC fine filament wires/cables". Various machines available under this facility are: two die duplex swaging machine and bull block machine of different sizes, hexagonal bar straightening machine, multi-die wire drawing machine, special purpose machine for cutting, end facing and deburring at both ends simultaneously and single wire twisting machine. These machines will be installed and commissioned in the new building which will be a national facility for LTSC wire fabrication.

Based on the extensive development work carried out which included composite billet design, optimisation of parameters for extrusion, drawing and ageing treatment to obtain suitable shape, size and distribution of α-Ti precipitates for flux pinning centres, an appropriate fabrication route has been standardised for 1.30 mm dia. wire containing ~ 500 Nb-Ti filaments each of 40 micron size with Cu:SC ratio of 1.30:1. 3 km single length wire has been produced successfully. Figs. 1, 2 & 3 show extrusion billet, extruded rod cross section and 1.3 mm dia wire respectively. Fig. 4 shows optical image of wire cross section after last heat treatment and Fig. 5 shows SEM micrograph of transverse section of 1.32mm dia Cu/Nb/Nb-Ti multifilamentary wire. A maximum critical current of 1394 Amps has been measured in Nb-Ti short samples at 5.5 Tesla field and 4.2 K temperature. Development of 0.86mm dia wire containing 1200 Nb-Ti filaments each of around 10μm size is in progress.

Fig.1 Cu/Nb/Nb-Ti multifilamentary billet assembly developed at AFD

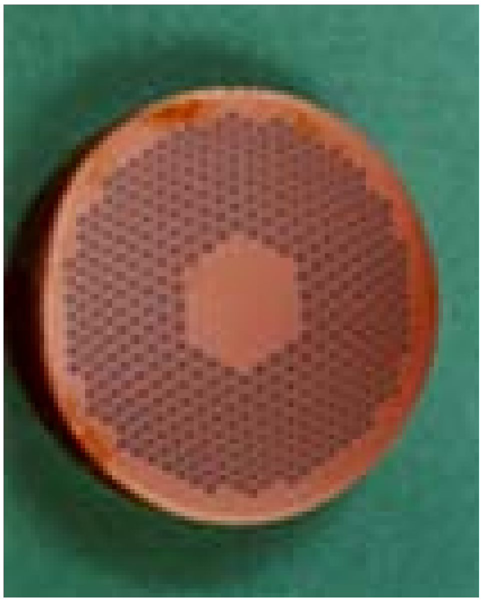

Fig.2 Cross section of extruded Cu/Nb/Nb-Ti rod (50mm dia)

Fig.3 1.3mm dia Cu/Nb/Nb-Ti superconducting wire (492 filaments, 40 micron size)

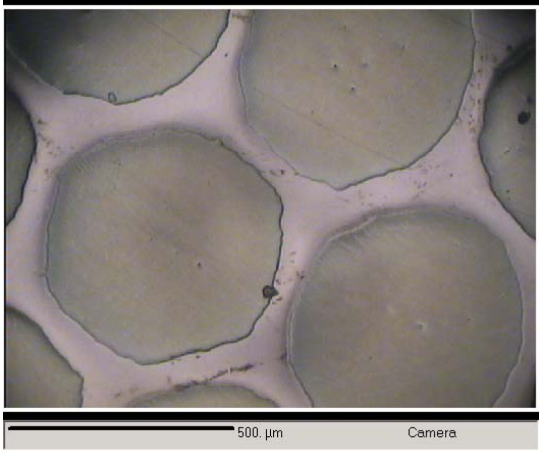

Fig.4 Optical image of transverse cross-section of multi-filamentary Cu/Nb/Nb-Ti composite after third stage of heat treatment Φ = 17.4mm

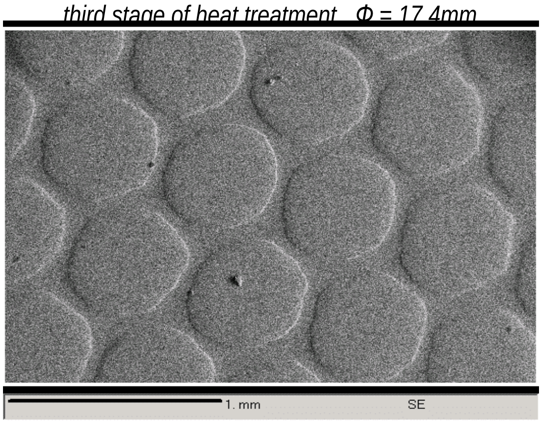

Fig.5 Transverse section of multi-filamentary Cu/Nb/Nb-Ti composite superconductor wire Φ = 1.32mm. Each filament Φ =40µm approx. (SEM)

The problem of stability is an important criterion for the design of all practical magnets using Nb-Ti superconducting wires. These magnets can quench at much lower currents which is known as degradation. Because the normal state resistance of superconductor is very high and current density is also high, the transition causes intense local heating which spreads to neighbouring parts of the winding. As a consequence, the normal zone grows rapidly until all the stored energy of the magnet has been dissipated as heat. This can be avoided by making a composite conductor in which the superconductor is brought into intimate contact with good conductor such as OFHC copper which improves the local cooling by bringing the cryogen (Liq. He) into close contact with every conductor in the winding.

The above wire was utilised for fabrication of superconducting cable for cyclotron magnet. A continuous soldering unit was designed, installed and commissioned for production of soldered superconducting cable. Fig. 6 shows complete layout of this unit. Process parameters were optimised and about 1 km long soldered cable was produced using eutectic tin-lead alloy by dip soldering process. An on-line ultrasonic testing system was also incorporated to check the bond integrity of soldered cable (Fig. 7).

Fig.6 Continuous soldering unit for superconductor wire

The superconducting state shows a number of extraordinary features: it allows, for example, a DC current to flow with no loss. Today, strong superconducting magnets, exploiting this zero

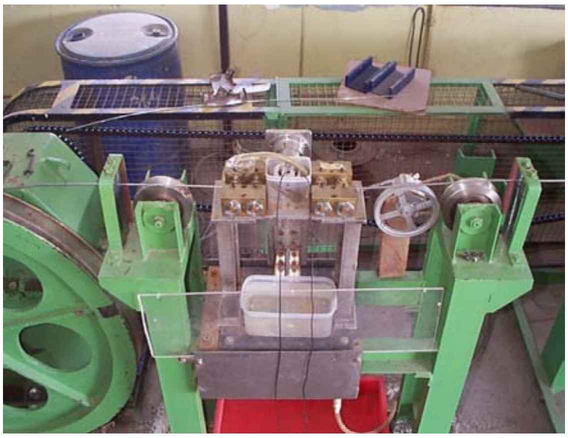

Fig.7 An on-line UT system for continuous soldering unit

DC resistance, are routinely used in science, research and technological development and in medical diagnosis, using Magnetic Resonance Imaging (MRI), the latter representing the biggest current market for superconductivity. In addition, the ultra low AC losses of superconductors may also result in potentially large energy savings in power applications, and demonstrations of power cables, transformers, motors or current limiters have already been made. Still another application is the exceedingly sharp, low noise microwave filters for base stations of radio communication systems. Finally, "quantum interference effects" in superconductors enable us to monitor magnetic fields, which are more than a billion times weaker than earth magnetic field, and make it possible to successfully record functions of the heart and brain.

In summary, there are a number of components and systems in the different fields of electric power, industrial processing, transportation, medical applications as well as information and communication, in which superconductors offer unique functions. Maglev trains which can attain speeds in excess of 500 km/hr are the application which has caught the popular imagination the most. Some of the other application of superconductor is in SQUID, magnetic ore separator, Superconducting Magnetic Energy Storage System (SMESS) and MHD generator.

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BARC GETS A NEW DIRECTOR

Dr S. Banerjee, Director, Materials Group, BARC, took over as Director, BARC, on April 30, 2004, from Mr B. Bhattacharjee at a simple but impressive ceremony held at BARC. Dr Anil Kakodkar, Chairman, Atomic Energy Commission and Secretary, Department of Atomic Energy, was present. Dr S. Banerjee is internationally well known for his work in the field of physical metallurgy and materials science. He has contributed extensively in basic research on metallurgy of zirconium and titanium based alloys and their applications in the development of thermo-mechanical treatments for processing several nuclear reactor components. His work provides a basis for analysing the radiation stability of structural materials in nuclear reactors.

Dr S. Banerjee, (left) Director, Materials Group, BARC, taking over as the Director, BARC, from the outgoing Director, BARC, Mr B. Bhattacharjee (right), in the presence of (centre) Dr Anil Kakodkar, Chairman, Atomic Energy Commission and Secretary, Department of Atomic Energy

Dr S. Banerjee, the new Director, BARC, presenting a bouque to Mr B. Bhattacharjee, the outgoing Director, BARC. Dr Anil Kakodkar, Chairman, Atomic Energy Commission and Secretary, Department of Atomic Energy, looks on.

The contributions of Dr Banerjee and his colleagues with regard to the development of shape memory alloys and their applications in heat shrinkable couplings are finding extensive applications in the light combat aircraft project.

An outstanding scientist, Dr Banerjee has been the recipient of many awards and honours. These include Shanti Swarup Bhatnagar Award in Engineering Sciences (1989), G.D. Birla Gold Medal of the Indian Institute of Metals (1997), INSA Prize for Materials Science (2001) and Indian Nuclear Society Award (2003). Notable among the international awards received by him are Acta Metallurgica Outstanding Paper Award (1984) and Humboldt Research Award (2004). Dr Banerjee is a Fellow of Indian National Science Academy, Indian Academy of Sciences, Indian National Academy of Engineering and the National Academy of Sciences.

CHAIRMAN, AEC, INAGURATES ESL AT KUDANKULAM

Dr Anil Kakodkar, Chairman, Atomic Energy Commission and Secretary, Department of Atomic Energy, inagurated the Environmental Survey Laboratory (ESL) at the Kudankulam Nuclear Power Project (KKNPP) of Nuclear Power Project of India Ltd (NPCIL) on February 29, 2004.

Speaking on the occasion, Dr Kakodkar affirmed that the Department was totally committed to people both within the plant site and outside with respect to issues related to the local environment and the eco-system.

ESLs are independent of the operating station and report directly to the Health Physics Division, BARC.

Speaking on the occasion, Mr S.K. Jain said that the corporation had put a premium on the transparency in its operations. The setting up of the ESL will mark the beginning of a sincere effort at monitoring the environment within a radius of 30 km around the project site.

Mr H.S. Khushwaha, Director, Health, Safety & Environment Group, BARC, said that since the very inception of nuclear industry, significant emphasis has been given for the safety and protection of radiation workers, public and environment. ESL at KKNPP is equipped with modern, sophisticated, state-of-the-art nuclear, meteorological and chemical instruments and are operated by trained and experienced scientists.

Mr S.K. Agrawal, Project Director, KKNP, Mr R.M. Sharma, Head, Health Physics Division, BARC, and Dr A.G. Hegde, Head, Environmental Studies Section, BARC, were present on the occasion.

Dr Anil Kakodkar, Chairman, Atomic Energy Commission, inagurating the Environmental Survey Laboratory at Kudankulam. To his right is Mr S.K. Jain, Chairman and Managing Director, NPCIL

Sitting on the dias from left to right are: Mr H.S. Khushwaha, Mr S.K. Jain, Dr Anil Kakodkar, Mr S.K. Agrawal and Mr R.M. Sharma.

INTERNATIONAL CONFERENCE ON LUMINESCENCE AND ITS APPLICATIONS (ICLA-2004)

An International Conference on Luminescence and its Applications (ILCA-2004), organised by Luminescence Society of India (LSI), was held at BARC, during February 9-12, 2004. The Conference was inaugurated by Dr Anil Kakodkar, Chairman, Atomic Energy Commission and Secretary to the Government of India, Department of Atomic Energy. It was presided over by Mr B. Bhattacharjee, Director, BARC.

Dr Anil Kakodkar, Chairman, AEC, delivering the inaugural address at the ILCA-2004

The Conference started with a welcome address by Dr V. Venkat Raj, Chairman, National Organising Committee, ICLA-2004 and former Director, Health, Safety and Environment Group, BARC. In his speech, he expressed happiness about the excellent response evoked by the conference amongst the international community and Indian scientists alike. He pointed out the significance of the conference being held in BARC, during the Golden Jubilee Year of the Department of Atomic Energy. Dr B. C. Bhatt, President, LSI and Convener, ICLA-2004, summarised the various activities conducted by the Luminescence Society of India since its inception in 1990. He also emphasised the need for the International meet on the topic as luminescence plays an important role in many application areas ranging from lamp industry to radiation dosimetry to medical diagnostics.

Dr A.G. Page, Convener, Technical Committee, gave details about the conference. Eight scientists from abroad (USA, Germany, Japan and Switzerland) participated in the conference. In all, thirty invited talks and ninety contributed papers on various topics of interest, were presented during the course of four days. Dr M. Itoh, Shinshu University, Japan, delivered the keynote address.

Mr B. Bhattacharjee, in his presidential address, discussed various applications of luminescence and contributions made by BARC in those areas. In this context, he specially mentioned the role played by BARC in the field of radiation dosimetry and medical diagnosis.

Dr Anil Kakodkar, in his inaugural address, mentioned about the task force set up earlier for R&D on phosphors for medical and dosimetric applications and lauded the work carried out by the members in these areas. He emphasised the need to take up time-bound programmes in other aspects and strive hard to complete them successfully. Dr K. V. R. Murthy, Secretary, LSI, proposed the vote of thanks.

Apart from fourteen technical sessions, a special evening lecture was arranged to highlight the applications of Luminescence in Diamond Industry by Mr Sripalkumar Desai.

The conference was attended by over two hundred delegates.

BARC CELEBRATES NATIONAL SAFETY DAY

The National Safety Day was celebrated on March 4, 2004 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 H.S. Kushwaha, Director, Health, Safety and Environment Group, BARC, inaugurating the Safety Exhibition organised on National Safety Day at the Central Complex auditorium

Mr H.S. Kushwaha, Director, Health, Safety and Environment Group, BARC, inaugurated the safety exhibition. In appreciation of the exhibition, he lauded the efforts taken towards inculcating safety awareness among the employees. A number of employees of BARC took active part in the programme.

As a part of efforts in promoting safety through the educational and motivational activities under the Accident Prevention Programme, Industrial Hygiene and Safety Section (IHSS), Radiation Safety Systems Division, BARC, organises this one-day common safety programme annually. The results of the Safety Slogan Contest-2003 and Safety Poster Contest-2004 (organised at BARC) were displayed in the exhibition. All the 54 entries in Safety Poster Contest were displayed. To evaluate the Best Safety Slogans and Safety Posters, the Head, Radiation Safety Systems Division, BARC, constituted a committee consisting of Dr Pushparaja, Head, RHC Section, Dr U.V.Phadnis and Dr R.M.Bhat, RS Section, RSSD and Dr V.V.S.Sanyasi Rao, Health Physics Division, BARC. Members of Industrial Hygiene and Safety Section, RSSD, BARC coordinated the committee.

SEMINAR ON "REGULATORY & SAFETY MEASURES FOR BARC FACILITIES" AND "NUCLEAR REACTOR SAFETY AND THERMAL HYDRAULICS"

A new safety framework for BARC was established three years ago by Director, BARC, pursuant to an Official Memorandum of the Government of India. This framework envisages that the regulatory and safety functions, which were earlier under the jurisdiction of Atomic Energy Regulatory Board (AERB), are to be exercised by an Internal Safety Structure of BARC. The Internal Safety Structure consists of a three-tier arrangement, with the BARC Safety

Council (BSC) as the Apex Body assisted by Operating Plants Safety Review Committee (OPSRC), Conventional & Fire Safety Review Committee (CFSRC) and Design Safety Review Committees (DSRCs), which in turn, are assisted by Unit Plant Level Safety Committees and Working Groups.

With a view to improve the awareness and encourage interaction among the persons associated with the safety framework of BARC facilities, a one-day seminar on "Regulatory & Safety Measures for BARC Facilities" and a half-day seminar on "Nuclear Reactor Safety and Thermal Hydraulics" were organised at the BARC, during November 27-28, 2003. The seminar was inaugurated by Dr Anil Kakodkar, Chairman, Atomic Energy Commission and Secretary, Department of Atomic Energy (DAE). In his introductory remarks, Dr V. Venkat Raj, Director, Health, Safety & Environment Group (HS&EG), BARC, and Chairman, BSC, said that the BSC was formalised in May, 2000 for the internal regulation of BARC. He also said that the framework of BSC was based on the regulatory model of the AERB and modification and additions were incorporated wherever necessary. After preparing and revising a few drafts over several months, further infrastructure was formulated and it reached a reasonably stable structure.

In his inaugural address, Dr Kakodkar described the seminar as the most appropriate stock taking meeting being held after three years of establishing the safety framework. In his enlightening talk, he highlighted the need to improve the knowledge base, principles of evolving an effective safety culture and the necessity for evolving an internal safety framework for BARC. He called upon the BARC fraternity to aim towards incident-free working. Mr B. Bhattacharjee, Director, BARC, gave the keynote address entitled, “Essence of BARC Safety Framework”.

The technical sessions consisted of eleven invited talks on "Regulatory & Safety Measures for BARC Facilities" and five invited talks on "Nuclear Reactor Safety and Thermal Hydraulics". Dr Venkat Raj gave two lectures titled, "BARC Safety Council Genesis and Functioning" and "Overview of Safety Related Research and Development". Mr S.K. Sharma, Chairman, Safety Review Committee for Operating Plants (SARCOP) and Vice-Chairman, AERB, delivered a talk on "Emerging Trends in Nuclear Safety and Regulation". Apart from this, a number of eminent scientists associated with the BARC safety framework, NPC, AERB and various Divisions of BARC delivered talks covering different aspects of safety and regulations for the nuclear facilities and applications of radiation in medicine and on quality assurance in engineering aspects of nuclear facilities.

The sessions were chaired by Dr Venkat Raj, Mr D. S. Shukla, Director, Chemical Engineering & Technology Group, Mr H.S. Kamath, Director, Nuclear Fuels Group, BARC, and Mr H. S. Kushwaha, Associate Director, HS&EG, BARC.

Dr Anil Kakodkar, Chairman, AEC, delivering the inaugural address at the seminnar

The seminar was conducted by the BSC Secretariat under the aegis of BSC with the active co-operation from Personnel Division, Accounts Division, Library & Information Services Division, Human Resources Development Division, Technical Services Division, Computer Division and Landscape & Cosmetic Maintenance Section. A booklet consisting of the talks delivered during the seminar was released during the inauguration of the seminar.

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

• डॉ. वी. वेणुगोपाल, सह-निदेशक, रेडियो रसायनिकी एवं आइसोटोप वर्ग, भाभा परमाणु अनुसंधान केंद्र, को हाल ही में वाराणसी में आयोजित फरवरी 9-11, 2004 के दौरान वार्षिक सामान्य बैठक में पदार्थ विज्ञान एवं इंजीनियरिंग के क्षेत्र में योगदान देने के लिये मेटीरियल रिसर्च सोसाइटी ऑफ इन्डिया (MRSI) पदक से सम्मानित किया गया ।

Dr V. Venugopal, Associate Director, Radiochemistry and Isotope Group, BARC, has recently been conferred with Materials Research Society of India (MRSI) medal for his contributions to the field of materials science and engineering during the Annual General Meeting of MRSI held at Varanasi during February 9-11, 2004.

• डॉ. इन्दिरा प्रियदर्शिनी, विकिरण रसायनिकी एंव रसायन गतिविज्ञान प्रभाग, (RC&CDD) भाभा परमाणु अनुसधान केंद्र को विकिरण रसायनिकी, प्रकाश रसायन एवं जीव विज्ञान के अनुसंधान क्षेत्र में प्रमुख योगदान को मान्यता देने के लिये नैशनल अकादमी ऑफ साइन्सिज़, इन्डिया, का अधिसदस्य निर्वाचित किया गया है। मॉडल प्रणाली में शीघ्रगामी शैली का उपयोग करके ये प्रति-ऑक्सीडेन्टस्, रेडियोरक्षक, एवं रेडियो सक्रियकरण में शामिल मुक्त सुधारवादी प्रतिक्रिया का अध्ययन कर रहीं हैं। हाल में ये रेडियोप्रोटेक्टरस जैसे प्राकृतिक उपज एवं जडी-बूटियों के रस का सशक्त प्रयोग करके प्रति ऑक्सीडेन्टस् के स्पष्टीकरण का अध्ययन कर रहीं हैं। डॉ. प्रियदर्शिनी ने समीक्षात्मक अन्तर्राष्ट्रीय पत्रिकाओं में 75 से अधिक शोध-पत्रों की सह रचना की है।

Dr Indira Priyadarsini, a scientist from the Radiation Chemistry & Chemical Dynamics Division, BARC, has been elected as a Fellow of the National Academy of Sciences, India, in recognition of her outstanding research contribution in radiation chemistry, photo-chemistry and radiation biology. Employing fast reaction techniques, she has been studying the free radical reactions involving antioxidants, radio protectors and radio sensitizers in model systems. She is currently working on the elucidation of mechanisms of antioxidant action involving natural products and herbal extracts with potential application as radioprotectors. Priyadarsini has co-authored more than 75 papers in peer-reviewed international journals.

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