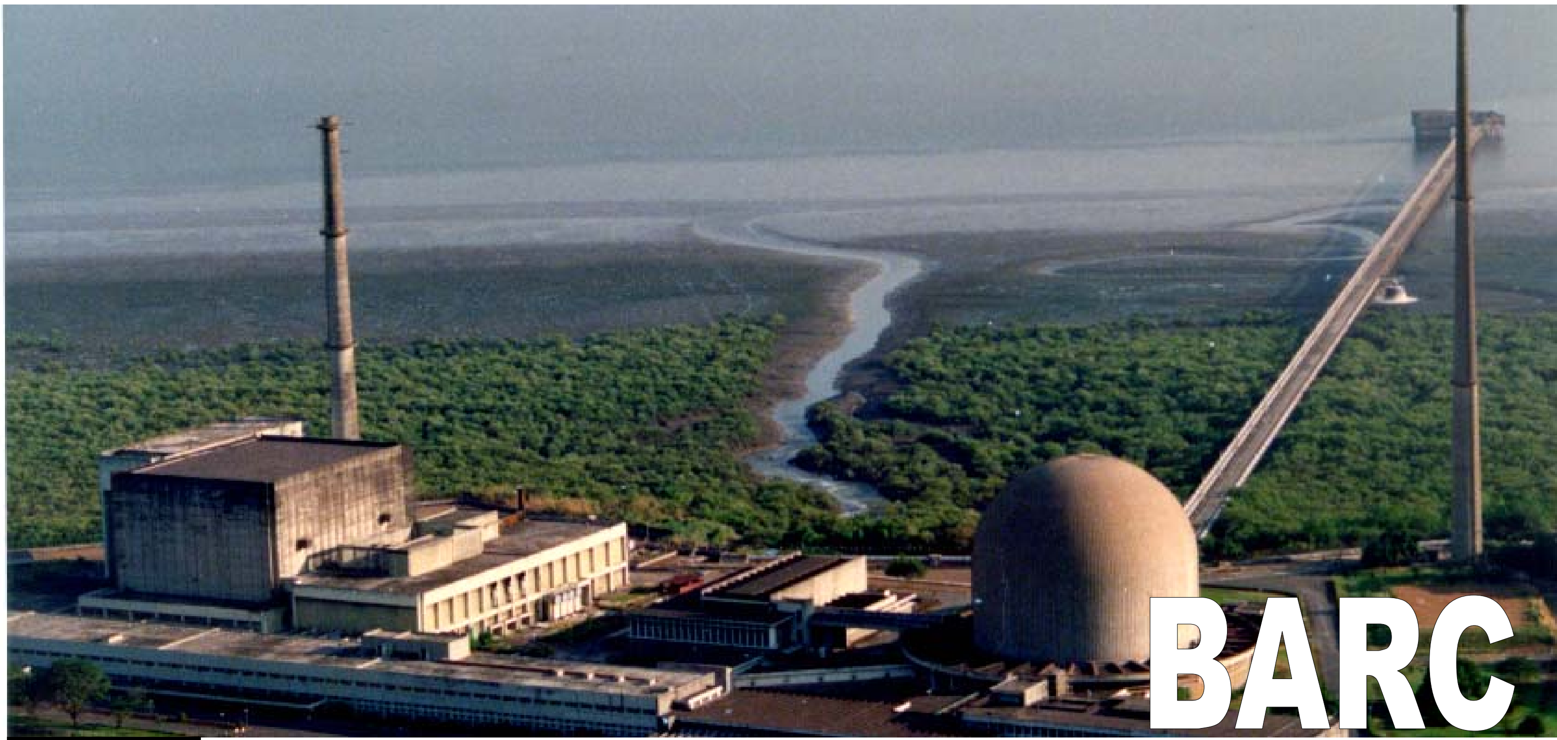

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Contents

NEURAL NETWORKS BASED OPERATOR SUPPORT SYSTEM FOR EVENT IDENTIFICATION IN NPPs

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Introduction

A nuclear power plant experiences a number of transients during its operations. These transients may be due to equipment failure or malfunctioning of process support systems. In such a situation, the plant may land in an abnormal state which is undesired. In case of an undesired plant condition, generally known as an initiating event, the operator has to carry out diagnostic and corrective actions. The objective of the plant diagnostic system is to identify potentially unsafe scenarios and to give the plant operators appropriate inputs to perform the corrective actions. When an event occurs starting from the steady state operation, thermal hydraulic parameters develop a time dependent pattern and these patterns are unique with respect to the type of event. Therefore, by properly selecting the process parameters and their value ranges, the Initiating Events (IEs) can be distinguished. To tackle this problem, a number of linear and nonlinear pattern recognition techniques can be utilised [1-5]. For this work, artificial neural networks have been utilised for event identification.

An operator support system known as Symptom Based Diagnostic System (SBDS) has been developed to identify eight IEs of Narora Atomic Power Station (NAPS). Data has been collected from various data sources such as Emergency Operating

Procedures (EOPS), Plant Safety Reports (PSRs) and process instruments at the plant site [6]. The data has been preprocessed to codify into a format which is required for the neural networks. As the behavior of parameters is different for each IE, the data for each IE is different too. Each IE is identified by a set of unique parameters and parameter values. An optimisation study has been carried out on various neural network algorithms such as Back Propagation, Resilient Back Propagation, Quick Propagation, Manhattan and Delta-bar-Delta to select an algorithm for this application. From the study, it is observed that the resilient back propagation algorithm converged to an optimum solution with minimum error and less computation time. This algorithm employs local adaptive learning scheme performing supervised batch learning in multilayer perceptions.

Neural Networks

Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way the biological nervous systems, such as the brain, process information. It is a system modeled on human brain. ANNs, like humans, learn by examples [7]. It is an attempt to simulate, within specialised hardware or sophisticated software, the multiple layers of neurons. Each neuron is linked to few of its neighbours with varying coefficients of connectivity that represent the strengths of these connections. Learning is accomplished by adjusting these strengths to cause the overall network to output appropriate results. A general characteristic of a neural network is the ability that quickly recognises the various conditions or states of a complex system once it has been suitably trained. The objective of this article is to describe the operator support system rather than neural networks. More detailed description of neural networks can be found elsewhere in [8-9].

Symptom Based Diagnostic System

Symptom Based Diagnostic System is a software tool used to diagnose abnormal events / transients in nuclear reactors based on reactor process parameters, detect deviations from normal operating conditions, determine the significance of the situation and recommend an appropriate response in a short time. It performs the above said tasks with the help of neural networks by operating on a large knowledge base which is developed by collecting the operational data from various data sources. It provides necessary and sufficient information to the plant operator to take appropriate actions to mitigate the abnormal plant conditions in adequate time. This system simulates the reasoning process of the human expert and aims at finding the plant status depending on the system failures, activity release from the Primary Heat Transport System (PHTS), etc. Hence, the occurrence of IE can be detected by continuously monitoring the reactor operating parameters such as PHTS Storage Tank Level, PHTS Pressure, PHTS Temperature, and Steam Generator Level.

Initiating event is detected by a set of unique parameters; however, there may be a few parameters which are common to two or more IEs. In such scenarios, the parameters' values / rate of variation will distinguish among the similar events. The functional block diagram of SBDS is shown in Figure 1. It mainly consists of three stages of processing, namely, the input, output and the event identification stage. In the input stage, the data is taken from the knowledge base stored in Microsoft Access, processed and written in a standard file format. The preprocessed data in the input stage is utilised for training the neural network in the event identification stage. The network processes the data through a bank of neuron layers and arrives at an optimum solution. Finally, the result obtained in the event identification stage is displayed in the output stage. In the output stage, the following features are displayed: the plant status, i.e., whether the plant is normal or an IE has occurred, parameters and their current status, trend of the relevant parameters and operator actions as and when required.

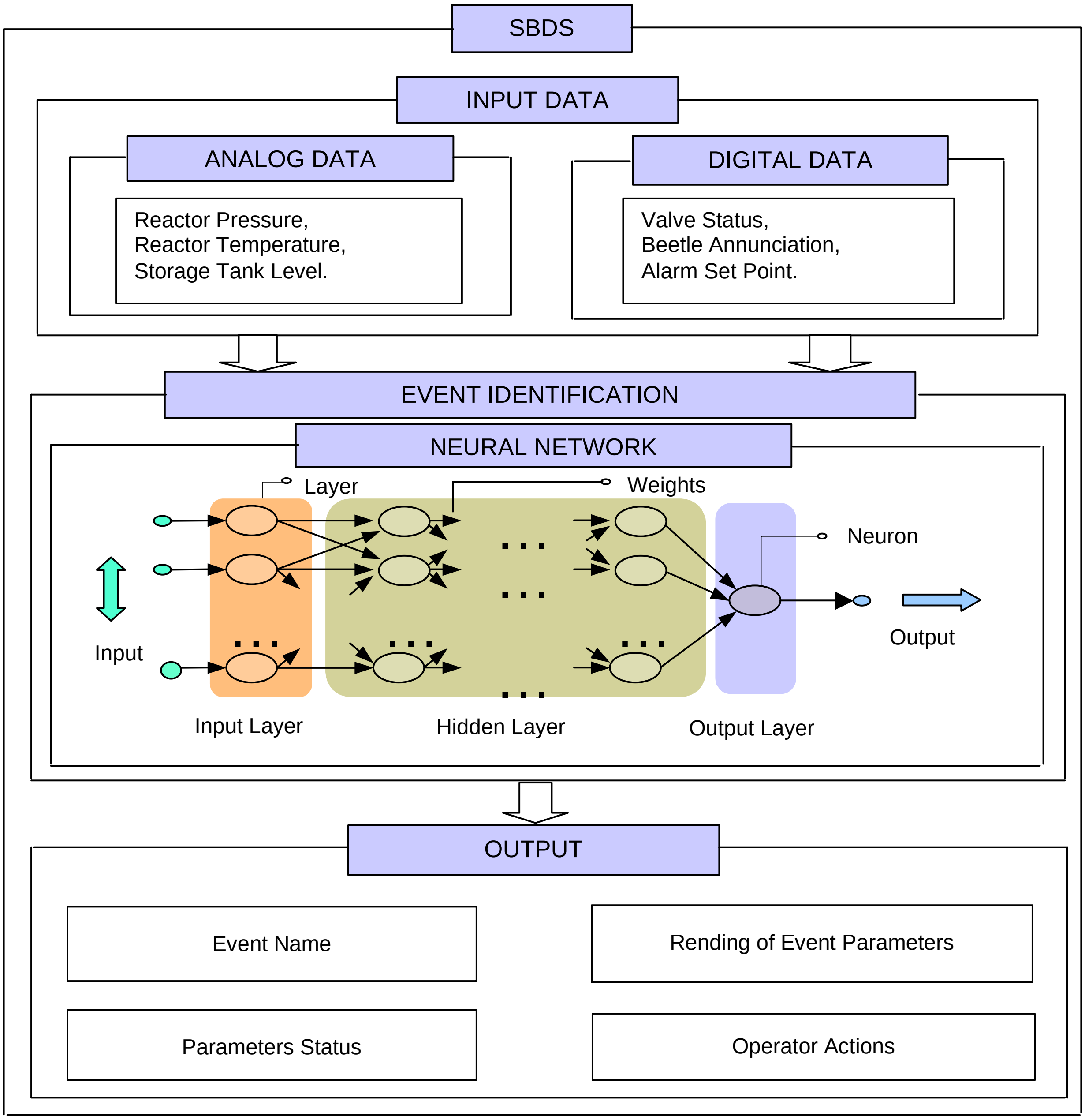

Fig.1 Functional block diagram of SBDS

The following eight initiating events of NAPS have been incorporated: Shutdown Cooling Heat Exchanger Tube Failure, Moderator Heat Exchanger Tube Failure, End Shield Cooling System Failure, Steam Generator Tube Rupture, End Fitting Failure, Ejection of Seal Plug and Shield Plug, Calandria Vault Cooling System Failure, Small Rupture of 10 mm diameter in PHT System and Rupture of Bleed Cooler Tube [6]. The process parameters are continuously displayed on operator screen. Whenever an abnormal condition arises, the system will record the time at which an event is started and the value of relevant parameters. The current version of the software is capable of identifying six IEs correctly, whereas the two events, i.e., Shutdown Cooling Heat Exchanger Tube Failure and Rupture of Bleed Cooler Tube could not be distinguished due to lack of sufficient information on these two events. This software can be further modified to investigate more number of IEs as well. This system will be able to produce good results for the properly trained events, whereas for the non-trained events, the plant status will be displayed as “Not Detected”. The features of SBDS have been explained with the help of a case study on Steam Generator Tube Rupture (SGTR) event. Similar analysis and the system features will be applicable to other IEs as well.

Case Study: Steam Generator Tube Rupture

Event description and identification

The event starts with a fall in D_2O storage tank level. PHTS pressure recorder shows a dip in PHTS pressure (in case of sudden rupture). Fluctuation in water level is observed in the affected Steam Generator (SG). As the SG level controllers are independent of each other, the level in the affected SG would get normalised after the initial rise. In such a situation, the reactor will continue to operate and the identification of the particular SG with leaky tube is mandatory. Confirmation of the faulty SG by manual sampling of steam and feed water for tritium is required. D_2O-H_2O leak detection system alarm annunciates in control room as D_2O enters the secondary side. Increase in PHTS feed flow and decrease in bleed flow will be observed in the control room.

In case of failure of operator action, the reactor would trip on "Low PHTS storage tank level" in about six minutes after the initiation of the incident. Following the break in SG tube, the release of activity from the PHTS into the secondary side of the affected SG will continue to increase, as the isolation of the affected SG would not be possible immediately. Beyond 30 minutes, the entire inventory in the PHTS storage tank as well as the 25 tonnes in small LOCA handling system would get exhausted, which would call for the cooling down of the PHT system [6].

Operator actions

In order to enable the plant personnel to initiate the necessary actions in the earlier stages of development of IEs, important operator actions have been identified from EOPs and stored in Microsoft Access database for all the stated IEs. For the case considered in this study, a list of important operator actions is given in Table 1. Whenever an event is detected, only those actions that are relevant to the detected event are displayed.

Table 1: List of operator actions for steam generator tube rupture event

Time (secs.)	Operator actions
120	If 2 tonnes of D_2O escape from PHTS St. Tk. and leak is not identified, then TRIP the reactor manually.
600	Collect samples from steam & water of individual SGs and analyse them quickly for identification of faulty SG.
600	Stop blow down of all SGs
1800	Reduce PHTS pressure slowly as per PHTS depressurization scheme, keeping it 5 kg/ sq.cm. more than boiler pressure.
1800	Take BPC on manual and open the SDV by jumpering and cool through CCW system till condenser vacuum reaches 400 mm of Hg. Cool down PHTS @ 5 ^oC per min. through SDV.
1800	Block ECCS.
1800	Before PHTS pressure reaches 20 kg/sq.cm., ensure that all PCPs are stopped.
1800	Isolate the affected SG, PCPs and the gland supply.
1800	Ensure warming up S/D loop and take into service at PHT temp.150 ^oC and stop BFPs.
1800	After cooling the PHT system to about 50 ^oC, drain the secondary side of SGs and take samples. Later drain the primary side of the SG.

The event-identifying flowchart has been drawn based on the event progression and is shown in Figure 2.

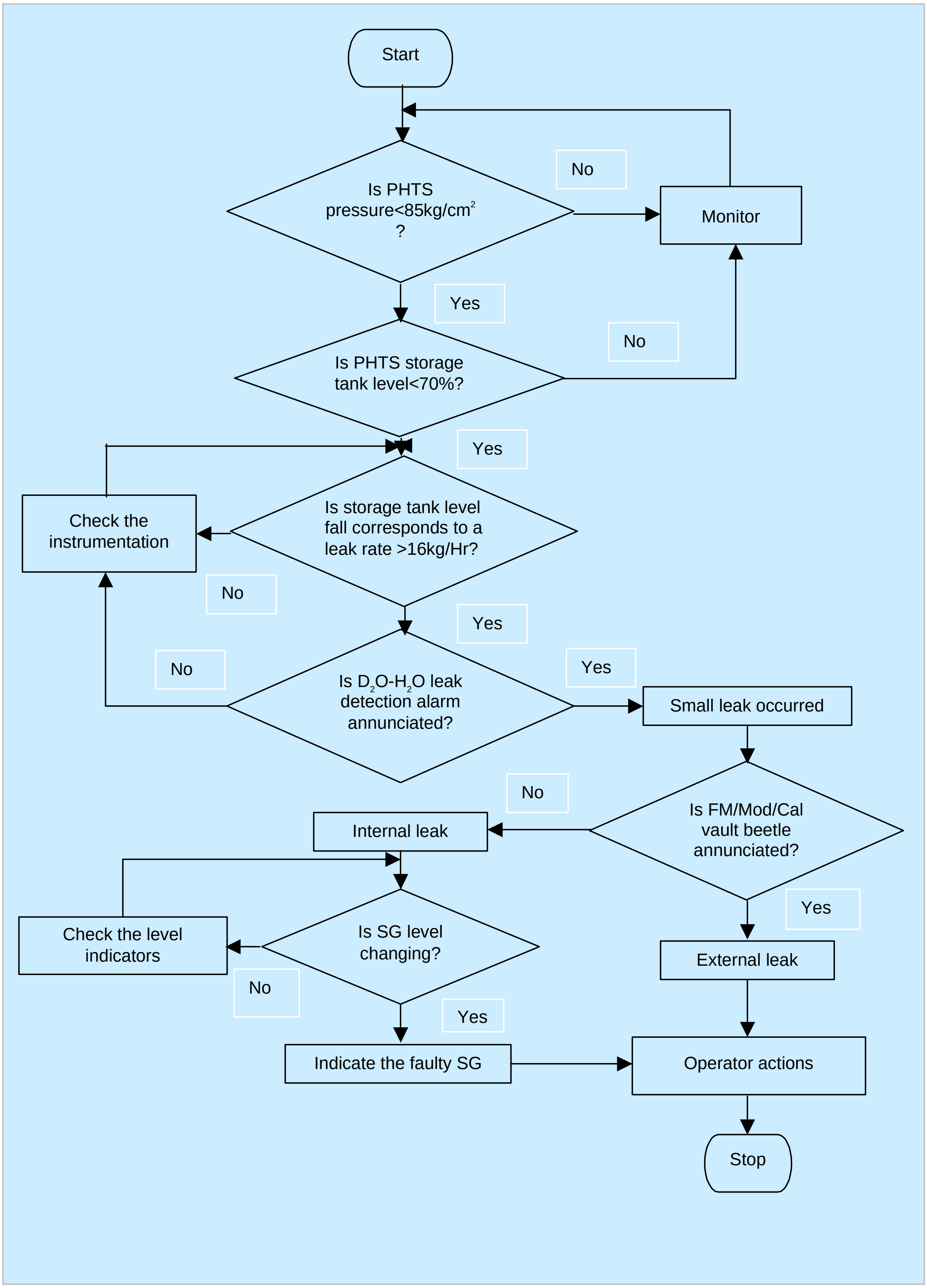

Fig. 2 Event identification flowchart for steam generator tube rupture event

Features of SBDS

SBDS enables the operator to know the status of the plant at any instant of time. Whenever an event is detected, the system will record the type of event, time at which event occurred and the relevant parameters and their values at the time of event. The features of the software have been explained by showing few of the windows displayed by the software. Figure 3 shows the status of the reactor and displays the relevant parameters of the event and their current status for the event SGTR.

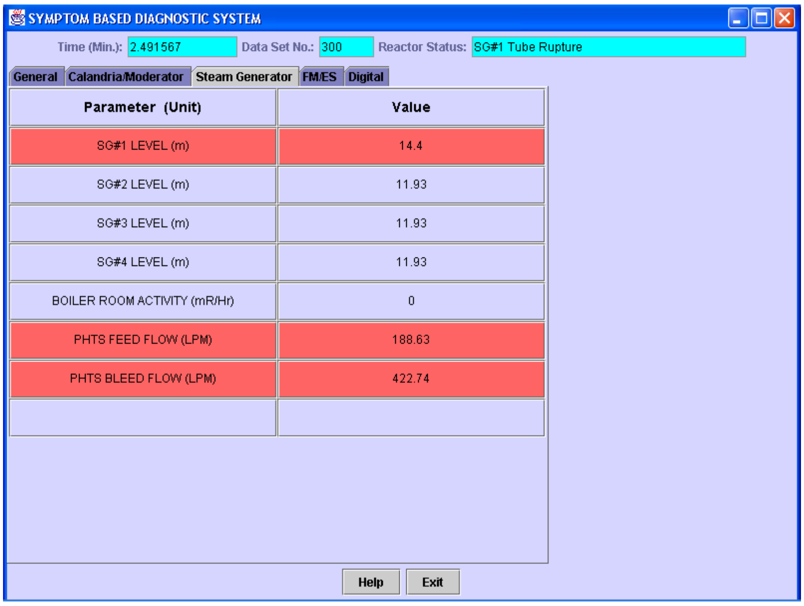

Fig. 3 Window showing the relevant parameters along with their current status for the event SGTR

A window that is displayed to show the operator actions is shown in Figure 4.

Graphical trend of the relevant parameters of a particular IE can also be displayed by this software. A window of this type is shown in Figure 5 for the event SGTR.

There are unique sets of parameters for different IEs and they have been categorised under different panels. By selecting a suitable panel, relevant parameters and their status can be seen on the operator screen. For example, under steam generator panel, a list of all relevant parameters of this IE is given. Under general panel, some important parameters which are common to a few IEs have been shown.

It is apparent from the study that any abnormal events that occur in a reactor can be detected by this type of system with the help of time dependent process parameters. It is also clear that the important parameters' trend can be seen on the operator screen while diagnosing. This helps the operator to know the timely dependent change in the parameters' value with respect to their normal operating values, drawing the inferences from a set of parameters. The operator can apply the time dependent necessary operator actions as and when required by simply looking on the operator actions window rather than searching for the resource documents. The special feature of this system is that whenever a parameter crosses its normal operating range, the system will flash that parameter and its

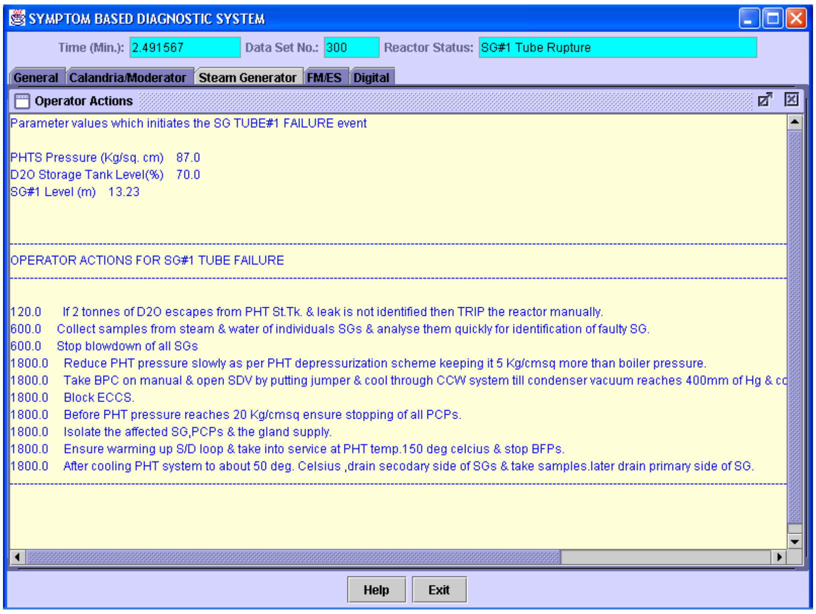

Fig. 4 Window showing the necessary operator actions for the event SGTR

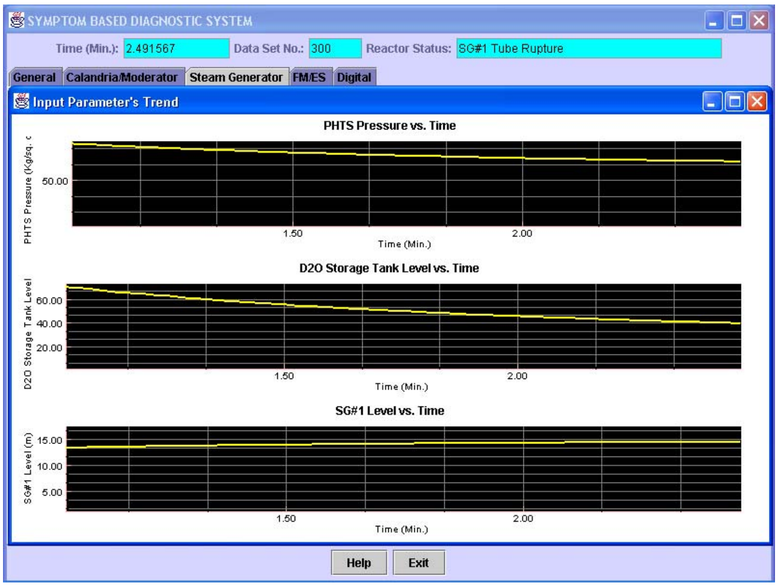

Fig. 5 Window showing the graphical trend of the parameters for SGTR event

value with red color which indicates an alert to the operator. Thus, SBDS could demonstrate its role as an efficient operator support system during abnormal situations.

Conclusions and Future Scope

Neural networks based operator support system has been developed for the Narora Atomic Power Station. However, it can also be used for diagnosing other nuclear power plants by incorporating the suitable modifications in the system. For the non-trained events, the system displays the plant status as “Not Detected”. However, the graphical trend of parameters is continuously displayed. The system’s response for six IEs was reasonably good except for the two events which could not be distinguished due to insufficient information on these two events.

Implementing this type of diagnostic systems in nuclear power plants can assist operators during adverse situations. This system can be applied for any type of plant after studying the plant thermal-hydraulic behaviour of process parameters during the simulated accident conditions. The capability of the developed software tool can be further improved by utilising the actual available data on transients that occurred.

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HIGH PRECISION POSITION CONTROLS BY MICROSTEPPING OF STEPPER MOTOR

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Introduction

Normal two-phase 50-pole stepper motors have rotational (rotor) least count of 1.8°. By an indigenous method, it was possible to achieve the rotor angular control upto 0.018°, i.e. one by hundredth of the natural least count. Here, the concept of electronic gearing is truly exploited and by direct rotor shaft precise control, the small linear repeated distances of interferrometric requirements of 50 nM have been achieved. This was verified by employing absolute 16-bit encoders and H.P. Doppler effect interferometer, for rotational and translational accuracies and repeatability.

This indigenous technique is having copyright (Indian patent office ref no. L-17595/98), and now can be obtained locally, as BARC has transferred the know-how to private entrepreneurs.

The technology developed at BARC is matured enough to be applied in various applications as already about a dozen of instruments and control systems have been supplied to various units under DAE.

In this write up, basics of the controls have been highlighted, with a list of equipment already made (or planned). Therefore, this technique can be employed where very small and precise angular or linear displacements are needed with repeatability.

Basic Microstepping Equation for Stepper Motor

Main torque equation can be derived for a two-phase permanent magnet stepper motor with A & B quadrature winding as :

$$T = pF_o(-i_A \sin\theta + i_B \cos\theta) + pL([-i_A^2 + i_B^2] \sin 2\theta + 2\, i_A i_B \cos 2\theta)$$

Where, T: Torque on the shaft, i_A : Instantaneous phase A current, i_B : Instantaneous phase B current, θ : Electrical angle of rotor, F_o : Total magnetic flux per coil, L : Variation of inductance with rotor position, p : Number of pole pairs. The proof of above is not within the scope of this write up, and is obtained by solving energy matrices. If μ is micro step angle, i_A=I Cos μ, and i_B = I Sin μ, so that $I^2 = i_A^2 + i_B^2$. Substituting these values in the above torque equation and simplifying, we get

$$T = -K_1 I \sin(\theta-\mu) - K_2 I^2 \sin 2(\theta-\mu).$$

Thus, it is possible to position the rotor of a stepper motor wherever required and in between the full steps by the type of excitation, i_A=I Cos μ and i_B = I Sin μ. This microstepping involves certain problems – the choice of μ, taking into account T(torque) vs 2θ, and residual torque in addition to the problems of stability associated with torque. Thus, microstepping control is very good for a motor with very low residual/detent torque, where the second term (2θ dependent in the above equation) is negligible. Also, the close loop octant zoning algorithm (BARC Proprietary) takes care of this secondary term and other sources of error and imperfections.

Choosing Stepper Motor

The excitation for the two-phase motor assumes that motor coils need to be bipolar. The circuits used to control the instantaneous currents in coils, A & B, i.e., i_A & i_B w.e.t μ : the microstepping angle, are Chopper circuits. The circuits scheme imposes certain restrictions on motor selection. Unstable chopping can occur if the chopping duty cycle exceeds 50%. To avoid this, it is necessary to choose a motor with low winding resistance, implying less inductance. The above will give higher microstepping rates, however, this implies less torque. The above postulate is valid when r.p.m. is less important than absolute position.

A compromise is to be made, i.e., choose a motor with lowest possible winding resistance that the gives required torque and use a higher power supply (upto 40V) and check that the chopping duty cycle does not exceed 50% at the maximum current. Along with the above postulates, the volt-ampere rating of the chopper current source has to match with the motor coil volt-ampere characteristics to have optimum performance.

Following motors were tried to establish the validity of microstepping concept. They are SRI-SYN STM 902, SRI-SYN STM 601, SRI-SYN STM 602, SRI-SYN STM 603, SLO-SYN M063-LF-401, SLO-SYN M061-LF-408, SLO-SYN M091-FD09, and VEXTA PM266M-E068.

Vector Control Fundamentals

A normal stepper motor is not ideally suitable for microstepping, due to inherent mismatches in coil magnetics, electronics, variation of torque angle vector on load, and due to presence of fringe magnetic leakage flux at each magnetic pole. The objective of this vector control technique and method is to position the rotor of the stepper motor at demanded microsteps for a normal stepper motor. To make a stepper motor ideally suited for microstepping is difficult as the above factors cannot be fully nullified. Hence this technique has to be used with any stepper motor to microstep.

The algorithm here is to move the stepper motor upto 1/100 of its full step, without any rotor position errors. Rotor position feed back is obtained through an incremental encoder in "close loop" operational mode, if desired. Normally, the control algorithm takes the Sinosoidal phase currents so that $I^2 = i_A^2 + i_B^2$ where $i_A = I\cos\mu$, $i_B = I\sin\mu$, and in the event of rotor positional error, the algorithm deviates from Sinosoidal excitation and corrects the rotor positioning by choosing a particular axis to change phase currents bit by bit to nullify the error and move to the desired micro-step position.

In a permanent magnet stepper motor stator field is generated by current flowing in the phase windings. The rotor field is due to the permanent magnet pole pairs which are radially on rotor. A two-phase stepper motor has two phases A & B separated by 90 electrical degrees, each phase having two possible current directions. The torque is generated due to interactions of the two fields and the rotor aligns to a position where field vectors are in equilibrium. The torque output can be seen to be Sinusoidal function of the electrical angle between the field vectors. By correctly choosing and controlling the *ratio* of the phase currents, it is possible to generate state equilibrium position anywhere between stable full steps.

Inaccuracies in microstepping can arise due to mismatches in the coil itself. Unequal maximum torque contributions from both the phases can give phase gain errors in the torque circle. Errors can even occur due to mismatches in the chopper drives and DAC electronics.

One of the most significant error source in micro-stepping positional application is load-torque. From no-load rotor position, the rotor moves to a new position with the application of external torque, where external torque is balanced by the opposite torque developed by the motor. For a given load torque, the step position error is inversely proportional to number of pole pairs on the rotor and to the maximum holding torque. However, special motors are optimised for microstepping applications with low detent (residual) torque.

All the above errors in microstepping are taken care of in the algorithm by close loop feed-back of the actual rotor position, and then exciting the coils in such a way as to obtain the demanded micro-step position of the rotor. Rotor is positioned through this algorithm by maximising the holding torque at the microstep position.

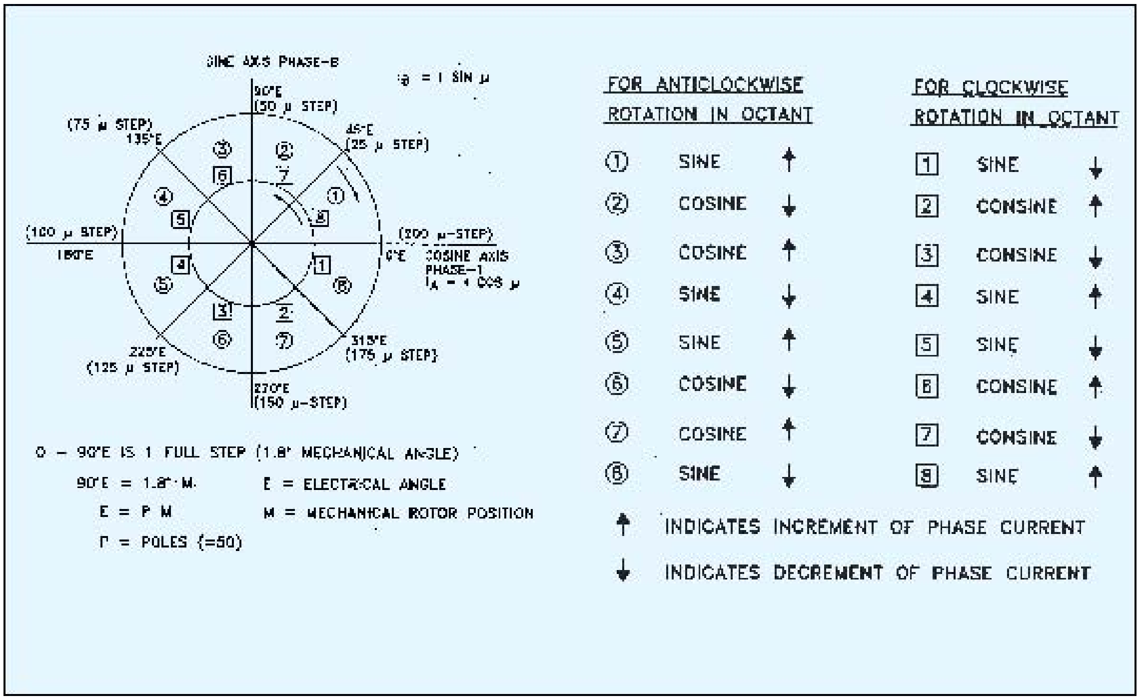


Fig. 1: Octant zoning algorithm for rotor vector position control

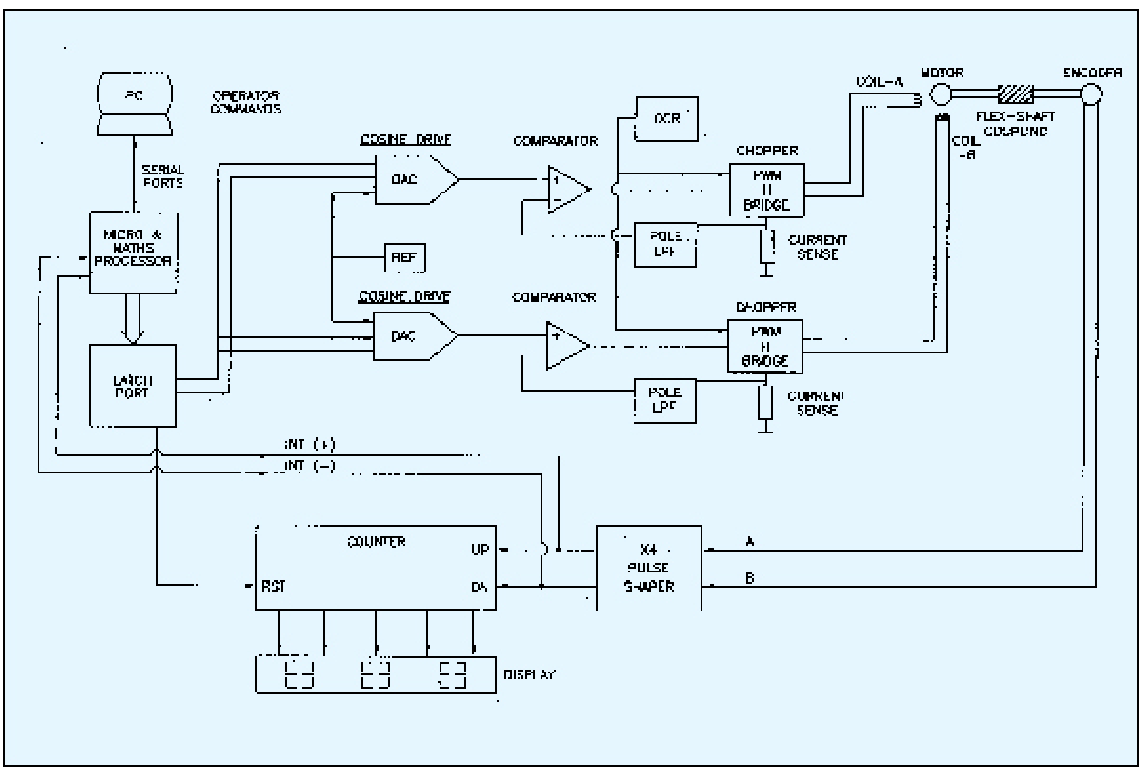


Fig. 2: Block diagram of the set up

The octant zoning algorithm is used to correct the microstep position in the event of an error. Error is noticed by software by counting the number of pulses in the interrupt routines. For 1/50 micro-step positioning, each microstep movement gives one pulse in the interrupt routine; thus, any deviation from these number of pulses gives error in microstep positioning. The torque circle is divided into eight equal octants, each having 45 degrees electrical angle spread. Depending on where the rotor position is at any moment, seen from the pointer in the Sine, Cosine table, the routine chooses the axis and the phase current is changed bit by bit till the demanded rotor position is reached.

When the error is noticed and the rotor (electrical vector) is in the octants 1, 4, 5 & 8, the choice of axis is Sine and if the rotor (electrical vector) is in the octants 2, 3, 6 & 7, the choice of axis is Cosine. When moving in the anticlockwise direction, if the rotor electrical vector is in octant 1, then Sine axis current is incremented; in octant 2, Cosine axis current is decremented; in octant 3, Cosine axis current is incremented; in the octant 4, Sine axis current is decremented; in octant 5, Sine axis current is incremented; in octant 6, Cosine axis current is decremented; in octant 7, Cosine axis current is incremented; and in octant 8, Sine axis current is decremented. For the clockwise rotation, the sequence gets reversed.

Physics behind this algorithm is to move from ideal interpolated Sine & Cosine torque circle to the actual torque position (aberated) circle by maximising the holding torque in the event of error due to imperfections of higher spatial harmonics of torque and other error sources.

Concept Used for Various Experiments and Systems

a) Fabery-Perot Interroferometer experiments at IIT- Mumbai
b) Low Strain Rate Generator, Metallurgy Division, BARC
c) Synchroscope for Nuclear Power Plant Simulator, Kaiga-NPCIL
d) Optical Parametric Oscillator (OPO) Prototype, L&PTD,BARC
e) Gamma Scanner Drive, MDPD,BARC
f) DNA chip, DRHR/MBD,BARC
g) Precise Travelling Probe Level Measurement for Critical Facility AHWR, RRMD,BARC
h) Absorber rod calibration facility for upgraded APSARA, RRMD,BARC
i) Laser Tuning at Bread Board Laser System, L&PTD,BARC
j) X-Ray Diffractometer for DST, DRHR,BARC

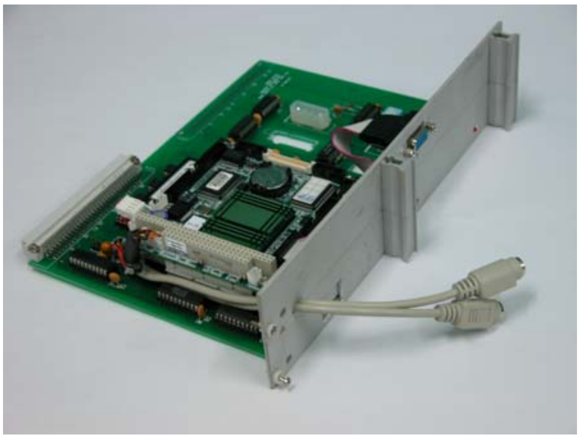
This scheme is to be used for Dye Laser Tuning Control System, Synchronized OPO, Long & Short Range Tunable OPO for L&PTD,BARC.

INTERFACE BOARD FOR INTERFACING PC/104 BUS-BASED SBC MODULES WITH EURO BUS-BASED BOARDS

Mohit Kalra, D. A. Roy and C. K. Pithawa
Reactor Control Division

A family of microcomputer boards on a proprietary bus called ‘EURO bus’, along with signal conditioning and power supply boards was developed in Reactor Control Division (Refer *BARC Newsletter* No. 202, November 2000 with news title, “Microcomputer boards for safety critical systems of Nuclear Power Plants and other high reliability industrial applications”).

These development efforts ensured self-reliance on delivering reliable computer-based safety critical systems of NPP and other high reliability industrial systems. These boards have been used in safety critical systems like Programmable Digital Computer System (PDCS), Reactor Regulating System (RRS), Process Control System (PCS) and Fuel Handling Control System (FHCS) in Kaiga-1, 2 and RAPP-3, 4, and are being used in various control systems of TAPP-3, 4. More than 5000 boards of this family are already in use in various C&I systems.



Interface board

Now, an Interface board has been designed at Reactor Control Division for interfacing SBC modules based on PC/104 bus to proprietary 'EURO' bus. With this interface board, the full family of proprietary 'EURO' bus-based Microcomputer boards developed at RCnD can be interfaced with the commercially available PC/104 bus- based SBC modules. This development provides a platform for developing customised I/O intensive embedded systems requiring high processing power. Use of PC/104 bus-based SBC module ensures upgradability and protects against chip obsolescence and supply denial.

The Interface board sits on the proprietary 'EURO' bus, while PC/104 bus-based SBC module is mounted as a mezzanine board on this interface board. The signal connections are through stackable PC/104 connector. A prototype Interface board has been fabricated, assembled and successfully tested at RCnD. This Interface board is being currently used in the core simulation computer for testing of microcomputer-based Apsara Reactor Regulating System at RCnD.

IAEA REGIONAL WORKSHOP ON "REGULATORY AUTHORITY INFORMATION SYSTEM"

An IAEA Regional Workshop on "Regulatory Authority Information System (RAIS Version-3)" was held at Hotel Sea Princess, Juhu Beach, Mumbai, during July 26–30, 2004. Mr H.S. Kushwaha, Director, HS&E Group, BARC, inaugurated the Workshop. During his inaugural address, he emphasised the objective and

Mr H.S. Kushwaha, Director, Heath Safety and Environment Group, BARC, delivering the inaugural address. Others on the dais are (from left to right): Dr B.C. Bhatt, Head, RPAD, BARC and Course Director, Dr Khammar Mrabit, IAEA Expert, and Dr K. Raghuraman, Head, ISD, DAE.

importance of RAIS as a tool for improving the national inventory of radiation sources, thereby establishing an effective control over radiation sources during its entire life cycle.

Dr K. Raghuraman, Head, International Studies Division, Department of Atomic Energy, welcomed the participants and brought out the important role that India can play in the regional cooperation programmes of International Atomic Energy Agency.

Dr Khammar Mrabit, Head, Policy & Programme Support Section, Division of Radiation and Waste Safety, International Atomic Energy Agency, Vienna, briefed the participants and the invitees about the importance of the regional workshop. He appreciated the facilities made available for the conduct of the workshop and emphasised the need for India to play an active role as a Regional Centre for Human Resource Development with its vast experience in conducting radiation safety related training programmes.

Dr B.C. Bhatt, Course Director and Head, Radiological Physics and Advisory Division, BARC, proposed the vote of thanks. There were 33 participants from RCA Member States which included Australia (2), Bangladesh(2), Cambodia (2), China (3), India (6), Indonesia(2), Republic of Korea(1), Malaysia(2), Mangolia (2), Myanmar (2), Nepal (2), Philippines (2), Singapore (1), Sri Lanka(2), and Thailand (2). In addition, there were 5 observers from India.

IAEA has developed a very comprehensive, flexible and user friendly data base package called the Regulatory Authority Information System (RAIS) which can be used for creating and maintaining the national registry of radiation sources. It requires developing adequate data management tools to facilitate data storage, analysis and follow up action. The principle requirement for any regulatory data management tool is the existence of classification of radiation sources, system of authorisation adopted, the regulatory requirements on responsibility distribution for radiation safety issues, the professional qualification requirements for occupational workers, etc.

Regulatory Authority Information system has been designed primarily as a management tool of information related to the regulatory control of radiation sources. Based on the experience gained in the field and new requirements introduced in the Code of Conduct, Categorisation Sources and Security of sources, RAIS version 2 was reviewed by IAEA and was updated to RAIS 3 to enhance its functionality and to make it customisable to match the needs of different regulatory requirements.

India participated in the Agency's Technical meeting (TM) to validate the running version of the Regulatory Authority Information System (RAIS) to ensure that it takes into account the complex and different needs of Member State in Vienna from May 17 to 20, 2004. RAIS-3 can be used for a variety of purposes such as:

- To manage authorisation process,
- To maintain inventory of radiation sources and installations,
- To develop inspection programme,
- To improve quality assurance program, and
- To assist young regulatory authorities in building their own regulatory systems.

The objective of the workshop was to familiarise the participants with the RAIS-3 data management system developed by IAEA and to invite suggestions for further improvement of the system for easy adaptability.

The 5-day programme for Regional Workshop consisted of lectures-cum-practical exercises by five faculty members, namely, Dr Khammar Mrabit, Mr Thomas Lorang, Dr Hazem Suman, Mr Karl Horak and Ms. Debbie Evanko. Twenty personal computers with inter-linking facility were provided for hands-on exercises by the participants on the RAIS Version-3. Necessary modifications were carried out in the programme on suggestions from the participants. The participants were provided with copies of RAIS Version-3 exercise materials and CDs of the revised RAIS-3 version.

The Workshop concluded on July 30, 2004. Valedictory Address was delivered by Dr R.B. Grover, Director, Knowledge Management Group, BARC & Director, Strategic Planning Group, DAE. During his address, he stressed the need for effective cooperation among the Member States for Human Resource Development and the role India can play for future training programmes in this region.

While presenting his remarks about the Workshop, Dr Mrabit, IAEA, thanked BARC for hosting the Workshop in India and making excellent arrangements during the Workshop. He indicated that India should serve as a regional centre in this area for effectively interacting with various Member States in this region for promoting the use of RAIS and to ensure an

Dr R.B. Grover, Director, KMG, BARC and Director SPG, DAE, delivering the valedictory address. Others on the dais are (from left to right): Dr B.C. Bhatt, Head, RPAD, Dr Khammar Mrabit, IAEA Expert, and Dr D.N. Sharma, Head, RSSD, BARC

effective regulatory system in the Member States. He valued the rich experience of India and availability of necessary infrastructure and human resources for making useful contributions in this field.

Dr D.N. Sharma, Head, Radiation Safety Systems Division, BARC, proposed the vote of thanks. During the feedback session, the participants appreciated the Workshop contents and thanked the Agency for giving them an opportunity to participate in the Workshop on this important topic.

XI WORKSHOP ON "NEUTRONS AS PROBES OF CONDENSED MATTER"

Neutron scattering is a powerful and important technique to probe microscopic structure and dynamics of condensed matter. It finds application in various areas of physics, chemistry, materials science, life sciences, etc. Several state-of-the-art experimental facilities to carry out neutron beam research have been established at the Dhruva reactor by the Solid State Physics Division, BARC. The UGC-DAE Consortium for Scientific Research (UGC-DAE CSR) facilitates scientists and research scholars from universities and national laboratories to carry out experimental research at the Dhruva reactor in collaboration with scientists at BARC.

UGC-DAE CSR and BARC have been regularly organising workshops on neutron scattering in order to encourage university scientists to use this technique and to create a dedicated group of researchers in this field. The present workshop is the eleventh in this series and will cover all aspects of neutron beam research. It will be held during January 27-29, 2005 at Training School Hostel, Anushaktinagar, Mumbai.

The course will consist of a series of lectures and a visit to the Dhruva reactor, BARC, Mumbai. The following topics will be covered:

- Fundamentals of Neutron Scattering
- Neutron Sources and Detectors
- Neutron Diffraction (single crystal, polycrystalline - chemical and magnetic, liquids and amorphous solids)
- Small Angle Neutron Scattering
- Neutron Inelastic and Ouasi-elastic Scattering

This workshop is open only to faculty members from universities and research Institutes. Those interested in experimental neutron beam research may apply on plain paper giving following details: name. age, qualification, address, telephone and fax numbers, e-mail address, details about participation in earlier UGC-DAE CSR sponsored courses workshops, list of publications in refereed journals and a one-page description of their current field of interest and relevance of neutron scattering techniques to it. Number of participants will be limited to about 25. Faculty members having UGC-DAE CSR projects are also welcome to apply. Financial assistance for travel (maximum of 2AC sleeper by train) and stay will be provided on request by UGC-DAE CSR.

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TROMBAY SYMPOSIUM ON "DESALINATION AND WATER RE-USE"

Over the last decade, the demand for fresh water has increased significantly triggered by higher industrial growth rate and increasing public awareness to assert their right to have access to safe drinking water. During this period, the role of desalination got recognised, as evidenced by the establishment of 1 MGD Sea Water Reverse Osmosis plant at Ramanathapuram and the decision by the Tamilnadu Government to continue the operation of brackish / sea water desalination plants established earlier by the Technology Mission for meeting the demand of potable water in rural areas. Department of Atomic Energy (DAE), which is the pivot for future energy resource augmentation, is already in the process of demonstrating that water can be produced at an affordable cost alongside a nuclear power plant. The industrialists of Gujarat such as Reliance, Essar, GHCL, Nirma, etc. have put up sea water desalination plants of different types and capacities to ensure cost affective and reliable production of fresh water to meet their needs. However, it must be borne in mind that desalination may not be the only solution and its role has to be accessed in the overall context of integrated water resource management scheme. In the last few years, a lot of innovations have taken place in terms of materials and equipment design and operation of various schemes including rain water harvesting, water recovery & recycle, brackish water desalination, treatment of chemically contaminated water, and sea water desalination through membrane & thermal routes. A vast amount of operational experience has also been accumulated in the operation of these schemes under a variety of constraints ranging from government policies, user preferences, infrastructural restraints and logistical bottlenecks.

As the country is surging towards high growth rate phase, it is necessary to make available the requisite quantity of water of matching end-use quality at affordable rate. This calls for a review of the state-of-the-art of various components of the integrated water resource management schemes in Indian context from the point of view of design and implementation at the macro and micro levels and to identify suitable measures.

With this objective, the Board of Research in Nuclear Sciences (BRNS) in collaboration with the Indian Desalination Association (InDA) has planned a two-day International Symposium on "Desalination and Water Re-use" at Multipurpose Hall, Training School Hostel & Guest House, Anushaktinagar, during February 10-11, 2005. This forum is designed to provide an interphase wherein the experts of technologies, policy makers, fund providers, users and suppliers are brought together to deliberate on the various issues concerning the technical and executional aspects of the water management schemes. The meeting would enable to formulate necessary guidelines in Indian context to achieve the objective of providing affordable fresh water to improve the quality of life and accelerate the industrial growth. The International Journal of Nuclear Desalination has agreed to publish selected papers free of charge in a special issue.

The Symposium intends to cover a wide range of topics including:

- Indian Scenario in Overall Water Management: Present Status and Challenges
- Nuclear Desalination: Options & Challenges
- Thermal Desalination
- Membrane Desalination Water Recovery & Re-use Technologies
- Desalination and Water Conservation Schemes for Rural and Remote Areas
- Rain Water Harvesting
- Hybrid Desalination Systems
- R&D in Desalination & Water Re-use
- Economics and Financing Aspects in Water Management
- Vision of Desalination & Water Re-use

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DAE GOLDEN JUBILEE SCIENCE QUIZ FOR COLLEGE AND UNIVERSITY TEACHERS

As a part of DAE Golden Jubilee Year celebrations, DAE Golden Jubilee Science Quiz was organised for college/university teachers. The programme was conducted in three rounds. A website, viz, www.daequiz.org.in was developed specially for this event. The first round was conducted online on June 27, 2004 in two different sessions and on June 28, 2004 in one session of one hour each. Ten best participants from each of the four zones of the country and 10 best participants on an All India basis were selected for the second round. In addition, the first and second rounds of the Quiz were based on objective type questions related to Nuclear Science and Technology in general and to the programmes of DAE in particular.

The second round of the Quiz was held at Nabhkiya Urja Bhavan, Anushkatinagar, on July 31, 2004 where 50 winners of the first round participated. These participants represented almost all parts of the country and included teachers of disciplines varying from Medical Sciences to Social Sciences and from Basic Sciences to Engineering Sciences. On the basis of the second round, two winners from each zone were chosen for the third and final round. The final round of the Quiz was held on August 1, 2004 at the Auditorium of Nabhkiya Urja Bhavan, Anushaktinagar. It was conducted by

Quiz Master, Mr Siddharth Basu

the well known Quiz Master, Mr Siddharth Basu.

Final round questions were of wide range and included video clippings on activities related to the Department. There was an overwhelming response from the audience and the auditorium was overflowing well before the programme started. The audience enjoyed every moment of the event. The winners of the DAE Golden Jubilee Quiz event were:

Audience at the Quiz event

North Zone (Winners):

Prof H.M. Agrawal, G.B. Pant University of Agriculture and Technology, Pant Nagar, Uttranchal, and Prof S.P. Mishra, B.H.U., Varanasi, U.P.

West Zone (1st runner up):

Mr Kuwar Harshad Kumar S, Rajeev Gandhi Institute of Technology, Mumbai, and Dr B.S. Shanbhag, K.J. Somaiya College of Science and Commerce, Mumbai.

East Zone (2nd runner up):

Dr B.P. Singh, B.S.K. College, S.K.M. University, Dumka, Jharkhand, and Dr Sushant Konar, I.I.T. Kharagpur, West Bengal.

South Zone (3rd runner up):

Mr Mukund Narayan Bapat, Regional Institute of Education, Mysore, Karnataka, and Mr T.N. Sunder, National College, Tiruchirapalli, Tamil Nadu.

The 50 participants were introduced to the

Participants of South Zone

activities of the department by arranging visits to TIFR, BRIT and BARC.

The Convener of the Question Bank Team was Dr B.S. Tomar; Local arrangements were coordinated by Mr R.K. Sharma; Liaison work was the responsibility of Mr S.K. Malhotra. Dr R.B. Grover was the Chairman of Organising Committee and Dr V.K. Manchanda was the Convener of the programme.

BARC MOURNS DR RAJA RAMANNA'S DEMISE

Dr Raja Ramanna, former Chairman, Atomic Energy Commission (AEC), died at the age of 79 at Mumbai on September 24, 2004 at Bombay Hospital, Mumbai.

A condolence meeting was held at BARC on September 27, 2004 to pay homage to Dr Raja Ramanna. The condolence meeting was attended by Mr Prithvi Raj Chavan, Minister of State in the Prime Minister's Office, Dr R. Chidambaram, Scientific Adviser to the Prime Minister of India, Dr Anil Kakodkar, Chairman, Atomic Energy Commission, former Chairmen of AEC, Dr H.N. Sethna and Dr P.K. Iyengar, besides others. Several dignitaries offered their tributes and personal condolence messages.

On behalf of the Indian Atomic Energy family, Dr Srikumar Banerjee, Director, BARC, read out the condolence message conveying heartfelt condolences to Dr Ramanna's family and praying for peace to the departed soul and for strength to bear the irreparable loss to the bereaved family.

DR R. RAMANNA - A SHORT LIFE SKETCH

Dr Raja Ramanna, after getting his B.Sc. (Hons) Physics degree from the Christian College, Madras, in 1945, proceeded to work in the field of nuclear physics at the King's College, London, for his doctoral degree (1949). He was one of the earliest to join Dr Homi Bhabha, first at the Tata Institute of Fundamental Research, and then moving to the Atomic Energy Establishment, Trombay. During his long and distinguished career in DAE, he was connected with many major events. He was a young reactor physicist in the team under Dr Homi Bhabha, when India's first research reactor was commissioned on August 4, 1956. Again, he was present in his capacity as Chairman, AEC, when the Fast Breeder Test Reactor attained first criticality at Kalpakkam on the night of October 18, 1985. In between had come the amazing leadership and skilful direction he had provided as Director, BARC, for the Peaceful Nuclear Explosion project - which was brought to a successful culmination at Pokhran on May 18, 1974. Dr Ramanna moved to New Delhi in 1978 as the Scientific Adviser to the Minister for Defence. Before his return to DAE three years later, he introduced many significant changes in DRDO.

Dr Ramanna played a leading role in organising physics and reactor physics programmes at BARC, Trombay. It was on his initiative that the construction of the Variable Energy Cyclotron was taken up in Calcutta in 1970 and successfully completed as a pioneering indigenous effort. As the Chairman of the Programme Coordination and Implementation Committee for the Reactor Research Centre (later renamed Indira Gandhi Centre for Atomic Research), he took keen interest in its evolution as a world class institution for developing the fast reactor programme. Again, during the early eighties, he took the initiative for setting up a Centre for Advanced Technology at Indore, devoted to the development of advanced accelerators, lasers and other related technologies.

Even after his retirement, Dr Ramanna has been active in the public life of the country, playing his role as a scientist statesman. When J.R.D. Tata established the National Institute of Advanced Studies in Bangalore, Dr Ramanna was invited to be its first Director. During 1999, he was a Minister of State for Defence in the Central Government, and was till recently a Member of Parliament in the Rajya Sabha. He was decorated with Padma Vibhushan besides Padma Bhushan and Padma Shri in recognition of his contributions to India's atomic energy programme and defence research. Dr Ramanna was also a very good musician and pianoist.

Dr Ramanna's outstanding leadership and contributions to the Indian Atomic energy Programme and defence Research will be remembered for a long time and will provide inspiration to younger generation of scientists. Dr Ramanna has been a consistent campaigner for the important place to be accorded to nuclear power in energy planning. In matters concerning nuclear weapons and the non-proliferation treaty, he has clearly formulated views that have moulded the national policy.

Dr Raja Ramanna is the only AEC Chairman to date, to have written his autobiography, *Years of Pilgrimage*. He wrote this soon after his retirement, and it is a valuable source of historical information, insightful observations and interesting anecdotes.

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

श्री एस. यू. सालुंके, पश्चंत्य प्रौद्योगिकी विकास प्रभाग, भाभा परमाणु अनुसंधान केंद्र को जुलाई २२-२३, २००४ के दौरान अणुशक्तिनगर, मुम्बई, में आयोजित "इमर्जिंग ट्रंडस इन सेप्रेशन साइन्स एन्ड टेक्नोलोजी" (SESTEC-२००४) की डीएई बीआरएनएस की थीम सभा में " इन-सीटु इलेक्ट्रालिटिक रिडक्शन ऑफ यूरेनियम यूज़िंग इलेक्ट्रोपल्स कॉलम" नामक शोध-पत्र की प्रस्तुति के लिए श्रेष्ठ पोस्टर प्रस्तुति पुरस्कार प्रदान किया गया। इस पुरस्कार में उन्होंने एक हज़ार रुपये की नकद राशि प्राप्त की।

Mr S.U. Salunke, Back End Technology Development Division, BARC, has been given the best poster presentation award for his paper titled, "In-situ electrolytic reduction of uranium using electropulse column", presented at the DAE-BRNS Theme meeting on the "Emerging Trends in Separation Science and Technology, SESTEC-2004," held during July 22 -23, 2004 at Training School Hostel, Anushaktinagar, Mumbai. He received a cash award of Rs 1000/-.

श्री एस. करमाकर, सिंक्रोट्रॉन विकिरण अनुभाग, भाभा परमाणु अनुसंधान केंद्र को सितंबर २-३, २००४ के दौरान एसआइएनपी (SINP) में इन्डियन फिज़िकल सोसाइटी (IPS) के द्वारा आयोजित वर्ष २००४ के लिए यंग फिज़िसिस्ट सम्मेलन में "सम रीसेंट हाइ प्रशर इन्वेस्टिगेशन आफ कार्बन नेनोट्यूब्स एन्ड अदर नोवल मेटीरियल्स" नामक शोध-पत्र की प्रस्तुति के लिए तृतीय श्रेष्ठ प्रस्तुति पुरस्कार से सम्मानित किया गया।

Mr S. Karmakar, Synchrotron Radiation Section, BARC, won the third best presentation award for his paper titled, "Some recent high pressure investigation of carbon nanotubes and other novel materials", presented at the Colloquium of Young Physicists (YPC) for the year 2004, organised by Indian Physical Society (IPS) and held at SINP during September 2-3, 2004.

श्री पी.पी. नानेकर, परमाणु ईंधन प्रभाग, भाभा परमाणु अनुसंधान केंद्र को नाभिकीय पॉवर प्लांट्स के इन-सर्विस निरीक्षण तथा टेस्टिंग तकनीक के विकास के क्षेत्र में विशिष्ठ योगदान के लिए वर्ष २००४ के नॉन-डेस्ट्रक्टिव टेस्टिंग (NDT) अचीवमेन्ट पुरस्कार से सम्मानित किया गया। एक प्रशस्ति-पत्र, स्मृति-पत्र तथा नकद राशि का यह पुरस्कार इन्हें इन्डियन सोसाइटी फॉर नॉन-डेस्ट्रक्टिव टेस्टिंग की मुम्बई शाखा के द्वारा प्रदान किया गया।

Mr P.P. Nanekar, Atomic Fuels Division, BARC, has been conferred with the 'NDT Achievement Award' in the field of Research & Development for the year 2004 for his contributions towards the development of Non-Destructive Testing (NDT) techniques for in-service inspection of nuclear power plants. The award which carries a citation, a plaque and cash prize, was given by the Indian Society for Non-Destructive Testing (ISNT) - Mumbai Chapter.

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