बीएआरसी न्यूज़लैटर
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DEVELOPMENT OF ELECTROLYTE CATHODE GLOW DISCHARGE ATOMIC EMISSION SPECTROSCOPY FOR THE ANALYSIS OF ELEMENTS AT TRACE AND ULTRA TRACE LEVELS

In the Forthcoming Issue

EC-SMPS hybrid version for nuclear instrumentation and control systems

A modular power supply product, developed in-house, for use in nuclear reactor protection and control systems, has been described in this article. Module-based power supplies are more beneficial and ultimately result in lower maintenance costs. This product, in it's third phase of development called ECPS-III or EC-SMPS Hybrid version, is being currently used in the reactor control and instrumentation system, of a PHWR-700MW of NPCIL

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MOBILE-BASED TELE-ECG FOR RURAL HEALTH CARE

Vineet Sinha, Sandeep Bharade, T.S. Ananthakrishnan, G.D. Jindal, P.K. Mukhopadhyay, R.K.Patil, G.P.Srivastava and A.D. Kamble
Electronics Division

and

Bhagyashree Sarode
Senior Research Fellow. BRNS Project

and

P.N. Jangale
Medical Division

and

Alaka D. Deshpande
Medicine Department, Grant Medical College & J.J. Hospital, Mumbai

Telemedicine enables a physician or specialist at one site to deliver health care, diagnose patients, give intra-operative assistance, provide therapy or consult with another physician or paramedical personnel at a remote site. Though, there is no substitute for face-to-face consultation between a clinician and a patient, there are medical cases that can be managed more efficiently, by adopting telemedicine. The concept of Telemedicine was introduced more than 30 years ago through the use of telephone, facsimile machine and slow-scan images. In this approach, the biomedical signal from the patient is transmitted using landlines such as Public Switched Telephony Network (PSTN) or the Integrated Services Digital Network (ISDN). However, these telemedicine applications are limited to communication between fixed locations equipped with conventional handsets. Therefore, there is a trend to develop wireless telemedicine built around satellite communication[1,2] . It requires expensive equipment, dedicated links and skilled manpower. Similarly wireless Local Area Networks (LANs) and short-range Radio Frequency (RF) transceivers, as used in hospitals, can't be used for timely ambulatory applications. To allow worldwide communication, therefore, mobile cellular network like Global System for Mobile (GSM) or better Third Generation network (3G) is needed[3].

Through this, a patient from rural area can be provided with a regular routine check via a mobile phone, without commuting to a hospital. Similarly routine inspections and monitoring can be carried out, while the patient is at home, traveling or at work. This also decreases the load on resources of the hospital, which can now cater to more number of demanding patients.

Vast area with varied topography, more than a billion population, high population per physician (around 2000) and majority of the population (more than 70%) living in isolated villages, support and justify the need for Telemedicine in our country. Though Telemedicine benefits all branches of medicine and surgery, cardiology needs special attention due to its higher incidence rate as well as the risk associated with heart diseases. Many a times, delay in transporting the patient from a village to a nearest city may prove fatal.

In view of the above and the fact that mobile phones are becoming more and more affordable, the Electronics Division has developed a hand-held battery-operated Tele-ECG with mobile connectivity to an expert. The details of this development follow.

What is ECG

Electrocardiography (ECG) is the graphical record of electrical potentials generated by the heart muscle. The history of Electrocardiography folds back to 1889, when Willem Einthoven gave evidence for the first time, of electricity generated by heart in both humans and animals in 1889, during the 1^{st} International Congress of Physiologists in Bale. He obtained the cardio-electrical signals from both the arms and the left leg, with the help of saline solution tubs wired to the input of a String Galvanometer as shown in Fig.1. He named this signal as ELECTROCARDIOGRAM[4,5].

Electrocardiography got an impetus in 1934, with the invention of a special-purpose amplifier called differential amplifier by BNC Matthews[6]. Interestingly, this invention originated from Life Sciences. Matthews modified the configuration of push-pull amplifier (originated in radio engineering as a means for increasing the output power) by carefully matching the tubes for equal amplification and assuring rejection of common mode signals. This development changed the face of electrocardiography; surface electrodes replaced saline tubs and differential amplifier and a strip chart recorder replaced the string galvanometer.

ECG is generally recorded in 12 different configurations by electrodes placed on the body surface, each configuration is called a 'Lead'. These are named as I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5 and V6, popularly known as Einthoven's Leads. Lead I is the difference between signals appearing at left arm and right arm; Lead II is the difference between signals appearing on left leg and right arm; Lead III is the difference between signals appearing at left leg and left arm; aVR is the signal at right arm measured with respect to average of signals at left leg and left arm; aVL is signal at left arm measured with respect to average of signals at left leg and right arm and aVF is signal at left leg measured with respect to average of signals at left arm and right arm. Similarly

Fig. 1: Shows the beginning of the recording of an electrocardiogram. Saline tanks are used as electrodes as shown in (a); the ECG obtained with the help of string Galvanometer is shown in (b) (*courtesy Einthoven W. 1901).*

Vi (i =1 to 6) is measured as the signal appearing at i^{th} chest position with respect to average of signals at right arm, left arm and left leg. This average signal is very close to zero and is often referred to as augmented ground or the reference. Leads I, II and III are also called standard leads or bipolar leads, whereas the other leads namely aVR, aVL, aVF and chest leads V1

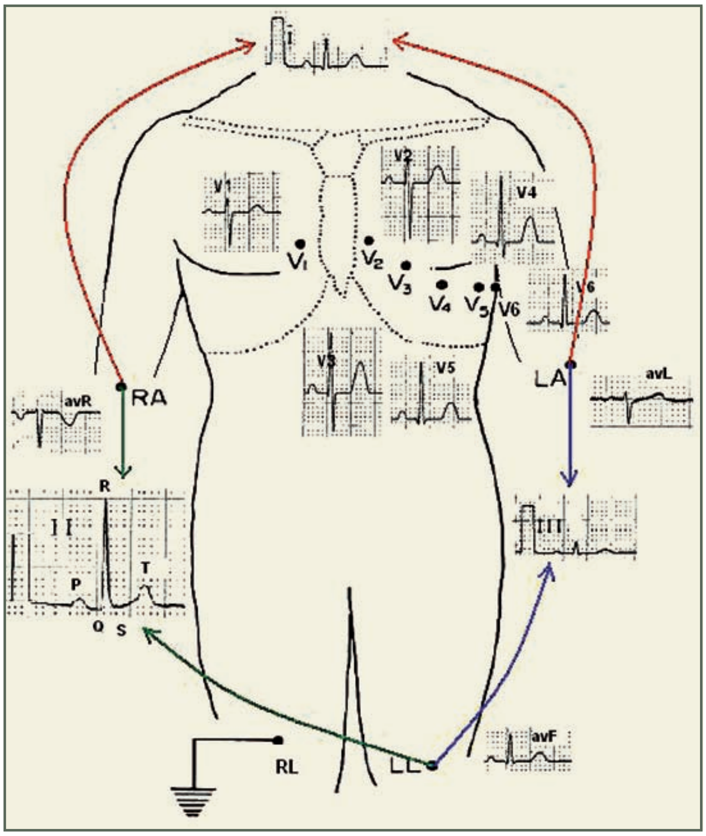

Fig. 2: shows anatomical placement of the electrodes and the ECG signal recorded in various configurations. The difference signals I; II and III are recorded between left arm and right arm; left leg and right arm and left leg and left arm respectively as shown in the figure.

to V6 are called unipolar leads. Generally any abnormality appearing in a particular lead is corroborated by one or more remaining leads. Fig. 2 shows the placement of electrodes and type of signal recorded in various leads.

Various deflections in the waveform are labeled as P,Q,R,S and T points, as shown in Lead II ECG in Fig. 2. P represents the depolarization of right and left atria. Q, R and S as a complex represent onset of depolarization of right and left ventricles. T represents the repolarization of ventricles. Sometimes there are additional points on the waveform such as U-wave, early and late potentials etc. The segment following T wave, till the onset of the next cardiac cycle, is commonly referred to as iso-electric segment and is used as reference for measurement of amplitude of different waves. Though P and T waves are more or less similar in all the leads except aVR, the morphology of QRS varies significantly from lead to lead as evident from the figure.

Heart diseases are easily detected from the ECG. Some cardiac disorders like thickening of the ventricle, bundle branch block produce electrical axis deviation, which can be detected from bipolar leads. Decreased voltages in the ECG represent diminished muscle mass probably subsequent to series of old myocardial infarctions. Decreased voltage can also be caused by conditions surrounding the heart such as fluid in the pericardium, pleural effusion and pulmonary emphysema. Cardiac hypertrophy or dilation and purkinje system blocks can cause prolonged QRS complex. Highly distorted (bizarre) QRS complexes are noted in destruction of cardiac muscle in the ventricles with replacement by scar tissue and local blocks in the conduction of impulses by Purkinje system. Ischemia and myocardial infarction are associated with significant differences between the levels of ST segment and reference segment. An old recovered infarction is detected by the presence of significant Q wave in the bipolar leads.

Considering the large number of applications of ECG signal in the diagnosis of several diseases and its ability in monitoring critically sick patients, large variety of ECG machines are produced and marketed, by several national as well as international companies. The models have variation in respect of the number of channels, recording options and interpreting provision as follows.

Diagnostic ECG

These are ECG machines having 1, 3 or 12 channels of input amplifiers for recording ECG. Twelve-channel machine records all the 12 leads simultaneously, whereas one-channel machine records all the 12 leads one by one and three-channel machine records 12 leads in 4 steps of three leads each. All these models have recording devices including thermal array recorder or an inkjet printer assisted by a micro-controller. Interpretation of ECG is normally available with imported machines, which is presently not available in indigenous ones.

Fig. 3 shows simplified block diagram of a one-channel ECG machine. The electrical potentials from the body are sensed with the help of metal electrodes labeled as RA, LA LL, V1, V2, V3, V4, V5 and V6. These signals are connected to pre-amplifier through amplifier protection and lead selector circuits, which configure these inputs into two differential outputs. The amplifier protection circuit is required to protect the amplifier IC from large voltages coming from the patient due to application of defibrillator or surgical diathermy. The calibration signal is also connected at the input of the pre-amplifier. The pre-amplifier output is used, to generate appropriate signal to be connected to the right leg of the subject, with the help of right leg drive circuit. This is specifically required to remove the mains interference in the output ECG signal. The pre-amplifier output is also connected to a base line restoration circuit in feedback loop. This helps to restore the base line quickly and nullify the change of DC potential at the electrode, when the lead is changed from the lead selector. The output of the pre-amplifier is connected to the isolation circuit as shown in the figure. The voltage supply to all the above blocks, on the left side of the dotted ine in the

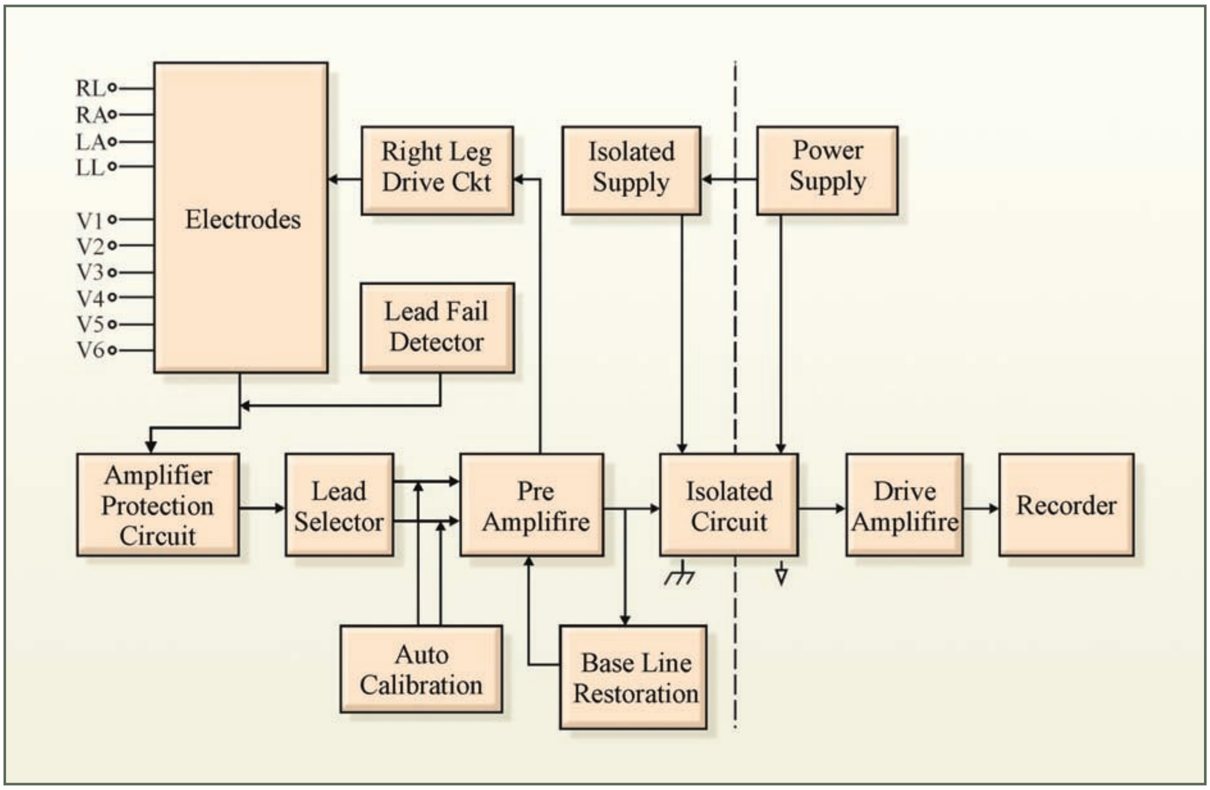

Fig. 3: Shows block diagram of a basic single channel ECG machine. The dotted line separates the circuits operated from isolated and mains power supply for patient protection

figure, is powered from isolated power supply, which has no electrical continuity with the earthing of mains power supply. This insulation between the commons of these two power supplies gives full protection to the patient against any accidental electrical hazard and keeps the leakage current less than 50 uA, well below the limits provided by international safety standards (IEC 60601-1-1:2000).

The isolation circuit is powered from isolated power supply as well as conventional power supply to input and output segments in this block respectively. These segments have no electrical connection between them. The input signal is transferred to the output section either through high insulation transformer or optically. The output signal from isolation circuit is amplified further by the drive amplifier and finally connected to a recorder. These blocks are powered by the conventional power supply.

A micro-controller and a printer replace the recorder in the latest version equipment, as the use of personal computers and printers has become common. Also the computing power within micro-controller is made use of, in producing the machine-generated interpretation on the electrocardiogram.

More recent systems have 3 channels of pre-amplifiers and following circuits. In this case, the lead selector selects leads in four steps. In Step 1, Leads I, II and III are amplified. In Step 2, Leads aVR, aVL and aVF are amplified. Similarly V1, V2 & V3 and V4, V5 and V6 are amplified in steps 3 & 4 respectively. A compact print out of all the leads is made available on A4 size paper. The latest trend in electro-cardiography, is to record all the 12 leads simultaneously. In this case, the Lead selector circuit is replaced by simple Wilson's network. Additional 11-channels of pre-amplifier and following circuit are incorporated. The outputs of 12 drive amplifiers are fed to ADC inputs of the micro-controller, which acquires and prints the ECG signal from all the 12 leads simultaneously.

ECG Monitors

For monitoring applications, some of the stringent specifications of ECG amplifiers are relaxed. For instance, the lower 3 dB point can be relaxed to 0.5 Hz in place of 0.05 Hz and the upper 3 dB to 70 Hz in place of 200 Hz. This range is considered adequate for monitoring the status of the patient during surgery and in Intensive Care Units. In this application, the ECG is continuously acquired from the subject in one or more leads and displayed in real time on the CRT Monitor. Alarm facility is provided for undue deviation in the heart rate or change in the status of arrhythmia. Also a 24-hour display is provided to the clinician, who can see on the patient's status, at a glance.

Ambulatory ECG (Holter ECG)

This application has different requirements than the diagnostic ECG or ECG monitor. In the first place, it has to be battery-operated and ultra-miniaturized as it is to be carried by the patient on his body for 24 hours, while he is performing his daily routine. The unit is supposed to acquire ECG signal from five leads (I, II, III, V2 & V5) and store them in memory. There is also a provision to highlight part of ECG, as and when the patient feels discomfort. At the end of 24 hours, the patient reports to his doctor, who downloads all the data onto his workstation for further analysis. This kind of recording has two main advantages:

1) Detection of angina pain in Ischemic Heart Disease (IHD) patients, which is normally missed in resting ECG and
2) Documentation of the type and severity of arrhythmias in patients with coronary artery disease, who have already suffered myocardial infarction in the past[7,8].

Tele-ECG

The concept of Tele-ECG was introduced more than

30 years ago, through the use of telephone lines. However, this application is limited to communication between fixed locations equipped with conventional handsets. The latest trend is to develop wireless telemedicine built around satellite communication[1,2], which requires expensive equipment, dedicated links and skilled manpower. Similarly wireless Local Area Networks (LANs) and short-range Radio Frequency (RF) transceivers, as used in hospitals, can't be utilized for rural applications. Therefore, for worldwide communication and rural health care, mobile cellular network like Global System for Mobile or better a Third Generation network is needed[3].

Mobile-Based Tele-ECG Developed at BARC

Tele-ECG system developed at the Electronics Division, BARC, comprises a hand-held ECG (HECG) unit which is connected via bluetooth to a mobile. The HECG acquires and processes the ECG signal of the patient in all the 12 leads in serial order and transmits the same with the help of a mobile tele-processor. At the operator's end, we have the cellular phone (GPRS activated) or a laptop / desktop. The acquisition unit can be activated, operated and controlled by either of them. All the functions, like changing of lead, viewing of acquired signal, storing of data, transmission of data, saving of a person's file, etc., can be performed from the mobile / laptop at the operator's end. Every patient's data file is stored as a bit map file (bmp/png) in the HECG unit as well as on the mobile / laptop. There is provision for generating automatic unconfirmed report of the patient on the mobile / laptop. If necessary, the operator can send the ECG file of the patient to an expert through GPRS network and seek his opinion for further management.

Fig. 4 shows the details of the HECG unit. The ECG signal from the patient is sensed with the help of surface electrodes labeled as RA, LA, LL, V1, V2, V3, V4, V5 and V6. The right leg is connected to the reference of HECG unit. These signals are connected to input protection circuits and buffers. This is particularly required to protect the sensitive amplifier from the transients coming from the ambience. The buffered signals are passed through a Wilson's network for deriving differential signals for various leads, which are connected to two 12:1 multiplexers. The output of the multiplexer is controlled through the micro-controller, to output appropriate signals for different leads as follows:

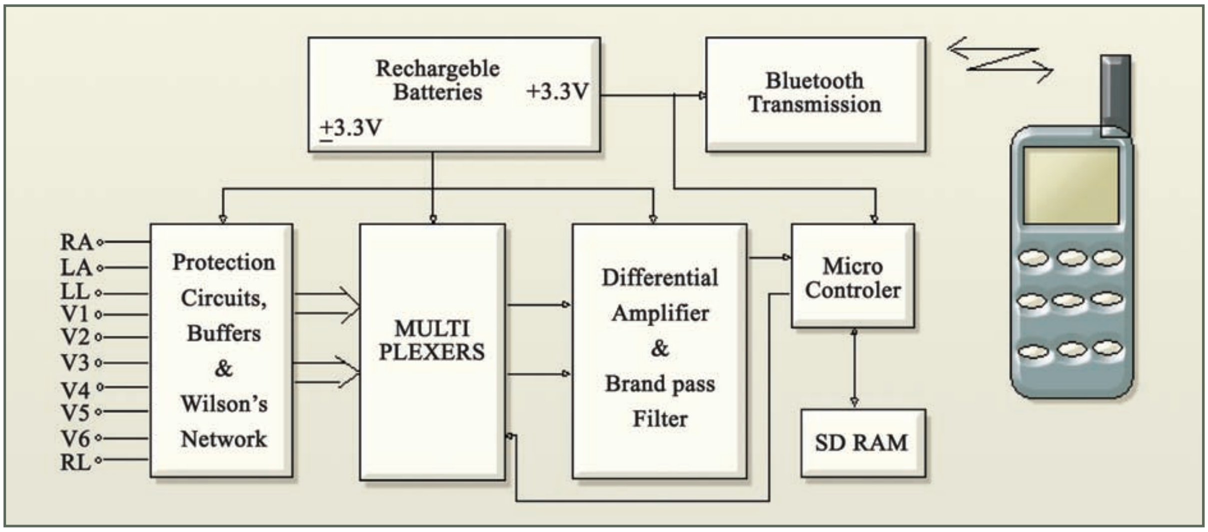

Fig. 4: Shows the details of the hand-held ECG unit. The unit is controlled and operated from the mobile phone through a Bluetooth link.

Lead	O/P of MUX-1	O/P of MUX-2
I	LA	RA
II	LL	RA
III	LL	LA
aVR	RA	(LL+LA)/2
aVL	LA	(LL+RA)/2
aVF	LL	(LA + RA)/2
V1	V1	(LA+RA+LL)/3
V2	V2	(LA+RA+LL)/3
V3	V3	(LA+RA+LL)/3
V4	V4	(LA+RA+LL)/3
V5	V5	(LA+RA+LL)/3
V6	V6	(LA+RA+LL)/3

The outputs from the multiplexers are fed as input to a differential amplifier followed with a band-pass filter. The gain is fixed as 1000 for first 6 leads and 500 for the later ones. The output of the filter is connected to ADC input of the micro-controller (based on ARM 7 micro-processor). Micro-controller also sends an output signal to multiplexers for selecting a particular lead. An SD-card is also interfaced to micro-controller for providing large storage capacity to the HECG unit. Also a blue tooth controller is interfaced to the micro-controller for transceiving the data, commands etc. from the cellular phone. The final specifications of the Bio-unit are as follows and meet the safety standards as prescribed by IEC 60601-1-1:2000.

Input Impedance	:	> 10 Mega Ohms
Gain	:	1000/500 (selectable)
Frequency Response	:	0.05 Hz to 150 Hz (3dB)
Common Mode Rejection Ratio	:	> 80dB
Patient Isolation	:	> 10 Mega ohms

Fig. 5 shows the flowchart of the embedded software, which is developed in 'C'. The system, on start, initializes the peripherals. The main application is an indefinite loop, which is entered into, after initialization of the timer. The timer handler is invoked every 2.5 millisecond. The handler also reads ADC data and transfers it via the bluetooth port. Also, it looks for commands via the bluetooth port, which may come from a mobile phone or laptop / desktop. The commands will correspond to change of lead (next lead) or start / stop. This will be executed as part of the handler. The initial data is acquired in Calibration mode. This signal also indicates the battery charge level and has been used to flag off battery low condition.

The application software on the mobile, first detects the Bluetooth device (Bio-unit) using the Service Discovery Protocol (SDP). Once the device is detected, the application prompts for the subject's name and starts receiving the CAL signal. This is developed using Java (J2ME). The commands are issued using the key pad '1' for change of lead (lead number is increased by one by the embedded system software and switches back to calibration mode when lead 12 is being acquired). The data received is saved in a buffer (1000 samples per lead, acquired for two and a half seconds). The application software in the mobile gives the facility for converting data into a PNG file and transfer the same via MMS (Multimedia Message Service) to any mobile of choice or it can also be emailed.

An application, which will lead to a diagnosis of the ECG data received, is under development. The application uses an algorithm developed by IIT Roorkee for detection of QRS complex. The information derived from the QRS complex will be used, to provide a machine-generated unconfirmed diagnosis. At present, this facility is being developed as a desktop / laptop based application.

Fig. 6 (a) shows the photograph of the Bio-unit, developed at BARC, with printed circuit board,

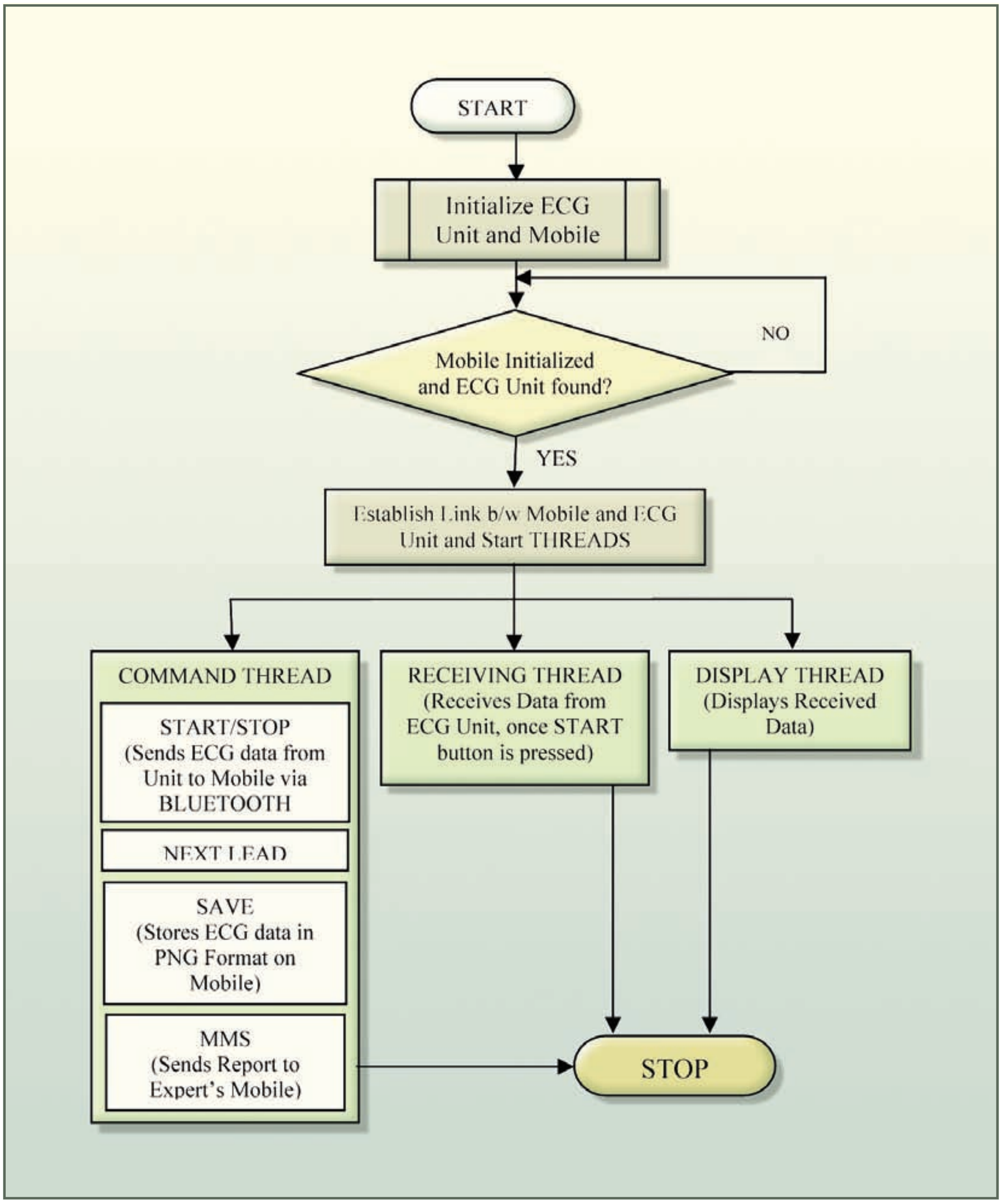

Fig. 5: Shows the operative scheme of the embedded software in the Tele-ECG unit and mobile application.

rechargeable battery and connecting leads. The box dimensions are less than 4.5 x 3.5 square inches and can be called handheld in true sense. The ECG acquired from a subject in Lead II and displayed in the mobile at the operator's end, is shown in Fig. 6 (b). The ECG received at the expert's mobile is shown in Fig. 6 (c). As can be seen there is no significant loss of information from Fig. 6 (b) to Fig. 6 (c). This Tele-ECG system has been tested in the laboratory on volunteers and is ready to be sent for field trials.

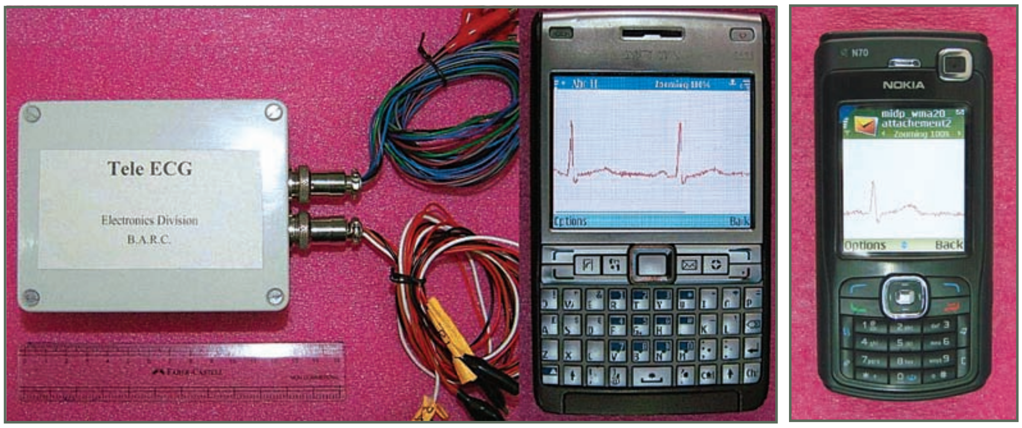

Fig. 6 (a): Photograph of the Tele ECG unit developed at the Electronics Division BARC. The controlling mobile is shown on the side.
Fig. 6 (b): Shows the mobile at the expert's end. No significant loss is seen in the received ECG waveform

The Tele-ECG system, reported here, is of considerable importance for developing countries, where more than 70% of the population inhabits rural areas and has meager access to medical facilities. This large section can now be provided state-of-the-art medical care with such Tele-systems.

Acknowledgements

The authors are thankful to Dr. S. Banerjee, Director, BARC, for inspiring us to undertake this development work and to Dr. V. Karira, Head, Medical Division, BARC for providing useful suggestions during this development. The authors also acknowledge the help provided by Ms. Gouri V. Sawant during testing of the unit and data acquisition.

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BARC NEWSLETTER

DEVELOPMENT OF ELECTROLYTE CATHODE GLOW DISCHARGE ATOMIC EMISSION SPECTROSCOPY FOR THE ANALYSIS OF ELEMENTS AT TRACE AND ULTRA TRACE LEVELS

CCCM, Hyderabad

An analytical technique - **Electrolyte cathode glow discharge Atomic emission spectrometer** – has been developed, for the sensitive determination of elemental constitutents, especially metals in a sample solution with good sensitivities of a few parts per billion and standardized for routine measurements. Studies are going on to understand the mechanistic processes involved in the emission, matrix effects on the analyte emission etc., to further improve the sensitivities of determinations. The technique particularly lends itself to analysis of radioactive samples when the cell is placed inside a glove box and the emitted radiation is transmitted to the spectrometer using an optical cable. Efforts are being made to suitably modify this technique.

ELectrolyte CAthode Discharge (ELCAD)

The Electrolyte cathode glow discharge or Glow Discharge Electrolysis (GDE).is a unique electrochemical technique, in which the sample solution is made to act as the cathode. Discharge is initiated between the metal anode and the liquid cathode by applying high voltage. ELectrolyte-as-CAthode glow Discharge Atomic Emission Spectrometry ELCAD-AES has become a viable analytical technique for on-line monitoring of the concentration of metals in solution, though no commercial instrument is available to date.

Gubkin [1] first demonstrated the possibility of the electrolysis of aqueous solution of metallic salts, using glow discharge in 1887 and since then, efforts have been made to develop [2] and mechanistic [3,4] studies of (GDE). The development and fundamental characteristics of ELCAD were investigated by a number of workers [5,6]. Cserfalvi and Mezei [5] developed the ELCAD-AES for continuous analysis of water. Acidified milk has also been analysed using this technique [7].

In our current study we have obtained a detection limit of about 15 ppb for mercury by liquid aspiration which is very superior to the detection limit of about 500 – 750 ppb normally obtainable by Inductively Coupled plasma Atomic Emission Spectrometry (ICP-AES). Similar detection limits are obtained for other elements too. Thus ELCAD-AES appears to be a promising low-cost technique for multi-element analysis.

Instrumental

A DC power supply capable of 0-1000V, 120 mA was used in constant voltage mode. A peristaltic pump was used to pump the sample solution at a constant flow rate ranging from 0.25 to 3.0 ml / min. The discharge spectrum was recorded using a spectrometer which consisted of a 1.0 m Czerny – Turner grating (3600 lines / mm) monochromator. The control of the monochromator and data acquisition were performed with the MSDOS-based software of Jobin-Yvon (JY-38, Jobin-Yvon, France).

ELCAD cell

The ELCAD cell consists of two parts, a tungsten pin anode maintained at a potential of between 700 – 1000 V, while the sample solution pumped through a glass capillary acts as the cathode, which was maintained at ground potential. The body of the cell anode and the housing for the glass capillary were constructed with polytetraflouro ethylene (PTFE).

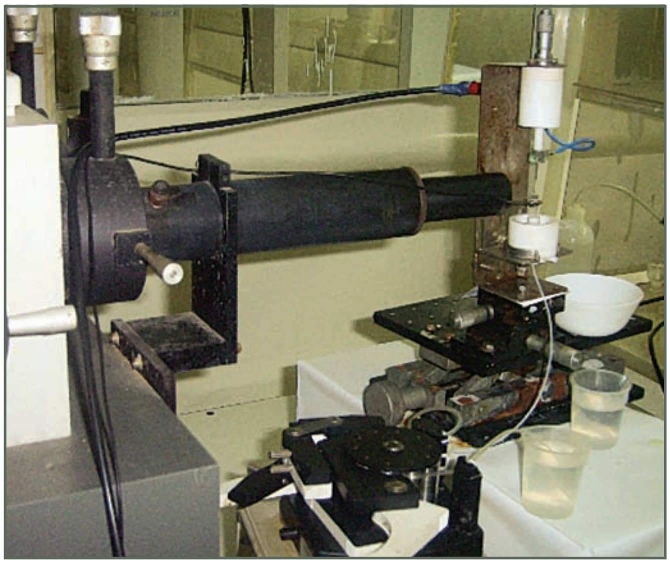

Fig.1. ELCAD-AES showing the plasma cell consisting of the moveable anode pin and the glass capillary with the sample solution cathode. The sample solution is pumped using a peristaltic pump. The cell can be moved in X,Y and Z directions precisely using micrometers to focus the discharge plasma onto the spectrometer

A micrometer- based arrangement has been fabricated, to precisely move the pin anode and vary the inter-electrode distance. A platform was fabricated using 3 micrometers to mount the discharge cell so that emission from the discharge plasma could be moved in x, y and z directions and positioned accurately onto the slit of the emission spectrometer. A metal ring is placed about 2 mm below the top of the glass capillary and is connected to the ground of the power supply. The solution overflows continuously forming a contact between the sample solution and the metal ring. The over-flowing sample is collected in the PTFE reservoir from which it is continuously drained away. About 750 V is applied and the distance between the anode and the solution acting as the cathode is reduced to near touching when discharge is generated. Once the discharge is struck the distance between the electrodes may be varied using the micrometer to desired extent. The ELCAD cell is shown in Fig. 1. The discharge plasma when the cell is in operation, may be seen in Fig. 2.

Plasma Instability

The stability of the plasma depends on various factors – the constancy of the voltage applied, the distance between the electrodes and the flow of the electrolyte solution etc. Thus a stable discharge requires that the inter-electrode distance remains constant. When the sample solution is pumped through a normal capillary, this becomes

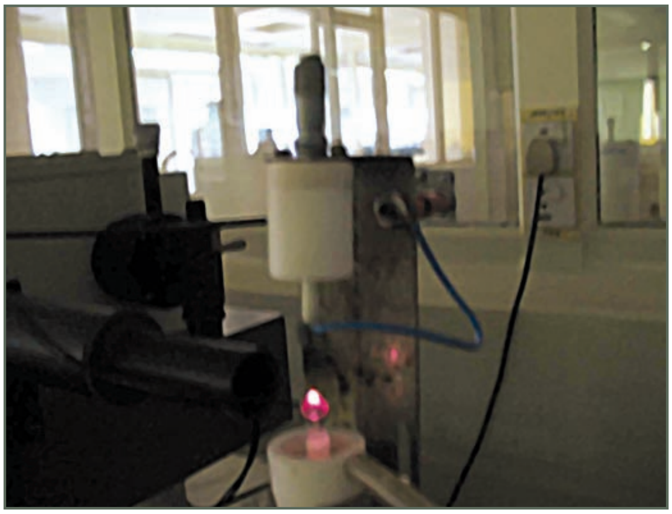

Fig.2. The ELCAD cell in operation with atmospheric plasma ignited; The discharge plasma is seen as a glow between the anode and the solution cathode.

possible only when the flow rate is maintained at a fairly high value, 5 to 10 ml / min as is usually seen. However, higher flow rates lead to not only more sample consumption but increased hydrogen production which again affects the discharge. A novel method has been devised by us, to maintain the inter-electrode distance constant at low flow rates. A thick walled capillary (4.5 mm O.D., 1.0 mm ID) was taken and a V-shaped groove with a width equal to the diameter of the orifice was cut from the centre to the edge, as shown in Fig. 3. The created channel allows the liquid to continuously flow along as it emerges from the orifice without rising up; the distance between the anode and the liquid surface remains essentially constant even at low flow rates. With such an arrangement, low flow rates of 1.25 to 2.5 ml / min, unlike 5 to 10 ml / min have been found to be adequate to maintain a flicker-free plasma. The lower flow rates lead to lesser sample consumption as well as lower hydrogen production that leads to plasma instability.

Optimization of the emission signal

The conditions for optimum emission such as discharge current, inter-electrode distance, pH of the sample solution, flow rate of the sample solution and the acid counter ion were obtained using Cu (327.4 nm) as analyte.

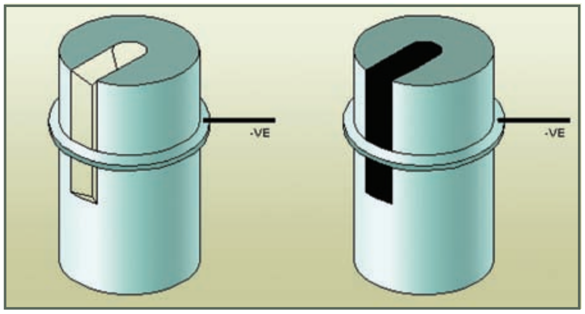

Fig.3. V-shaped groove in the glass capillary to obtain constant inter-electrode distance at a low flow rate of sample solution.

A discharge current of 70 - 80 mA has been found to be optimum. The signal due to the analyte remains stable over a narrow pH range of 1 – 2.5 and decreases rapidly when the pH is increased above pH 2.5 and no visible signal is observed above a pH of 3.0. Below a pH of 0.75, the plasma tends to become unstable along with decreasing signal. The order of increasing signal intensity when different acids were used was – HF < H_2SO_4 < HNO_3 < HCl. However, in our subsequent experiments nitric acid was used for the preparation of the electrolyte solution for convenience.

The following conditions were found to yield optimum signal:

Disharge current – 70 mA
Inter-electrode gap – 3 – 3.5 mm
pH – 1.0
Acid counter ion – nitrate.

Analytical performance

Using optimized parameters, calibration plots were built for Ca, Cu and Hg in the concentration range of 50 ppb to 10 ppm. These are shown in Fig. 4.

Table 1 presents the detection limits obtained for some elements. As may be seen from the table, the technique shows excellent sensitivities.

Table 1: Detection limits of a few elements

Element	Wave length (nm)	Our detection limits # (ppb)	Literature* (ppb)
Ca	422.7	16	20
Cu	327.4	12	30
Cd	228.8	4	10
Pb	405.8	48	80
Hg	253.7	15	---

* Michael R. Webb et al., *JAAS*, 2007, 22, 766-774.
#: 3σ on background

Conclusions

Electrolyte cathode discharge, an atmospheric glow discharge when coupled to an atomic emission

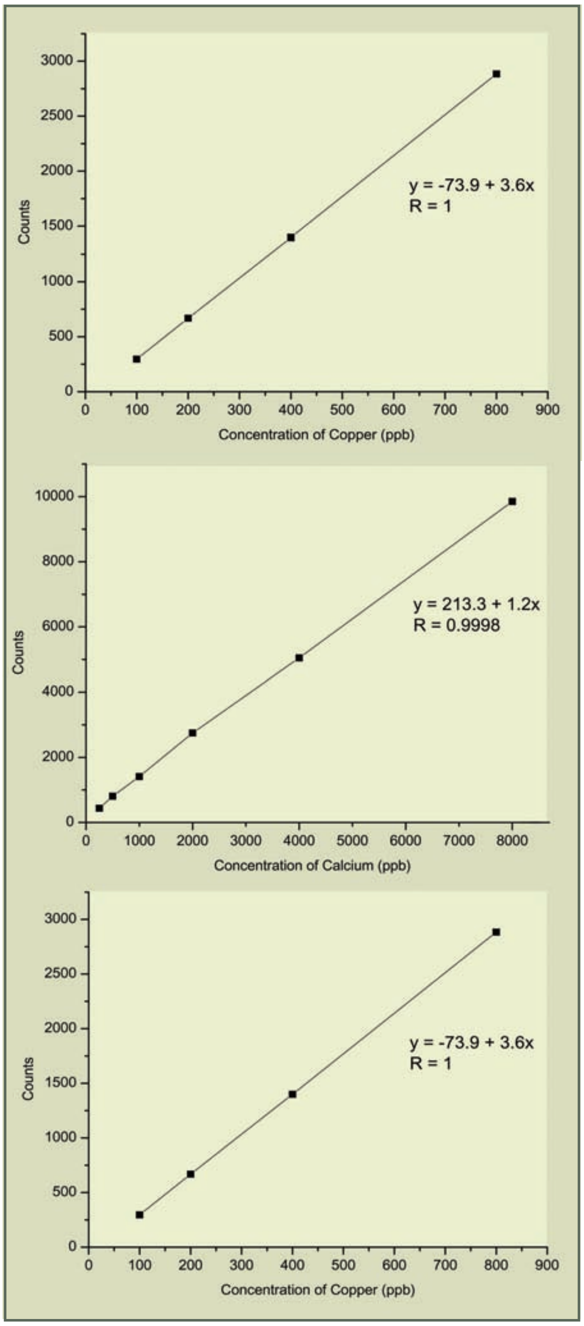

Fig. 4: Calibration plots for some metal ions, Ca, Cu and Hg

spectrometer offers a highly sensitive analytical technique, for the determination of metals in sample solutions, with detection limits in the range of a few tens of parts per billion. In comparison to the more expensive techniques such as ICP-MS and ICP-AES, it offers several advantages, though there is a sensitivity trade-off to some extent.

More investigations with respect to complex matrices are however needed, before the method can be completely accepted for routine sample analysis.

Because of the simplicity of the source, it especially lends itself to remote operation, when placed inside a Glovebox. An optical cable can transmit the emission to the atomic emission spectrometer placed outside the box, thus enabling the instrument to analyze radioactive samples with ease. Experiments are being planned in this direction.

ELCAD-Advantages

- Inexpensive
- Low power ~ 75 w
- Atmospheric plasma, no vacuum requirements
- No Ar gas consumption
- Spectra – less line-rich
- Detection limits reasonable - 10s of ppbs (Table 1).

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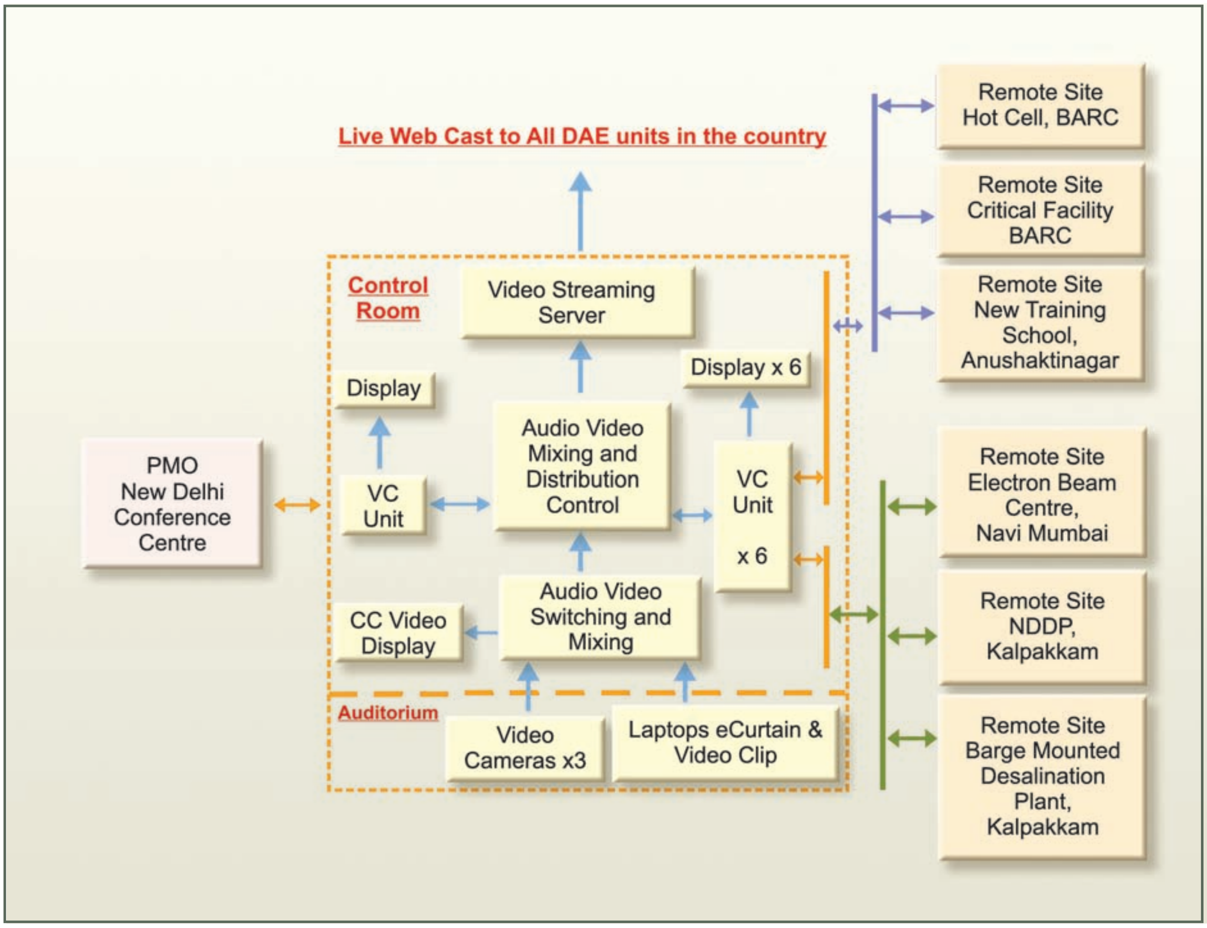
REMOTE INAUGURATION OF NEW BARC FACILITIES: A REPORT

Computer Division, BARC

Six new facilities of BARC were inaugurated remotely by the Honorable Prime Minister of India on Founder's Day. The central electronic control of the inauguration function was located in the Central Complex Auditorium of BARC, where Chairman AEC, Director BARC and many other dignitaries and scientists of BARC were present.

The Director BARC initiated the inauguration event from the CC Auditorium. The live audio-video web cast of this event was done at all other places in BARC and at outstation DAE and BARC units, at about 15 locations in the country.

The Computer Division BARC, designed and deployed the complex multimedia communication system,consisting of multi-site Video Conferencing (VC) system, live video web casting system and



Central Control Station at BARC

associated audio-video peripherals. Schematic of the multisite set up is shown in the diagram.

The function began with a welcome to the Honorable Prime Minister followed by distribution of the Life Time Achievement Awards by the Honorable Prime Minister.

The inauguration of remote plants was carried out by unveiling of an electronic (soft) curtain. A-V system at PMO consisted of a VC unit and a Tablet PC with touch screen control, which was used by PM to unveil the electronic curtain. The VC unit enabled the audio-video interactions among dignitaries present in CC, BARC, Mumbai, remote site staff and PM from New Delhi. The six remote sites were Hot Cell Facility and Critical Facility at BARC, Mumbai, New Training School, Anushaktinagar, Mumbai, Electron Beam Centre, Navi Mumbai, NDDP, Kalpakkam and Barge Mounted Desalination Plant, Kalpakkam.

Each site inauguration involved, a brief introduction of a site by Director BARC, an Audio-Video clip play back from CC and the transfer of control to remote site for live interaction. The remote site facility officials then welcomed the PM and requested him to inaugurate the facility. This was followed by unveiling of the electronic curtain by the Honorable PM, by clicking on a button on the Tablet PC. Suitable different versions of audio-video signals were provided at New Delhi, Mumbai and other remote sites, for effective natural interactions.

This set-up enabled us to successfully carry out the remote inauguration from PMO, New Delhi and to web cast live, the entire event throughout the country.

FORTHCOMING SYMPOSIUM

National Symposium on Frontiers in Photobiology (FIP-2009)

BARC in association with the Indian Photobiology Society, has organized a national symposium from Aug. 24-26, 2009, at the Multipurpose Hall, BARC Training School at Anushaktinagar, Mumbai. The scientific programme of the symposium includes oral as well as poster presentations and also invited talks, Papers on the folloing topics are invited from authors:

Photosynthesis; light and dark reaction
Molecular Biology of Photosynthesis
Bioluminescence, Photomorphogenesis, Visual processing, Circadian rhythms
Photophysics and Photochemistry related to Biomolecules, Biosenors and Ionophores
Artificial Photosynthesis and Bio-inspired Chemistry
Environmental Photobiology and photorepair
Photodynamic Effects and Photodynamic therapy in Cancer
Biophotonics and Single Molecule Spectroscopy
Nanoparticles and Quantum Dots in Photobiology

An abstract of about 300 words along with the registration form is to be sent to the convener.

Important Dates
Registration &
submission of abstracts - 31st May, 2009
Intimation of acceptance - 30th June, 2009

For further details one may contact

Dr. Jayashree Sainis
Convener, FIP-2009
Molecular Biology Division
Bhabha Atomic Research Centre
Trombay, Mumbai 400 085
Tel:022-25595079
Fax: 022-25519163
Email: jksainis@yahoo.com

MoU WITH JADAVPUR UNIVERSITY ON INITIATION OF STRESS CORROSION CRACKING OF AUSTENITIC STAINLESS STEELS IN REACTOR SIMULATED CONDITIONS

Under the XI[th] plan (Corrosion aspects of nuclear structural materials, XI – N- R & D – 01.09), an MoU with Jadavpur University was signed. This MoU entitled "Scientific Collaboration to jointly build a recirculation loop test facility and study the crack initiation and its precursor phenomenon leading to stress corrosion cracking in austenitic stainless steels in simulated nuclear reactor environment" was signed between the Materials Science Division, BARC and Jadavpur University, Kolkata. Dr. A. K. Suri, Director, Materials Group, BARC and Mr. Sanjay Gopal Sarkar, Registrar, Jadavpur University signed the MoU on October 15, 2008 at BARC. The scope of the MoU includes (a) setting up and running, continuously a recirculation loop facility with an autoclave suitable for working in the following environment: working temp. 280 - 320ºC, working pressure: 8 – 12 MPa, environment – high purity water (Sp. conductivity – 0.055 μS /cm as inlet water) with controlled levels of dissolved oxygen, (b) stress corrosion crack initiation studies in reactor simulated environment using Crevice Bent Beam (CBB) specimens from selected austenitic stainless steel grades from among SS304L / SS304LN / SS316L / SS316LN, with varying degree of cold / warm working or sensitization and establishing the preferred location of crack initiation, crack morphology and characterization of the stress corrosion cracking susceptibility by measuring the crack depth and (c) establishing precursor events to stress corrosion crack initiation using SEM and AFM examination of tested specimen. The MoU duration is of four years and a student from Jadavpur University will work on this topic, for doctoral degree. The SCC growth rate measurements are already being done at the test facility, by the Materials Science Division, BARC.

Signing of the MoU between Jadavpur University and BARC on October 15, 2008: From (L-R) Prof. P. K. Mitra, Mr. Sanjay Gopal Sarkar, Prof. M. K. Mitra from Jadavpur University and Dr. A. K. Suri, Dr. Vivekanand Kain of Materials Group, BARC and Ms. S. Malini from IFB, BARC

PREVENTION OF EVENT PROGRAMMES AND DEVELOPMENT OF RADIATION PROTECTION STANDARDS AT NUCLEAR POWER PLANTS: REPORT OF A THEME MEETING

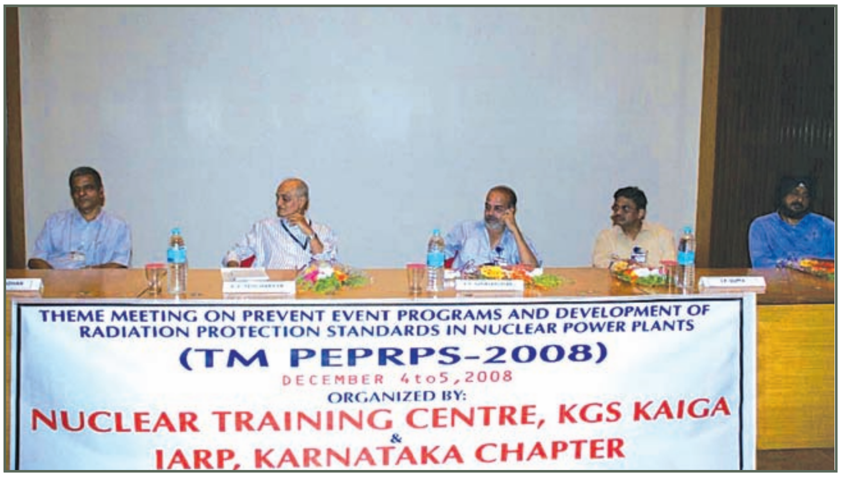
The Health Physics Division, BARC Mumbai, the Indian Association for Radiation Protection, Karnataka Chapter, Kaiga and Nuclear Training Centre, Kaiga, Generating Station 1-4, Kaiga had organized a theme meeting to prevent event programmes and to discuss the developments, in the recommendations of the International Commission on Radiological Protection, during December 4-5, 2008 at the Kaiga Generating Station.

The theme meeting was organized to share the operating experience and prevent event programmes in the field of radiation protection in nuclear power stations. The strategies adopted for control of occupational exposures were presented by operation and maintenance persons. This included deliberations on the applications of Just-In-Time Briefs, Assessment of events (Low Level Events, Significant Events etc.), Operating experience sharing and measures adopted to prevent the recurrence of events in Indian nuclear power plants.

Mr. Sunil Gadgil, Senior Mechanical Engineer, Kaiga Generating Station 1&2 shared his operating experience related to prevent event programmes at KGS for enhancement of industrial safety through sharing of operating experiences.

Mr. D.Subba Rao, Senior Engineer from Kaiga Generating Station 3 & 4 discussed the safety aspects and innovations in the radiation protection programmes of Annular Gas Monitoring System leak arresting and O-10 Channel repair.

Mr. Sudhir Kumar, Senior Engineer from fuel handling section of KGS 1 & 2 explained the strategies adopted, to control exposures in fuel handling section. He discussed the prevent event programmes in fuel handling section which helped in achieving ALARA exposures for the fuel handling persons. Mr. S.K. Pal, Senior Health Physicist and Mr. Alok Kumar, Senior Engineer from mechanical maintenance section, explained various measures adopted for minimizing collective doses at TAPS 3 & 4. Mr. V.K. Sehgal, ALARA



At the inaugural function (from left to right: Mr. R.S.Varadhan, (HPD, BARC) Mr. K.A.Pendharkar, (Head, HPD, BARC) Mr. V.V. Sanath Kumar, (Site Director KGS) Mr. J.P. Gupta (Station Director, KGS) Mr. J.S. Virdhi, (President, IARP Karnataka Chapter)

Delegates and participants at the theme meeting

coordinator, from Narora Atomic Power Station explained Collective dose reduction strategies during En Mass Coolant Channel Replacement campaigns at NAPS.

Usefulness of the Information System on Occupational Exposures (ISOE) to assess the trends of occupational exposures in various power stations around the world and the techniques adopted to control and bring down the collective doses in the power stations, were discussed during the theme meeting. This systematic information sharing through regular workshops and symposia was useful to all the power stations in the world to adopt innovations in the field, to improve techniques to carry out maintenance activities in the shortest time with lowest collective doses among 400 nuclear power stations. The information sharing system was useful to the Indian nuclear power plants too, by way of implementing strategies for effective control of collective doses per reactor.

The developments in the field of radiation protection through the recommendations of the International Commission on Radiological Protection, covering various aspects of radiation protection, were discussed by radiation protection professionals from different nuclear power stations. The theme meeting provided ample opportunity to the operation, maintenance specialists and radiation protection professionals, to share the basis of the recommendations, the changes in the methodology of implementation of the recommendations etc. in field of radiation protection. Presentations on ICRP recommendations included modeling of various risks due to the exposure of ionizing radiation; the results of effects of low-level radiation exposures, development of risk coefficients and development of methodologies to assess the effects of exposure to radiation in case of terrorist attacks in public domains etc., were discussed.

About 100 participants had benefited from the presentations and deliberations during the theme meeting.

The participants included health physics professionals and ALARA Coordinators from nuclear power plants, specialists from Health Physics Division, BARC Mumbai. eighteen presentations relevant to the theme meeting were presented during December 4-5, 2008. The Inaugural address was given by Mr. V.V. Sanath Kumar, Site Director, Kaiga Generating Station 1-4 Site.

THEMATIC DISCUSSION MEET ON "COMPOSITIONAL CHARACTERIZATION OF MATERIALS BY X-RAY EMISSION AND ION BEAM TECHNIQUES" (CCMXIB-2008): REPORT AND RECOMMENDATIONS

The Thematic Discussion Meet on "Compositional Characterization of Materials by X-ray Emission and Ion Beam Techniques"(CCMXIB-2008) was held on 26th September, 2008, at C- Block Auditorium, Modular Labs, BARC and was organized by Dr. T. Mukherjee, Dr. A. K. Tyagi and Dr. (Ms). D. Joseph.

Introductory remarks were given by Director, BARC. He appreciated the efforts for this kind of meeting and recommended that similar meetings be held more frequently. In particular, he mentioned the use of Synchrotron machine for EXAFS studies. He recommended that techniques based on X-ray absorption also need to be included in future discussion meets. He also emphasized on indigenous development of instruments.

There were two sessions -a pre lunch session chaired by Dr. J. P. Mittal, former Director, Chemistry Group and a post lunch session chaired by Dr. S. K. Sarkar, Head, Radiation and Photo Chemistry Division. The first speaker was Dr. D. K. Avasthi from IUAC, Delhi who delivered a talk on ERDA for materials characterization. Dr.V. S. Raju, from CCCM, Hyderabad spoke on Ion beams vs x-rays as probes. He discussed the merits of ion beams and x-ray techniques, with a little insight into their theory and problem solving in a wide range of research applications. Dr. Lokesh Tribedi, TIFR, briefed on Heavy ion-atom collision in Solids. He explained that characteristic x-ray emission in collisions of highly charged ions with matter can be used, to probe the various atomic collision mechanisms citing examples of results obtained from the BARC-TIFR Pelletron based experiments in TIFR. Dr. B. S. Tomar from RChD, BARC and Dr. Daisy Joseph, from NPD, BARC summarized the FOTIA-based experiments such as RBS and PIXE respectively. Dr. Tomar gave a brief description of the RBS, ERDA and NRA techniques, followed by results carried out at Folded Tandem Ion accelerator (FOTIA) and 14UD Pelletron accelerator at TIFR. Dr. Daisy showed some exciting applications of PIXE from FOTIA in Materials Sciences, Geology and Forensic Sciences. Dr. K. Bhanumurthy from MSD, BARC gave an idea of Micro-chemical analysis by EPMA, Dr. K. V. G. Kutty, IGCAR spoke on WDXRF for SS characterization. Dr. N. L. Misra, from FCD, BARC spoke on TRXRF on Nuclear Materials and Dr. V. Natarajan, RChD, briefed on the use of EDXRF technique for the determination of uranium in mixed oxides of Th and U. Dr. S. N. Jha, RRCAT, Indore explained Synchrotron-induced XRF and informed that a dedicated XRF beam line was being setup at Indus-2 SRS facility, by the Indus Synchrotron Utilization Division, RRCAT and invited collaborative proposals for future projects, in order to use Synchrotron more efficiently. The Director, Chemistry Group gave Concluding remarks. A decision was taken to have similar meets on a larger scale in the future, on all aspects of X-rays such as emission, absorption and diffraction.

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

Dr. J. Krishnan

प्रतिष्ठित उपलब्धियों एवं अविष्कृत तकनीकों विशेषतया संलयन जोड़ तथा विसरण अनुबंध को ध्यान में रखते हुए डा. जे. कृष्णन, सीडीएम, भाभा परमाणु अनुसंधान केंद्र को इन्सटिट्यूशन ऑफ इंजीनियरस (एफआइई, जून 08) एवं इन्डियन नैशनल अकादमी ऑफ इंजीनियरस - (एफएनएई - जन. 2009) में एक सम्मानित सदस्य के पद पर निर्वाचित किया गया।

In view of his distinquised achievements and expertise in Manufacturing technologies, especially in fusion welding and diffusion bonding Dr. J. Krishnan, CDM BARC, has been elected as a fellow of the Institution of Engineers (FIE, June 08) and Fellow of the Indian National Academy of Engineers (FNAE- Jan. 2009).

Dr. B. S. Kademani

डॉ. बी.एस. कडेमनि, भाभा परमाणु अनुसंधान केंद्र के वैज्ञानिक सूचना संसाधन प्रभाग को पिछले 25 वर्षों से पुस्तकालय एवं सूचना विज्ञान में उत्कृष्ट योगदान को मान्यता देने हेतु इन्डियन लाइब्रेरी एसोसियेशन के द्वारा एक प्रतिष्ठित "इला -कौला - बेस्ट लाइब्रेरियन अवार्ड -2008" से सम्मानित किया गया। इन्होंने फेचिनफॉरमेशनसज़ेन्ट्रम (एफआइज़ड) कालश्रुही, जर्मनी में वर्ष 1991 में लाइब्रेरी एन्ड सांइटिफिक डोकिमेंटेशनङ हेतु अंतर्राष्ट्रीय एटोमिक एनर्जी एजन्सी (आइएईए) की सम्मानित सदस्यता प्राप्त की । इनके 70 से अधिक अनुसंधान शोध- पत्र राष्ट्रीय एवं अंतर्राष्ट्रीय पत्रिकाओं में प्रकाशित हुए हैं तथा चार सम्मेलन खण्डों का संपादन एवं संकलन किया है। आप अंतर्राष्ट्रीय (फेडरेशन ऑफ लाइब्रेरी एसोसियेशन एन्ड इन्सटिट्यूशन) विज्ञान के सम्मानीय स्थायी सदस्य एवं भारत की ओर से वर्ष 2005-2009 के साइंस एन्ड टेक्नालोजी लाइब्रेरीज़ सेक्शन के सदस्य भी हैं।

Dr. B. S. Kademani, Scientific Information Resource Division of BARC, has been conferred the prestigious "ILA-Kaula-Best Librarian Award-2008" by the Indian Library Association, in recognition of his outstanding contribution to the Library and Information Science field, for the last 25 years. He was the recipient of the International Atomic Energy Agency (IAEA) Fellowship in 'Library and Scientific Documentation' in 1991 at the Fachinformationszentrum (FIZ), Karlsruhe, Germany and Vienna International Centre(VIC), Vienna, Austria. He has published over 70 research papers in national and international journals, edited four conference volumes and many compilations. He is a Standing Committee Member of IFLA's (International Federation of Library Associations and Institutions) Science and Technology Libraries Section from India for the term 2005-2009.

M. F. Husain

Portrait sketched by Dr. Homi J. Bhabha

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