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AERB Newsletter

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ATOMIC ENERGY REGULATORY BOARD

Mission: The mission of Atomic Energy Regulatory Board is to ensure that the use of ionizing radiation and nuclear energy in India does not cause unacceptable impact on the health of workers and the members of the public and on the environment.

Contents

From the Chairman's Desk

New year greetings to all…

The year 2013 has seen AERB carrying out varied and extensive safety reviews in the use of nuclear energy. The reviews encompassed ongoing verification of suitability of site for a Nuclear Power Plant at Gorakhpur in Haryana & nuclear fuel fabrication plants at Rawatbhata in Rajasthan, issuance of construction permission to Fast Reactor Fuel Cycle Facility (FRFCF) and issue of consent for commissioning up to 75% of full power for Kudankulam unit-1. Especially challenging has been the first of its kind review of FRFCF, an integrated facility set up to achieve close-loop fuel cycle for Prototype Fast Breeder Reactor (PFBR). The design review of this facility included review of safety features engineered to avoid criticality during reprocessing of fuel, fabrication and assembly.

AERB has been participating in international fora for mutual exchange of information and for enriching its regulatory practices. In fact, the end of this year saw AERB hosting the WER Regulators forum, a meet designed towards the sharing and harmonizing regulatory practices amongst the global users of WER (i.e. Kudankulam) type reactors. AERB also routinely participates in international exercises such as the ConvEx. This is a regime of emergency preparedness exercises co-ordinated by the International Atomic Energy Agency with participation from member states. Details of participation in these international fora are provided in the newsletter.

For effective implementation of some areas of regulations, AERB has long-standing associations with various national organizations such as the Bureau of Indian Standards and National Disaster Management Authority. A collaboration was further established with National Institute of Secondary Steel Technology (NISST) to address instances of inadvertent radioactive contamination in ferrous and non-ferrous materials from recycling industries. The highlights of the MoU with NISST are part of this newsletter.

The regulatory control of use of medical diagnostic x-ray equipment is steadily being improved. Undoubtedly, the launching of "Diagnostic x-ray module" of the AERB e-governance portal, e-Licensing for Radiation Applications (e-LORA), has had a major role in this. The e-LORA facilitates utilities to declare/record details of medical x-ray equipment online. At the time of going to press the number of equipment declared/recorded is likely to cross 4000. This number is expected to increase in the coming months owing to advertisement campaigns taken up by AERB. One such advertisement that appeared in leading national dailies is printed in this newsletter. Further, AERB has authorized suitable and trained Quality Assurance (QA) service providers for addressing QA requirements of medical diagnostic x-ray equipment. By authorizing nine such agencies presently, AERB is ensuring both patient radiation protection and providing utilities an opportunity to fulfill AERB stipulations.

Post-Fukushima, there has been a renewed impetus to addressing severe accident management more rigorously world-wide. AERB and the Safety Research Institute of AERB has in its agenda, studies relating to severe accidents, so as to be able to lay down apposite regulations relating to severe accidents and accident management. Glimpses of the studies are given in this edition as feature articles.

AERB had instituted the Environmental Protection awards to the units of Department of Atomic Energy (DAE) recognizing the efforts by the units towards protection, sustenance and conservation of the environment. The winners of the Awards for the year 2012 were Heavy Water Plant (Kota), Bharatiya Vidyut Nigam Limited (BHAVINI) and Electronics Corporation of India Ltd. (ECIL) in various catagories. The article on DAE Safety & Occupational Health Professionals meet, during which the awards were given, gives the details.

(S.S. Bajaj)

Safety Review and Regulation

AERB Board Meeting

110th Board meeting was held on August 28, 2013. Status and activities of Fast Reactor Fuel Cycle Facility (FRFCF) were reviewed. FRFCF is a fuel cycle facility located at Kalpakkam. This facility is being set up to achieve closed loop fuel cycle for Prototype Fast Breeder Reactor and to cater to reload fuel requirements of PFBR. It is an integrated facility comprising Fuel Reprocessing Plant, Fuel Fabrication Plant, Reprocessed Uranium oxide Plant, Core Sub-assembly Plant and Waste Management Plant including Near Surface Storage and Disposal Facility. Sufficient engineered features have been designed to avoid criticality during fuel reprocessing, fabrication and assembling. The Board discussed the recommendations made by AERB committee against external events of natural origin which included reviews to address the accidents like that happened at Fukushima. The study performed by IGCAR to address radiological consequences due to extreme flood and other events was also reviewed. The Board examined and accepted the proposal of granting Consent for Construction of Fast Reactor Fuel Cycle Facility at Kalpakkam.

The Board reviewed the safety status of Kudankulam Nuclear Power Project (KKNPP) unit-1&2. AERB had earlier granted clearance for First Approach to Criticality (FAC) and Phase-B Low Power Physics Experiments (LPPE) for KKNPP-1. The first criticality of KKNPP-1 was achieved on July 13, 2013. During FAC, response of all related systems was satisfactory and the measured values were in line with estimations. After reviewing the results of FAC, AERB granted concurrence for conduct of Phase-B LPPE for KKNPP-1, which was completed on July 26, 2013. Based on further review of the results, clearance was given on August 14, 2013 for raising reactor power up to 50%FP and synchronization of generator of KKNPP-1 at appropriate power (Phase-C1). AERB observer team was posted continuously at site since Initial Fuel Loading (IFL) stage to ensure compliance of various stipulations during commissioning activities.

The Board discussed the results of health assessment of Reactor Pressure Vessel (RPV) of TAPS-1&2. Based on RPV inspections and considering the progress made by station towards implementation of post Fukushima safety upgrades, the license for operation of TAPS-1&2 was extended up to December 31, 2014.

While reviewing the annual report 2012-2013, Board noted that out of 32 significant events reported from operating nuclear power plants (NPPs), 30 were rated as International Events Scale (INES) level-0 and 2 events as INES level-1. The overall safety review status of operating NPPs was also presented to the Board. The Board appreciated the review & follow-up by AERB towards the progress in the implementation of all the safety recommendations in NPPs and other nuclear facilities.

Board discussed about the legacy sources and AERB's initiatives for updating source inventory. Board reviewed the status of internet based system e-Licensing Of Radiation Applications (eLORA) for filing of applications and issue of consents for the regulation of radiation sources and facilities. Board endorsed the actions taken by AERB to address the issues related to radioactive contamination in recycled metal/finished products.

Regulatory Inspections

AERB officials carried out periodic Regulatory Inspections as well as special inspections at Nuclear and Radiation Facilities to review the safety status and verify compliance with the regulations. In addition, industrial safety aspects were inspected every month for Nuclear Power Projects. Unplanned inspections were also carried out for selected radiation facilities.

Board Members of AERB and an invitee at the Board Meeting

Safety Review and Regulation

Consents issued by AERB

Radiation Facilities / Activities

Type of Facilities / Equipments	No of Consents Issued	Type of Consents Issued
Radio therapy facilities	19 (Linac), 03(Telecobalt)	Licence
Medical Cyclotron facility	03	Licence
PET-CT and SPECT-CT	10 (PET-CT) / 1 (SPECT-CT)	Licence
Manufacturing facilities of diagnostic x-ray equipment	16	Licence
Industrial Radiography Facilities	21	Licence
HDR Brachytherapy	06	Authorisation
Supply of diagnostic equipment	10	Authorisation
Gamma Irradiation Chamber (GIC) Equipment	15	Authorisation
Well Logging	21	Registration
Facilities using unsealed radio-isotopes for research	05	Registration
Self shielded x-ray unit and PCB analyser	10	Registration
IRGD (Nucleonic gauges) Facility	33	Registration
BRIT facilities	1	Licence (under Factories Act, 1948)

Nuclear Facilities

Extension of licence for operation of TAPS 3&4 upto August 2016
Renewal of license for operation of NAPS-1&2 up to June 2018
Extension of licence for operation of RAPS 3&4 up to October 31, 2017
License for operation of CORAL facility up to December 2014
Permission to proceed with construction activities of RAPP-7&8 beyond 91.7m EL (July 31, 2013)
Clearance for First Approach to Criticality (FAC) and Phase-B Low Power Physics Experiments (LPPE) for KK NPP Unit # 1 (July 04, 2013)
Clearance for Raising Reactor Power up to 50% FP & Synchronization of Generator of KK NPP Unit # 1 (August 14, 2013)
Clearance for Construction of Fast Reactor Fuel Cycle Facility (FRFCF) (September 12, 2013)
Consent for Commissioning of Monazite Processing Plant at IREL, OSCOM (November 7, 2013)
Renewal of License for Nuclear Fuel Complex, Hyderabad upto August 19, 2017
License for operation of High Pure Rare Earths production at IREL, Udyogamandal (November 11, 2013)

AERB Safety Guidelines/Guide Published

AERB Safety Guidelines 'Siting, Design, Construction, Commissioning, Operation, Closure and Monitoring of Tailing Management Facilities for Uranium Ore Processing' (AERB/FE-FCF/SG-4)

Uranium ore is excavated from uranium mines and processed to recover uranium. This process involves crushing, grinding, leaching, and filtration in the processing plant to obtain the uranium as a concentrate or intermediate product. This process generates tailings containing unrecovered uranium, its daughter products, and chemicals.

The safety guidelines provide detailed guidance on siting, design, construction, commissioning, operation, maintenance, closure and monitoring of the tailings management systems for uranium ore processing. The guidelines cover requirements and guidance on radiological and environmental surveillance aspects to be considered during the construction and pre-operational period, operational period and post-operational period of tailings pond. Instrumentation and in-service inspection aspects for tailings management system are suggested for the effective monitoring of tailings management system. Methodology to control an emergency situation arising out of any abnormal condition is included.

AERB Safety Guide 'Protection against Internally Generated Missiles in Nuclear Power Plants' (AERB/NPP/SG/D-3)

To perform the intended functions without undue risk to the plant personnel and public at large, nuclear power plants (NPP) are required to be designed to withstand the effects of various natural and man-induced events. Among others, one needs to consider the effects of missiles resulting from failure of plant equipment, earthquake or wind-induced missiles and site-proximity missiles.

The safety guide provides detailed guidance on protection of structures, systems and components important to safety from the effects of missiles resulting from failure of plant equipment. General design considerations for missiles generation and protection methods against their effects are detailed in this safety guide.

Nuclear Safety

IAEA Workshop on Incident Reporting System, Root Cause Analysis and Corrective Actions

Albert Einstein once said that "the only source of knowledge is experience", the operating experience from a nuclear power plant is an important source of knowledge and is given high priority by the regulatory body, AERB. This can be gauged by the mere fact that one can find the requirements related to operating experience feedback in Safety Code "Nuclear Power Plant Operation" AERB/SC/O (Rev-1). AERB also has a Safety Guide on this topic "Operational Safety Experience Feedback on Nuclear Power Plant" AERB/SG/O-13.

In addition to this, operating experience feedback is taken into consideration during re-licensing of a nuclear power plant for operation as provided in AERB safety guide on "Renewal of Authorisation for Operation Of Nuclear Power Plants" AERB/SG/O-12.

Apart from this, utility is required to submit report on event that takes place at NPPs, which has or may have any safety significance. These reports are discussed and deliberated in safety committees which are comprised of experts from various fields. These reports are disseminated to other NPPs to take necessary corrective action based on this operating experience.

India is a participating country to the International Reporting System for Operating Experience (IRS) and shares experience with other nuclear countries through International Atomic Energy Agency (IAEA) via IRS every year. The knowledge of IRS and its web based system would enable users to share operating experience effectively, identifying lessons learnt from international events/issues and good practices in order to promote and enhance nuclear safety.

In order to increase and improve awareness of IRS, Root Cause Analysis (RCA) and Corrective Actions (CA), AERB organized IAEA workshop on 'IRS, RCA and CA' during November 4-8, 2013 at Niyamak Bhavan, Mumbai. IAEA technical consultants and other international experts were invited to brief on IRS and various RCA techniques used in various countries for identification of CAs.

Officers from Nuclear Power Corporation Limited (NPCIL), Bhabha Atomic Research centre (BARC), Indira Gandhi Centre for Advanced Research (IGCAR) and Atomic Energy Regulatory Board (AERB) participated in this workshop.

The workshop consisted of theoretical explanation coupled with practical exercises. Following exercises were carried out:

IRS Coding and Exercise

Mr. Xavier, IRS coordinator presented International Reporting System for operating experience (IRS), its background and history, safety principles, requirement for operating experience analysis and use, role and responsibilities of IRS national coordinator, roles of the IAEA & Nuclear Energy Agency (NEA), roles of the IRS meeting co-coordinator, roles of IRS advisory committee preparation of IRS report and use of IRS coding system. This was followed by hands on exercise to participants on using IRS coding system through sample IRS event reports.

Root Cause Analysis (RCA) & Corrective Actions (CA)

Mr. Robert Nichols and Mr. Yuri Martyneko explained purpose of an event investigation, understanding and application of basic human performance knowledge to event investigation, selection and application of appropriate investigation techniques like task analysis, change analysis, barrier analysis, gathering information by interviewing, events and casual factor charting to develop corrective action for prevention of repeat event. This was followed by application of explained RCA and CA techniques to sample event examples.

Participants and IAEA faculty members at the IAEA Workshop

NPCIL and AERB had selected few SERs and had carried out RCA using different techniques. The salient outcome of these brainstorm were presented to IAEA experts.

In order to utilize the experience gained by this workshop and to improve upon the existing mechanism of IRS event reporting and strengthening of significant event reporting on operational events, AERB asked stations to arrange training sessions to station personnel involved in RCA task at each NPP, utilizing trained participants from this workshop.

Participation in ConvEx exercise

The 'Convention on Early Notification of a Nuclear Accident' and the 'Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency' are the prime legal instruments that establish an international framework to facilitate the exchange of information and the provision of assistance in the event of a nuclear accident or radiological emergency. The aim of these conventions is to minimize the consequences of nuclear accident or radiological emergency. These conventions were adopted in the year 1986 following the accident at Chernobyl Nuclear Power plant. Convention Exercises (ConvEx) is a regime of emergency exercises coordinated by the International Atomic Energy Agency (IAEA) in co-operation with Member States to verify the arrangements for responding under the 'Early Notification' and/or 'Assistance Conventions'. These exercises are of three types i.e. ConvEx-1 (a, b, c & d), ConvEx-2 (a, b, c & d) and convEx-3. Broadly ConvEx-1 is related with communication & notification, ConvEx-2 for requesting/providing assistance and ConvEx-3 cover all aspects of early notification & assistance convention.

During July 2013 to December 2013, India participated in two ConvEx exercises i.e. ConvEx-2a & ConvEx-3. The details are as follows:

ConvEx-2a Emergency Exercise

On October 23, 2013 a ConvEx-2a exercise was coordinated by IAEA. The scenario was a powerful car bomb exploded outside a shopping mall in the capital city with involvement of a Radiological Dispersion Device (RDD). Over 30 countries participated in the exercise. India participated in the exercise through the national contact point i.e. Crisis Management Group of Department of Atomic Energy (CMG-DAE). The purpose of this exercise was to test the ability of national competent authorities to complete the appropriate reporting forms.

ConvEx-3 Emergency Exercise

The objective of ConvEx-3 is to test/evaluate the full operation of the information exchange mechanisms and requesting and providing assistance. During November 20-21, 2013 a ConvEx-3 exercise was coordinated by IAEA. Prior to this, ConvEx-3 exercises were conducted in the year 2001, 2005 and 2008 based on nuclear emergency at Gravelines NPP (France), Cernavoda NPP (Romania) and Laguna Verde NPP (Mexico) respectively. This was the fourth ConvEx-3 exercise and was based on radiological emergency. 57 member states and 9 International organisations registered to participate in ConvEx-3 exercise. Nineteen members from India (AERB - 6, CMG-DAE - 4, BARC-6 and NPCIL-3) participated in the exercise through the national contact point registered under the Early Notification and Assistance Conventions i.e. Crisis Management Group of Department of Atomic Energy.

The aim of this level of participation was to test effectiveness of communications, to train response personnel in using the IAEA's emergency message services and to test provision for advice to affected nationals and businesses.

Highlights of the ConvEx-3 exercise

In the simulated exercise, Kingdom of Morocco was chosen 'Accident State'. The exercise scenario was based on a severe radiological emergency triggered by a nuclear security event with serious transnational/trans-boundary implications.

This exercise lasted for about 25 hours in real time. Messages/information from the IAEA through USIE Exercise website, USIE Mail service, USIE fax service and telephone service were received at CMG-DAE. The receipt of the messages at CMG-DAE was confirmed to Incident & Emergency Communication cell of IAEA. Necessary advisory notes were issued by India during exercise.

In response to assistance request by Morocco, India offered required medical assistance comprising of medical experts and relevant logistics to treat patients.

India, Turkey, Mexico and IAEA were selected for Assistance Mission. India was included as a Field Assistance Team (FAT-1) with the capabilities and resources for radioactive source search, waste management, decontamination of spaces and lands. Independent evaluation on response was carried out.

During the exercise, team members got conversant with various protocol and documents, IAEA's Response and Assistance Network (RANET) and Joint Radiation Emergency Management Plan of the International Organisations arrangements.

ConvEx-3 exercise gave the experience on the requirements of exercise controller and exercise evaluation process.

VVER Regulators Forum Meeting / Discussion Meet

VVER Regulators Forum Meeting at Kanyakumari, India

AERB recognizes international cooperation as a measure for enhancing effectiveness of regulatory control and harmonizing international regulatory practices and accords due importance to the same. During December 11-13, 2013, AERB hosted a three day meeting of the VVER Regulators Forum at Kanyakumari near Kudankulam Nuclear Power Plant, Tamil Nadu. This forum, founded in the year 1993 consists of the nuclear regulators of countries around the globe, operating reactors of Russian VVER design. The forum comprises nuclear regulatory organizations from Armenia, Bulgaria, China, Czech Republic, Finland, Hungary, Iran, Russian Federation, Slovakia, Ukraine and India. This forum mainly aims at sharing the experiences of global nuclear regulators and harmonizing the regulatory practices. It also helps in mutual sharing of the review methodologies adopted by different regulatory bodies before granting clearance for this design in their own countries, which works towards enhancing the global nuclear safety in these reactors.

This was the 20th annual meeting of the forum and was held in India for the first time since the inception of the forum in 1993. Shri S. S. Bajaj, Chairman, AERB; Shri S. Duraisamy, Vice-Chairman, AERB; Shri R. Bhattacharya, Secretary, AERB; Shri K.J. Vakharwala, Director NPSD; Shri P.R. Krishnamurthy, Director OPSD and other officials from AERB participated in the meeting. All the member countries of VVER forum, other than Iran, Slovakia and China, participated and presented their respective country reports. The reports dealt with comprehensive information about latest update and recent developments in legislations, nuclear safety, regulatory activities, operational aspects of special interest, probabilistic safety assessment, etc. Apart from this, the Forum also deliberated over adequacy of measures taken after the Fukushima accident. The delegates visited Kudankulam Nuclear Power Plant (KKNPP), the unit-1 which has been synchronized to the grid recently.

Considering the interest and curiosity of the media with respect to arrival of top management of AERB and senior regulators of the international regulatory bodies, a press briefing was held on Dec 13, 2013 in the afternoon and media personnel were apprised on the significance of the forum and deliberations which took place.

National and International delegates at the VVER Regulators Forum Meeting, Kanyakumari

Discussion Meet on "PHWR Safety R&D with Focus on Severe Accidents"

A Discussion Meet on "PHWR Safety R&D with Focus on Severe Accidents" was organized at AERB on October 29, 2013. The objective of the discussion meet was to identify the existing capabilities and take a stock of work being carried out by different agencies like AERB, BARC and NPCIL with a view to identify the need for consolidation and synergizing the efforts and also identify the gap areas for further work. About 100 delegates from BARC, AERB, NPCIL and from academic institutions participated in the Discussion Meet.

There were three technical sessions followed by inaugural session. In the inaugural session, Shri Avinash J. Gaikwad, Head NSAD, AERB welcomed the dignitaries, invitees and other delegates. This was followed by inaugural addresses by Shri K. K. Vaze, Director RDDG (BARC) and Shri S. G. Ghadge, Director (Technical), NPCIL in which significant differences in the progression of severe accidents in PHWR compared to that of LWRs were highlighted.The need for correlating the analysis and experiments related to severe accident and identifying and filling the gap areas was emphasized. The necessity of demonstrating the strength of calandria vessel for in-core retention was also stressed in the inaugural address. Shri S. S. Bajaj, Chairman, AERB in his presidential address briefed about the uniqueness of progression of severe accident in PHWRs. He stressed about the consolidation of work undergoing at different institutes and identification of gap areas and development of mechanism to fill the gaps.

In every technical session, there were presentations from AERB, NPCIL and BARC. With the theme of reactor behaviour during severe accident for technical session-1, coolant channel behaviour under heat up conditions (with and without moderator cooling available) including studies on separate effects/material properties, channel ballooning/sagging, cascading effect of channel slumping, calandria vessel as 'core-catcher', in-vessel debris cooling, structural integrity of calandria, single channel events (e.g. feeder stagnation break), fuel coolant interactions, effect on neighbouring channels, steam explosion etc. were presented and discussed. Technical session-2 concentrated on containment response to severe accidents and the topics discussed were hydrogen related studies, PAR, containment pressurization and heat up under no cooling conditions, containment leak tightness, structural

Discussion Meet / DAE Safety & Occupational Health Professionals Meet

integrity of containment under elevated temperature/pressure conditions for extended periods, extreme loading conditions such as aircraft crash, core concrete interaction and radiological consequence studies (fission product release/transport). Other areas related to severe accident assessment studies such as thermal hydraulic – neutronic

Technical Panelists at the Discussion Meet (L to R): Shri Avinash J. Gaikward, Director, NSAD, AERB; Shri K. K. Vaze, Director RDDG, BARC; Shri S.S.Bajaj, Chairman, AERB and Shri S. G. Gadge, Director(Technical), NPCIL

coupling (3D), fuel behavior under accident conditions, fuel failure criteria, fission product release and SAMG/diagnostic/ decision support were discussed in technical session-3. Panel discussion followed the technical sessions with Chairman, AERB; Director (Technical), NPCIL; Director (RDDG), BARC as the panelists. There were active participation between the delegates and the panelists. It was concluded that mechanistic based criteria need to be used for severe accident modeling. Database need to be generated for core fuel and structural material properties at high temperatures. A comprehensive list of international collaborative projects related to severe accident assessment and management should be prepared. Integrated computer code on severe accident assessment should be developed. It was concluded that state of the art report on activities related to severe accident assessment will be prepared.

30th DAE Safety & Occupational Health Professionals Meet at Uranium Corporation of India Limited (UCIL) during December 18-20, 2013.

The 30th Department of Atomic Energy (DAE) Safety & Occupational Health Professionals Meet was jointly organized by Atomic Energy Regulatory Board (AERB), Mumbai and Uranium Corporation of India Limited (UCIL) during December 18-20, 2013 at Narwapahar, Jharkhand. This Meet is organised annually with various themes on Industrial Safety and Occupational Health by AERB jointly with DAE unit to promote and motivate Safety and Occupational Health aspects in units of DAE.

The themes for this year's three day Meet was on "Safety in Mining and Milling Activity" and "Chronic Respiratory Diseases". This Meet was inaugurated by Shri S.S. Bajaj, Chairman, AERB. About 200 delegates from various DAE Units and DAE aided institutes participated in this Meet. A Monograph on "Safety in Uranium & Thorium - Mining & Milling and Chronic Respiratory Diseases" was released by Shri R. Bhattacharya, Secretary, AERB followed by the briefing about the important milestones, significant achievements of the past Meets and highlights of this year's Meet. Shri D. Acharya, CMD, UCIL & Chairman, Steering Committee gave away the prizes to winners of logo competitions conducted for the Meet and addressed the gathering. The AERB Environmental Protection Awards for the year 2012 were presented to the winning units: Heavy Water Plant (Kota), Bhartiya Vidyut Nigam Ltd. (BHAVINI), Kalpakkam and Electronics Corporation of India Ltd. (ECIL), Hyderabad for their contribution towards protection, sustenance and conservation of the environment. Chairman AERB released the technical proceedings, commemorating the Meet and delivered the Inaugural Address. One of the major highlights of this year's Meet was that the Dr. S.S. Ramaswamy Memorial Endowment Lecture was delivered by Shri Rahul Guha, Director General, Directorate General of Mines Safety, Dhanbad on "Present Occupational Safety and Health (OSH) Scenario in Indian Mining Sector". A Technical Exhibition on Nuclear Technology, Safety Appliances, Public Awareness & Safety and Regulatory aspects was organised during the Meet for the benefit of the participants and to encourage interactions between industries and DAE units. Shri S.S. Bajaj, Chairman, AERB inaugurated the exhibition. About 13 exhibitors including AERB, AMD, BARC and other manufacturers/suppliers had displayed their exhibits.

Three technical sessions covering Safety in Mining & Milling aspects, Safety Regulation in Mining & Milling, Chronic Respiratory Diseases and other areas of interest were held on the first day. The talks / lectures in these sessions were delivered by renowned experts from DAE as well non-DAE facilities. The following days had oral / poster presentations by participants on various areas in Industrial Safety & Occupational Health. The Meet was concluded by a Valedictory Session, wherein prizes for winners of Poster, Cartoon and Slogan Competitions conducted amongst DAE Employees were distributed.

Shri S.S.Bajaj releasing the proceedings of 30th DAE Safety & Occupational Health Professionals Meet at UCIL, Narwapahar

Radiological Safety

Three Vulnerable Radioactive Sources Recovered

A company located at Varanasi, involved in sorting and threading of cotton, employed radioactive sources (nucleonic gauge) for density measurements. Way back in 1998, the company had obtained the mandatory No-Objection Certificates (NOC) from Bhabha Atomic Research Centre for use of three Americium-241 sources. These were 50 kev gamma sources with a long half life of 432 years

A Typical Crading Machine

The company was not submitting the mandatory periodic safety reports to AERB in spite of repeated reminders. AERB officers could locate the institution and communicated to the Director of the company on whose name the NOCs were issued. It was learnt that the use of radioactive sources for this purpose had been stopped long back in 2003 itself. The present management and workers were not aware of the existence of these sources, as no record of the same was available.

It was observed during investigation that the display unit of the Nucleonic Gauge, with radioactivity was removed and was treated as scrap in a store room, due to which it became extremely difficult to trace the exact location of the Gauge. On radiation survey of the entire premises of the company and the full range of equipment, the officers could finally locate the sources at the bottom of a crading machine at around 5 cm from the floor. It was observed that though the radiation level near the source was higher than background, it was not likely to cause any health affect, to near by workers, taking into account the level of radiation and occupancy in the area.

Recovered Sources

AERB officers packed these sources and kept them under the lock and key arrangement at a location away from workers, with the commitment from the management that it will be under continuous supervision, pending disposal. AERB has initiated appropriate action against the errant institution.

Workshops & Training Courses

- One day Workshop on familiarization of Radiotherapy users with e-Licensing of Radiation Applications (e-LORA) was conducted for users from radiotherapy institutions in Mumbai. A live demonstration of the radiotherapy module of e-LORA was given prior to making the radiotherapy module operational. In this workshop, Radiation Safety Officers from radiotherapy institutions in Mumbai attended. Live Registration of the participants as radiation professionals in e-LORA system of AERB was also done during the workshop. Demonstration programmes were conducted at Bangalore, Hyderabad, New Delhi and Kolkata to familiarize e-LORA system among the stake holders of radiotherapy and diagnostic radiology.
- A one day meeting with the suppliers of Radiation Monitoring Instruments was organized on July 2, 2013, to assess the demand-supply gap for the recycling steel industries. About 10 no. of suppliers of radiation survey meters in India attended the programme. The objective of the programme was to make the suppliers aware of exact requirements of radiation monitors and to know the capability to supply sufficient radiation survey meters, if the need arises.
- AERB has begun the accreditation of private agencies for carrying out Quality Assurance testing of diagnostic radiology equipment. A training course for two weeks on radiation protection was conducted in this connection. AERB had earlier issued an advertisement calling for such agencies. Around 30 applications with 80 nominations were received.
- A one day awareness programme on radiological safety aspects in diagnostic radiology was conducted on July 7, 2013. About 60 radiologists, x-ray technologists and medical practitioners attended the programme. The aim of the programme was to make the participants aware of radiological safety aspects in operation of diagnostic radiology equipment.
- A refresher programme for Safety and Security in Industrial radiography was conducted. This programme was specifically held for Site-in charges and Radiographers who are not in the field for more than five years. The programme was useful in updating the basic safety and security requirements and the applicable regulatory requirements before rejoining the industrial radiography field.
- A one day workshop was organized on August 8, 2013 and September 16, 2013 to provide awareness cum field demonstration to cargo handling personnel at Chennai Airport and Sahar Air Cargo Complex respectively for the safe handling and storage of packages containing radioactive material.

Radiological Safety

Accreditation of Laboratories

AERB accredited laboratories carrying out measurement of radionuclide content in commodities and/or environs. Presently there are fifteen laboratories accredited by AERB. Out of these seven are Environment Survey Laboratories (ESL) at Nuclear Power Plants (NPPs). Accreditation to ESL is based on requirements spelt in "Criteria for Accreditation of Environmental Survey Laboratories (ESL) of BARC for Radioassay of Environmental Samples 2012" and other laboratories is based on requirements as per "Accreditation of laboratories for measurement of radionuclide content in commodities -2003".

ESL at D.A.E. Township, Sadras (W), RAPS site, TAPS site, KAPS site, Kundankulam and KGS site were accredited for environmental samples and commodities. The accreditation is valid till January 31, 2018. The accreditation of ESL of NAPS for environmental samples and commodities is valid till January 31, 2014. A list of laboratories other than ESL and its validity of accreditation is tabulated below:

For Food Products, Packaged Drinking Water and commodities other than ESL:

Sr. No.	Name & address of the Laboratories	Valid for	Valid up to
1.	M/s MSME Testing Centre, (Formerly Regional Testing Centre) 65/1, G.S.T. Road Guindy, Chennai - 600032	Food Products,Packaged Drinking Water	Jul 31, 2015
2.	M/s Saturn Quality Certifications Pvt. Ltd., F-132-A, Priyanka Tower, Basai Darapur Road, Near FUN Cinema, Moti Nagar, New Delhi- 110015	Packaged drinking Water	Apr 30, 2015
3.	Mangalore University, Mangalagangotri, Karnataka - 574199.	Packaged drinking Water and Commodities (mineral, ore, food, soil, sediment and water)	Dec 31, 2014
4.	Health Physics Division (formerly Environment Assessment Division) Health, Safety and Environment Group, Bhabha Atomic Research Centre, Trombay, Mumbai -400085	Packaged drinking Water and Commodities (mineral, ore, food, soil, sediment and water)	Dec 31, 2014
5.	Board of Radiation and Isotope Technology, Vashi Complex, Vashi, Navi Mumbai - 400 705	Commodities	Mar 31, 2014
6.	Modern Test Centre, Neelanchal Nagar, 3rd Line, Berhampur, Ganjam - 700 010, Orissa.	Packaged Drinking Water and Food commodities	Feb 28, 2014
7.	M/s. Monarch Biotech Pvt. Ltd. 37-A, SIDCO Industrial Estate Thirumazhisai, Chennai - 600 124.	Packaged Drinking Water, Commodities (food matrices), water, soil, metals and fly ash	May 31, 2016
8.	Radio Analytical Laboratory, Regional Centre, BRIT, KMIO Campus, Bangaluru- 560029	Food items for human consumption, animal feeds, poultry feeds and other miscellaneous items (steel, activated charcoal, ultramarine blue, fly ash and sodium bicarbonate)	Aug 31, 2016

AERB initiatives

AERB inks MoU with the Government of Arunachal Pradesh for formation of Radiation Safety Cell

In view of tremendous increase in medical diagnostic installations using medical x-rays in the country, a decision was taken to decentralize the regulation of these units by setting up a Directorate of Radiation Safety (DRS) in States by signing MoU with State Governments and Union Territories. Accordingly, the DRS established by AERB in two states viz.; Kerala and Mizoram are fully functional now. Besides, the MoU has been signed in eight states viz. Madhya Pradesh, Tamil Nadu, Punjab, Chhattisgarh, Himachal Pradesh, Gujarat, Maharashtra and Odisha.

Shri R. Bhattacharya, Secretary, AERB exchanging the MoU with Ms. Indra Mallo, Secretary, Department of Health and Family Welfare, Govt. of Arunachal Pradesh

On October 7, 2013, Shri R. Bhattacharya, Secretary, AERB and Smt. Indra Mallo, Secretary, Department of Health and Family Welfare, Government of Arunachal Pradesh signed an MoU to facilitate setting up of Radiation Safety Cell (RSC) in the State. Dr. M Basar, Senior Surgical Specialist of Arunachal State Hospital and Dr.R.M.Nehru, AERB witnessed the signing. The RSC staff, after due training, would inspect the medical diagnostic facilities in the state periodically to ensure compliance of safety standards laid down by AERB.

Internal Auditor Training as per ISO 9001:2008 Standard for AERB Officers

AERB has opted certification under ISO 9001 standard by Bureau of Indian Standards (BIS) for its consenting activities, regulatory inspection and preparation of regulatory documents since November 15, 2006. BIS Auditor carried out Surveillance Audit with respect to ISO 9001:2008 Quality Management System (QMS) at AERB during December 13, 2013. Based on the recommendations after the BIS recertification audit in November 2012, an in-house internal auditor training cum certification programme was organized for twenty-five officers of AERB by BIS faculties during October 17-18, 2013. The trained internal auditors carried out the second internal audit of various technical divisions of AERB during November-December 2013

AERB Staff and BIS Auditor at the In-house Internal auditor training cum certification programme

AERB signs MoU with National Institute of Secondary Steel Technology (NISST)

During the past few years, cases of radioactive contamination in ferrous and non-ferrous items have been reported to AERB, majority of them are in re-cycling steel industries. Radioactive contamination in steel occurs due to accidental melting of radioactive source along with scrap. The radioactive sources reach the scrap stream due to various reasons.

In light of above, it is necessary & expedient to control radioactive contamination in metal products arising from inadvertent entry of radioactive material in the scrap metal used in metal recycling industry for manufacturing of products thereof. To counter the problem of radioactive contamination, it is envisaged to increase awareness of various stakeholders of re-cycling steel industry and set up a lab for suitable contamination checks with accreditation from AERB at NISST campus. NISST being in the field for the last 25 years has contributed a lot in terms of reducing specific energy consumption, Green house gas emissions, higher productivity, dissemination of latest developments & better operating practices and improvement in power factor, etc; besides undertaking R&D activities.

Therefore, a Memorandum of Understanding (MoU) has been signed by

Shri R. Bhattacharya, Secretary, AERB singhing MoU with Shri R.K. Bagchi, Director NISST In presence of Joint-Secretary, Ministry of Steel

NISST and AERB on January 13, 2014. Highlights of this MoU are as under:

1. NISST will organize six cluster level programmes throughout the country in consultation with AERB to educate the industry on the ill effects of such contamination and preventive measures to be adopted. During conduction of these training/awareness programmes, AERB will deliver lectures educating the steel industry on issues related to metal contamination and its effects on human health & society at large.
2. NISST will display the guidance material on the subject prepared by AERB on its website for information of metal recycling industry. NISST will also establish facilities for testing of radioactive contamination with financial assistance & necessary guidance from AERB by setting appropriate laboratories. Such labs will be accredited by AERB.
3. During the course of its various activities and interactions with steel industry, NISST will disseminate information about the potential environmental & health risks and economic & financial consequences.

Human Resource Development and Safety Research Programme

AERB Training Activities

Three Stipendiary Trainees (Cat-I) selected from NFC Panel successfully completed their one year training programme, which included class room training, on-the-job training (OJT) and viva-voce. Subsequent to the training, they have been absorbed in AERB as Scientific Assistants (B).

One technical talk on "KKNPP-1: First Approach to Criticality and Phase-B Experiments" by Dr. A Ramakrishna, Head, TS &RPS, ITSD, AERB was organised. The reactor physics commissioning experience for first approach to criticality and Phase-B low power experiments of KK-NPP-1 were discussed. The talk also brought out safety review related to these activities, performance of system during commissioning, a comparison with IPHWR practices etc.

Shri C. S. Varghese, NPSD, AERB delivered the second technical talk on confidentiality requirements given in AERB document "Manual on maintaining confidentiality of information submitted by Responsible Organisation (RO) or Clients". This talk covered the procedures brought out in the AERB manual to maintain the confidentiality of the information submitted by the RO from the time it is received for the regulatory consenting process until its return to RO after completion of regulatory consenting process.

Safety Research Programme (SRP)

Two meetings of Committee for Safety Research Programmes (CSRP), one at Mumbai and another at Kalpakkam, were held in the presence of project coordinators and principal investigators, to review the progress of on-going projects, and consider funding of new project proposals. During the meeting at Chennai, CSRP members visited the ongoing project facilities at IIT, Madras and CLRI, Chennai.

The Committee agreed for funding of following new project proposals.

Sr. No.	Project Title	Principal Investigator (PI)
1.	Development of Novel Polymeric Detectors for Selective Dosimeters for Selective Dosimetric Analysis	Dr. V. S. Nadkarni, Goa University, Goa
2.	Development of a Standardized Thermal Infrared Imaging Technique for Monitoring Temperature Distribution at Power Plant Outfall Sites	Dr. Usha Natesan, Anna University, Tamil Nadu
3.	Synthesis and Characterization of Al2O3 for Ion Beam Dosimetry PESIT, Bangalore	Dr. K.R. Nagabhushana, Assistant Professor,
4.	Study on Levels and Effects of Natural Radiation in the Environment of Different Regions of Manipur	Dr. Sarangthem Nabadwip Singh, Churachandapur Govt. College, Manipur

At Kalppakkam, the Committee reviewed the progress of following 5 on-going projects and recommended for their renewal:-

1. Development and Testing of Corrosion Inhibitors for Firewater System materials (48/01) (PI: Dr. N. Rajendran, Associate Professor, Anna University)
2. Influence of stiffness of the system and heat input waveform on transient CHF in horizontal channels under LPLF conditions (45/07) (PI: Prof. S.V. Prabhu, Dept of Mechanical Engg, IIT Bombay)
3. Lysimeter based sub-surface investigations to assess the transport behaviour of Contaminants in the vodoze zone surrounding near surface Disposal Facility at Kalpakkam (46/02) (PI: Prof Sudhakar Rao, Dept of Civil Engineering, IISC, Bangalore)
4. Experimental and Numerical Investigations of Heat Transfer in Tube, Single Rod Annulus and Rod Bundle Geometrics using Supercritical Fluid Freon-22 (47/01) (PI: Prof. R.P. Vedula, Dept. of Mechanical Engg, IIT-Bombay)
5. Non-contact strain measurement of zircaloy using digital image correlation (DIC) under high temperature ambience (48/03) (PI : Dr. M. Ramji, Asst. Professor, Engineering Optics Lab,Dept. of Mechanical Engg, IIT-Hyderabad)

CSRP Members and the invitees at the ongoing project facility at IIT, Madras

AERB AWARDS

AERB started its award scheme from the year 2013 to promote excellence among its staff and recognize outstanding achievements of those engaged in regulatory and associated research and development activities. AERB award scheme comprises of a total of 8 individual awards with an annual budget of Rs.6.4 lakhs along with an additional Rs.2.0 lakhs for group achievement award. The categories of awards are: Young Scientific Officer Award, Outstanding Performance / Special Contribution Award, Leadership Award-1 (higher than SO/G), Leadership Award-2 (lower than SO/G), Meritorious Service Award and Group Achievement Award. In all these categories, awards for the year 2012-13 were distributed during the annual function of AERB on November 23, 2013.

Shri K. J. Vakharwala being felicitated with AERB Leadership Award

LIST OF AWARDEES (2013)

Cat. I - Young Scientific Officer Award

1. Shri S.K. Pradhan, SO/E, NSAD
2. Shri Devendra V. Pimpale, SO/E, NPSD

Cat. 2 - Outstanding Performance / Special Contribution Award

1. Shri J. Arunan, SO/G, OPSD
2. Shri Virendra R. Dhotre, SO/D, NPSD

Cat. 3 - Leadership Award-1

1. Shri Ajai S. Pisharadi, SO/F, SSED

Leadership Award-2

1. Shri K.J. Vakharwala, Director, NPSD

Cat. 4- Meritorious Service Award

1. Shri Ashok B. Gerira, APO, ADMN.
2. Smt. Radha Raghavan, PS(NS), OPSD

Cat. 5 - Group Achievement Award

Group-1 (Reactor Physics)

1. Dr. A. Ramakrishna, SO/H+, ITSD
2. Smt. Reeta Rani Malhotra, SO/G, ITSD
3. Shri G.M. Behera, SO/E, ITSD
4. Dr. Obaidurrahman K., SO/E, NSAD
5. Shri Susheel Kumar, SO/D, ITSD
6. Smt. Bharati Ingavale, SO/D, NPSD
7. Dr. L. Thilagam, TO/D, SRI

Group-2 (Periodic Safety Review of NPP)

1. Shri R.U. Parmar, SO/G, OPSD
2. Shri P.S. Virdi, SO/F, OPSD
3. Shri Vivek Piplani, SO/F, OPSD
4. Shri Neeraj Kumar, SO/E, OPSD
5. Shri Avinash Shrivastava, SO/E, OPSD
6. Shri S. Mukherjee, SO/E, OPSD
7. Shri Anup Prabhakaran, SO/E, OPSD
8. Shri Nishant Kumar Sangam, SO/D, OPSD
9. Shri Sunil Pagar, SO/D, OPSD

Group-3 (SRRC Inspection Programme)

1. Shri V. Mohan, Head, SRRC
2. Shri M. Senthilkumar, SO/D, SRRC
3. Ms. S. Renuga, SA/C, SRRC
4. Shri Amit Sen, SO/E, RSD
5. Shri Pravin J. Patil, SO/D, RSD
6. Shri Alok Pandey, SO/D, RSD
7. Shri R.K. Chaturvedi, SO/D, RSD
8. Shri Meghraj Singh, SO/D, RSD
9. Shri Ganesh Bokam, SO/D, RSD
10. Smt. Smita S. Haryan, UDC, Accounts

Group-4 (Review of Nuclear Projects)

1. Shri Fredric Lall, SO/H+, NPSD
2. Shri C.S. Varghese, SO/H+, NPSD
3. Shri Animesh Biswas, SO/F, NPSD
4. Shri D.V. Pimpale, SO/F, NPSD
5. Shri Anjit Kumar, SO/E, NPSD
6. Shri V.R. Dhotre, SO/D, NPSD
7. Shri S.T. Swamy, SO/G, NPSD

Group-5 (Nuclear Security)

1. Shri Fredric Lall, SO/H+, NPSD
2. Shri L.B. Mahale, SO/F, OPSD
3. Shri S.K. Pradhan, SO/F, NPSD

Group-6 (Radiological Safety Review of FCF)

1. Shri Soumen Sinha, SO/E, IPSD
2. Shri Nidhip M. Chodankar, SO/D, IPSD
3. Shri Mohandas P.V., TO/D, IPSD
4. Smt. Soumya Varghese, SA/D, IPSD

Official Language Implementation

Hindi section was in the thick of activity towards implementation related commitments for the period July-December 2013. The salient features of the activities are as follow:

The progress on the Regulatory Documents' Translation Project is much rewarding. Hindi section moved an inch closer to the goal of hundred percent bilingualization of all the codes, guides and standards published by AERB with the next lot of 33 documents all set to go ahead with the Hindi printing. In addition, the Annual Report, AERB bulletin and the Newsletter have also been translated in Hindi.

As part of the annual Hindi inspection schedule, Internal Hindi inspection was carried out in RSD on December 19, 2013. The inspection team included Smt. Sangeeta Nakhwa, AO-III and Shri K. Zahir Hussain, AD(OL) who had a detailed discussion with Head, RSD on effective implementation of OL in their division and to work out a strategy to enhance the Hindi output in the day to day work of the division.

Two Hindi workshops were conducted by the Joint Official Language Co-ordination committee of the five units of DAE situated in Anushaktinagar during the above mentioned period. The first one was held in Advanced Training Institute (ATI) between July 30, 2013 and August 01, 2013 in which three employees of AERB were nominated. The second joint Hindi workshop was organized in AERB between December 4 and December 6, 2013 and four employees from AERB were nominated for this workshop. Also, a half day Hindi workshop was organized exclusively for the Officers/employees of AERB on August 13, 2013. Fifteen Officers and employees from various divisions of AERB were nominated for this workshop.

A Hindi talk was held on Vipassana Meditation technique on August 23. 2013 for which the guest speaker was Ms Preeti Dedhiya, disciple of renowned Vipassana guru, Shri S.N. Goenka. The event attracted crowds in large number who listened in rapt attention and everyone savoured the sublime experience yearning for an encore.

On September 19, 2013, Hindi Day Celebrations were held in Multipurpose Hall, TSH, Anushaktinagar under the auspices of the Joint Official Language Co-ordination Committee of the five units situated in Anushaktinagar viz. AERB, DPS, DCSEM, HWB and BRIT. Padmavibhushan Dr. Jayant Narlikar was invited as the Guest Speaker who gave a talk on "Rashtriya Ekta, Vigyan aur Hindi Bhasha.

The guest speaker, Ms. Preeti Dedhiya (3rd from left) with AERB staff at the Hindi talk on Vipasana Meditation Technique

The Prize distribution function for the Hindi competitions organized in March, 2013 was held on December 09, 2013. Shri S.S.Bajaj, Chairman, AERB graced the occasion as the chief Guest and gave away the prizes to the winners.

AERB Annual Day Programme - 2013

The AERB Day Programme was celebrated on November 23, 2013 at AERB Lawns. Around four hundred and eighty personnel, which included AERB staff and their family members, graced the occasion. The programme started with the welcome address from Shri Vaibhav P. Gholap, Secretary, AERB Staff Club. This was followed by a musical and dance programme from AERB Staff and family artists. The family members of AERB staff presented a good cultural programme consisting of dances, songs, music etc. The winners of various sports tournaments conducted by Staff Club in the year 2013 were awarded prizes. The meritorious children of AERB employees were also felicitated. This was followed by presentation of AERB Awards. The artists of the programme were presented with mementos in appreciation of their talent and nice performance. A festive dinner hosted by AERB followed this programme

NSAD-SSED - Winners of the AERB Premier League - 2013

During the year 2013, sports tournaments were successfully completed for Cricket, Swimming, Brisk walk, Table Tennis, Badminton, Chess and Carroms. This year also in the AERB Premier League, a cricket tournament for AERBites, 6 teams from various divisions of AERB participated. The matches of 8 over a side were played. The winners of the competition were NSAD-SSED with Administration as runners-up.

Feature Article

Hydrogen Issues in Nuclear Reactor Containment

Vivek A. Kale and Avinash J Gaikwad
Nuclear Safety Analysis Division, AERB

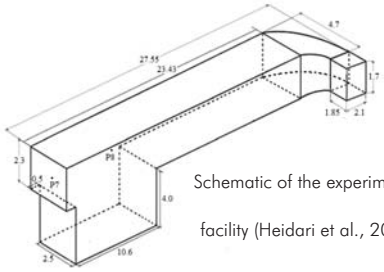
Study of distribution and combustion of hydrogen generated during severe accident in nuclear reactor containment has been a subject of interest for the past three decades since the Three Mile Islands (TMI) accident (1979). Recently, series of events at Fukushima (Japan) have accentuated the same concerns. Under unmitigated severe accident situations, the temperature and pressure loads caused by combustion of hydrogen released in the containment might lead to undesirable conditions. To prevent and mitigate such a situation the issues related to hydrogen generation, distribution and removal need to be investigated and resolved. Detailed modeling of hydrogen combustion mechanism is necessary to predict local temperatures and pressure loads and their impact on the structures. This will help in the design, analysis and review of the safety provisions in the containment as a whole to mitigate the effects of hydrogen or to prevent it altogether.

The pressures and the temperatures developed during such scenarios depend upon the combustion regime of the mixture. These modes can be broadly classified as diffusion flames and premixed flames. Diffusion flames usually do not lead to high pressure transients. Premixed flames can be classified as deflagrations and detonations.

Deflagrations are the flames travelling at subsonic speeds. Slow deflagration is the initial result of ignition with flame speeds few m/s and pressure rise is of the order of initial pressure. These can accelerate to high speeds where resulting pressures can be much higher than the initial pressure. Detonation is supersonic combustion regime with flame speeds greater than sonic speed in combustion products which can develop highest local pressures. Thus identifying the possible combustion regime is important in this regard. The possibility of encountering these regimes is predicted based on experimentally developed criteria such as σ (ratio of densities of reactants and products) and λ (detonation cell size) criteria. If the values of σ and λ corresponding to given mixture conditions exceed the critical values of σ and λ (determined empirically), flame acceleration to high speeds and transition to detonation can be expected.

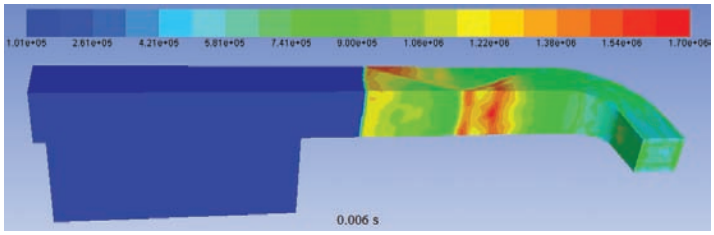
Considering the uncertainties involved in the sequence of events in the postulated low probability severe accidents and wide range of time and length scales associated with the hydrogen combustion process in the containment, CFD simulation is a useful tool to assess the influence of different parameters on the phenomenon. Appropriate models were selected to simulate deflagration and detonation processes i.e. eddy dissipation model for deflagration and Arrhenius kinetics for detonation and improvements were made in these models to resolve hydrogen issues.

An example of detonation calculation is presented here. Schematic of the experimental setup is shown in the following figure.



Schematic of the experimental facility (Heidari et al., 2011)

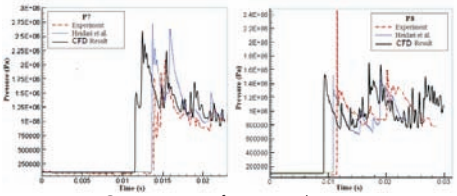
It is a closed channel filled with uniform hydrogen air mixture (25.5% H_2). Mixture is ignited at one end using high explosive charge (direct initiation of detonation). The reaction rate is modeled by global Arrhenius rate equation. Contours of pressure at a selected time step are shown in the figure below.



Contours of pressure (Pa) at a selected time step

Comparison of pressure histories obtained in the present work with the experimental and computational results from the literature (Heidari et al., 2011) are shown at two monitoring points (P7 and P8).

The predictions show reasonable agreement with the experimental results for the case presented here as well as for other simulated cases. The criteria mentioned above were also verified for the selected cases.



Comparison of pressure histories

The methodology developed is being extended to the study of hydrogen related phenomena in real scale containment. Realistic predictions require the use of multistep chemical kinetics for modeling reaction rates, finer temporal and spatial resolutions to capture the phenomena involved in high speed flow regimes, accurate modeling of regimes such as mixture ignition and transition to detonation. Development of such CFD capability at AERB for characterization of hydrogen combustion will help in the safety review of hydrogen related issues. Present study is an important step in this direction. Such studies at AERB will be helpful in carrying out independent verification of safety analysis carried out by utilities.

Feature Article

Evaluation of Failure Probability of NPP Components using Higher Order Response Surface Method

Jagannath Mishra
Safety Research Institute, Kalpakkam

The safety of a nuclear power plant (NPP) depends upon a number of factors – intrinsic and extrinsic to the plant. The probabilistic safety analysis of NPP is performed to quantitatively assess the risk posed by these factors. The basic ingredient of quantitative risk assessment is the estimation of failure probability of safety related components under these intrinsic and extrinsic loads. However, these components are designed based on working stress design method or load and resistance factor design method, which doesn't readily provide failure probability of these components under various loading states. This necessitates the development of a methodology based on structural reliability theory for evaluation of failure probability of components considering uncertainties in loading states defined by loads, material strengths and dimensions.

In this direction, a method based on Higher Order Response Surface Method (HORSM) is developed for evaluation of failure probability of components. The HORSM is based on response surface approach, which is computationally efficient and gives reasonably accurate estimate of failure probability. The developed method use orthogonal Chebyshev polynomial for order estimation of random variables, mixed-order selection and higher order response surface generation. This method is validated against the well known technique of Monte Carlo Simulation (MCS), which is the most accurate of all the available methods but is computationally too intensive and often prohibitive for components with low failure probabilities.

Figure-1 shows the comparison of the failure probability estimated from HORSM and other methods like First Order Reliability Method (FORM) and Higher Order Stochastic Response Surface Method (HOSRSM) for the limit state based on burst margin of the rotating annular disk. The limit state is highly non linear as shown in equation-1. The properties of stochastic parameters are listed in Table-1. For each iterations, which represent the 'seed value' of random number set used in the analysis, the failure probability estimated from the HORSM is fairly close to value estimated using MCS. Also the closeness of the predicted failure probabilities for all the ten iterations shows the robustness of the developed method.

$$g(X) = \sqrt{\alpha_m S_u \Big/ \left(\frac{\rho \left(\frac{2\pi\omega}{60} \right)^2 (R_0^3 - R_i^3)}{3(385.82)(R_0 - R_i)} \right)} - 0.37473$$

Equation-1

For the wider application of the developed method it is integrated with a finite element code. The integrated method helps in modeling of components in larger details for better prediction of the response as well as realistic representation of loads and boundary conditions. The developed method has the capability to assess the component failure probability under failure modes like plastic collapse, fatigue as well as instability of a postulated crack.

Table - 1

Random variables	Material utilization factor α_m	Ultimate strength of material S_u(lb/in2)	Material density r (lb/in3)	Angular velocity w (rpm)	Outer radius R_o(in)	Inner Radius R_i(in)
Distribution	Weibull*	Gaussian	Uniform†	Gaussian	Gaussian	Gaussian
Mean	0.9378	220000	0.29	21000	24	8
Standard Deviation	0.04655	5000	0.00577	1000	0.50	0.30

*Scale parameter = 25.508; shape parameter = 0.958.
†Uniformly distributed over (0.28–0.3).

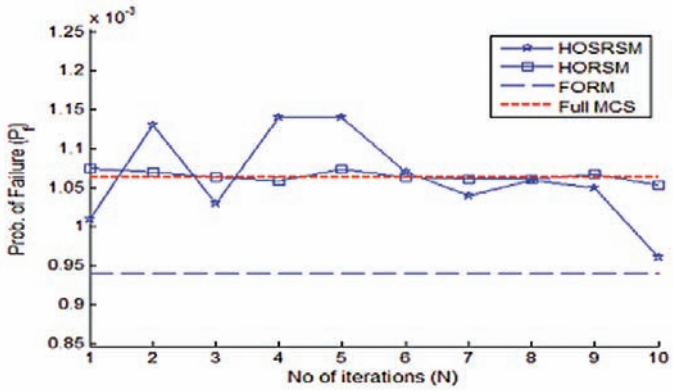


Figure-1: Probability of failure of rotating disk for 10 set of random numbers

The method has been demonstrated for failure probability estimation of two safety related components: (i) expansion bellow at RCB penetration and (ii) AHX of Safety Grade Decay Heat Removal system of PFBR.

(I) Expansion Bellow at RCB Penetration

Expansion bellows are used in the containment penetrations as

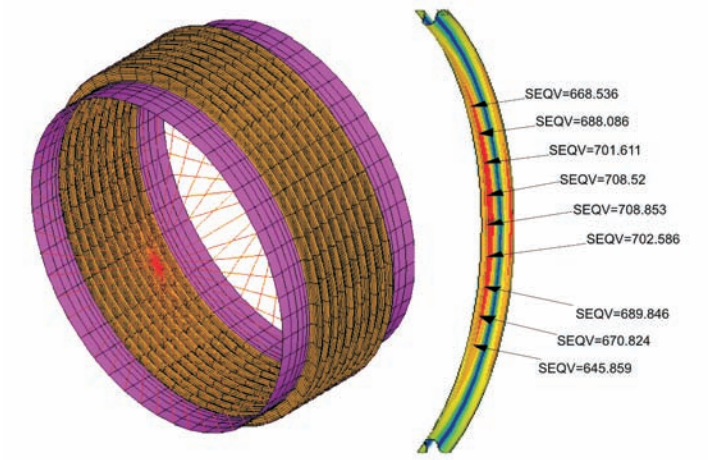


Figure-1: FE model and Von Mises stress range of expansion bellow at RCB penetration of PFBR

soft connection to mitigate the effects of differential movements between the penetrating pipe and containment shell. The bellow has lower design margins than that for other mechanical components and a potential source of leakage of contaminations to atmosphere in the event of failure of their structural integrity. An analysis of bellow under the operating load is carried out using its parametric finite element model. The predominant failure mode observed from the analysis of expansion bellow is low cycle fatigue. The FE model and Von Mises stress range in the bellow inner surface due to thermal expansion is shown in figure-2. The failure probability of bellow evaluated by HORSM is of the order of 1.0e-6. The low failure probability indicates that the expansion bellow will maintain

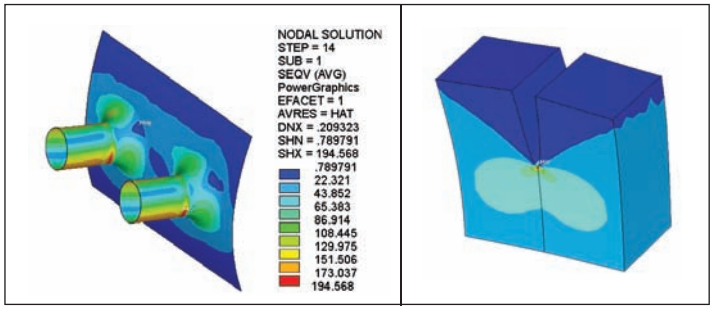


Figure-3: Stress profile during SSE (a) Von Mises stress in the header-tube junction (b) Stress profile near postulated crack

the structural integrity with high reliability at the normal operating condition.

(ii) AHX of Safety Grade Decay Heat Removal System

A fully dedicated and Safe Shutdown Earthquake (SSE) qualified Safety Grade Decay Heat Removal (SGDHR) system is available in PFBR for removal of decay heat from core. One of the most critical components of SGDHR system is Sodium Air Heat Exchanger (AHX) that dissipates decay heat from sodium to atmospheric air. In view of safety importance of AHX, failure probability of AHX is estimated for load during Safe Shutdown Earthquake (SSE). The result of seismic analysis of AHX along with intermediate piping systems shows that AHX header-tube junctions are the most stressed parts in this system as shown in the figure-3.

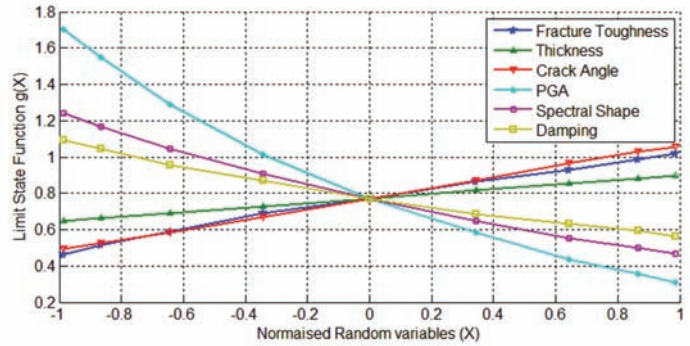


Figure-4: Sensitivity of limit state function g(X) with stochastic parameters

The failure probability of most stressed header-tube junction is estimated for two failure modes using well established R6 Method. The failure is defined by plastic collapse of header-tube junction and crack growth of AHX tube with a postulated 90^0 circumferential (conservative estimate) crack under SSE event. The variability is considered in the parameters like material toughness parameter, thickness of pipe, crack angle and SSE load defined by peak ground acceleration, spectral shape and spectral damping. Sensitivity analysis is carried out to find the dependence of limit state function on these parameters and is shown in figure-4. It is observed that SGDHR have very low probability of breach of its structural integrity under SSE events.

The two examples mentioned above has demonstrated that the developed method can be used for the failure probability estimation of actual components of NPP for operating and accidental load conditions. Since developed method is computationally efficient and robust, it will be useful to assess the reliability of important safety system of NPP during regulatory review of design.

e-Licensing System of AERB

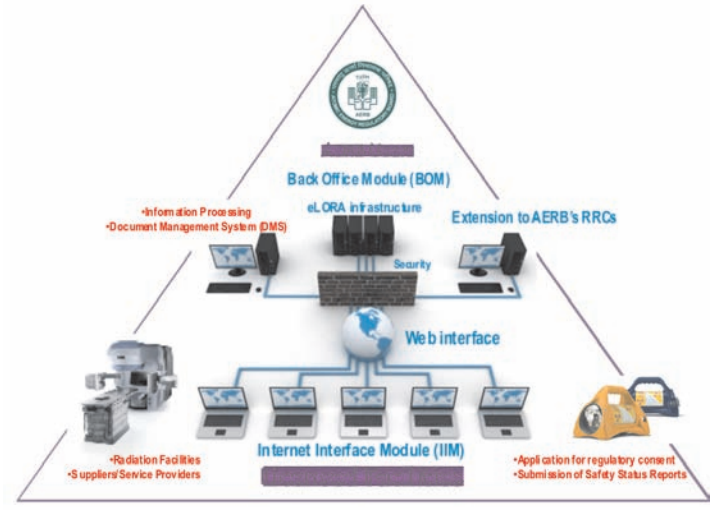
Introduction

As part of e-Governance initiative of AERB for delivering regulatory services and exchange of information between AERB and its licensed radiation facilities, AERB had initiated the implementation of a web-based system, named eLORA (e-Licensing of Radiation Applications).

About eLORA System

eLORA system is aimed for complete automation of regulatory processes associated with the use of ionizing radiation in India. The regulatory framework of eLORA system is compliant to AERB's Safety Guide on Consenting Process (SG/G-3) and Safety Manual (draft) on Regulatory Inspection Process (SM/G-3). eLORA system is built on web-based technology to ensure its availability across the globe through internet. Its robust architecture ensures complete business continuity and information security. Logically eLORA system is divided in to two parts, namely Internet Interface Module (IIM) and Back Office Module (BOM).

Internet Interface Module (IIM): IIM establishes a medium for exchanging information among AERB and the users of Radiation Facility / Supplier / Service Providers. This module is accessible only by the registered users through internet. These users are given with username and password for secure access to IIM. The IIM facilitate following:



1. Fast submission of requisite information to AERB
2. Inventory management of radioactive sources and radiation generating equipments and management of their Licenses
3. Management of institute employees such as Radiation Professionals and other radiation workers
4. Easy to fill e-forms for getting various regulatory clearances
5. Tracking the processing status of submitted applications
6. Management of measuring and monitoring equipments
7. Alerts, acknowledgement, notifications through email and SMS

Back Office Module (BOM): BOM is designed for AERB personnel to carry out core regulatory activities. This module is accessible to the users of AERB and facilitate following:

1. Improvement in efficiency as system has automated workflow for dispensing of cases
2. Improvement in data verification and validation capabilities as each submitted information is supported by documentary proof
3. Uniform workflow and checklist based review for consistency in decision making
4. Enable faster and efficient interactions with radiation facilities while dealing with users and public at large with transparency perceived
5. Generation of standard and ad-hoc reports from database for better decision making
6. Electronic management of documents using advance document management systems
7. BOM is scalable for extension to be used from Regional Regulatory Centres (RRCs) of AERB

Phase wise operation of eLORA system

As informed in our previous issue of newsletter, eLORA system was made operational for registration of Radiation Professional (RP) on May 3, 2013. This module permits Radiation Professionals (term 'Radiation Professional' referred in eLORA pertains to qualified radiation worker whose role is defined in relevant AERB safety code) to submit on-line application for registering themselves as Radiation Professional. Initially registration process was opened for professionals of Radiotherapy practice (viz. Radiation Oncologist, Medical Physicist, Radiotherapy Technologist and Service Engineers). The system is now also operational for registration of Radiation Professionals of Diagnostic Radiology (viz. Radiation Safety Professional and Service Engineers).

Update on e-LORA:
(As on February 18th 2014)

Status of diagnostic radiology related regulatory activities through e-LORA	
Institution applied	151 (RT) + 1425 (DR) = 1576
Institution approved	68 (RT) + 1048 (DR) = 1116
Institutes Operational in eLORA	1116 (newly registered) + 239 (migrated existing RT institutes) = 1355
Radiation Professional applied	2357 (RT) + 675 (DR) = 3032
Radiation Professional approved	1189 (RT) + 390 (DR) = 1579
Number of X-ray equipments declared	2605
Record Licence for Operation of X-ray Equipment	75

RT = Radiation Therapy, DR = Diagnostic Radiology.

(Contd. on page 18)

NOTICE

FOR USERS OF RADIOACTIVE SOURCES & RADIATION GENERATING EQUIPMENT

IT IS AN OFFENCE TO POSSESS OR USE RADIOACTIVE SOURCES* OR RADIATION GENERATING EQUIPMENT# WITHOUT A VALID CONSENT, ISSUED BY ATOMIC ENERGY REGULATORY BOARD (AERB), UNDER THE PROVISIONS OF ATOMIC ENERGY ACT, 1962 AND ATOMIC ENRGY (RADIATION PROTECTION) RULES, 2004.

Statutory requirements to possess or use radioactive source or radiation generating equipment are:

- Must have a valid consent (licence) from AERB
- Install only type-approved equipment
- Ensure safety and security of radiation sources at all time
- Follow radiation protection requirement
- Ensure periodic Quality Assurance checks as applicable
- Send periodic safety report to AERB
- Ensure safe disposal of sources not in use with due approval from AERB

Detailed information and relevant application forms may be downloaded from AERB website http://www.aerb.gov.in

*Radioactive Sources include, radioisotopes used in:

- Gamma Irradiator
- Gamma Chamber
- Industrial Radiography
- Nucleonic Gauge
- Well Logging
- Radiotherapy
- Nuclear Medicine
- Research Applications etc.

#Radiation Generating equipment include, all accelerators and X-ray devices used in:

- Radiotherapy
- Medical Cyclotron
- Computed Tomography
- Diagnostic Radiology
- Industrial & Research Accelerator
- Industrial Radiography
- Baggage Scanner etc.

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Niyamak Bhavan, Anushaktinagar
Mumbai - 400094

(Contd. from page 17)

On August 12, 2013, eLORA system was made operational for Radiotherapy institutes. For Radiotherapy institutes which are already licensed by AERB, AERB is creating their account and sending usernames of functional users (viz. Employer, Licensee and RSO) by post and password to each individual by email to ensure complete authenticity. For new/up-coming Radiotherapy institutes, an Institute Registration in eLORA system is required. For Institute Registration, an e-form is available on eLORA home page. Initially the system was made operational for Radiotherapy institutes located at Mumbai and later on other institutes are being released in a phased manner.

On October 17, 2013, extension for diagnostic radiology was released in eLORA system. This module permits users of Diagnostic Radiology institutes to register their institute in eLORA and declare their existing equipments. Also, diagnostic radiology module was extended for obtaining operational licence for existing x-ray equipments.

In order to provide operational training on eLORA, AERB conducted series of training programs at Mumbai, Bangalore, Hyderabad and Delhi. AERB is also planning to conduct more training sessions in coming days in other cities of India.

Government of India
ATOMIC ENERGY REGULATORY BOARD

सत्यमेव जयते

ATTENTION ALL OWNERS/ USERS OF MEDICAL DIAGNOSTIC X-RAY EQUIPMENT!!

It is a statutory requirement to obtain Licence/ Registration from Atomic Energy Regulatory Board (AERB) from radiological safety point of view to operate medical diagnostic x-ray equipment such as:

Interventional Radiology (Cath Lab), Computed Tomography, C-Arm, Radiography & Fluoroscopy/ Radiography (fixed/ mobile/ portable), Mammography, Dental Radiography, BMD.

To facilitate the Licencing process AERB hereby announces the launch of the e-Governance system, i.e., e-LORA (e-Licensing of Radiation Applications). Henceforth, all licenses will be issued through e-LORA system only.

The steps involved to obtain AERB Licence/Registration are:

1) Register your Institute through e-LORA
2) Declare your X-ray equipment details on-line
3) Record your Licence details on-line, if Licence is already obtained
4) In case valid Licence is not available, obtain Licence/ Registration for operation through e-LORA

Owners/users who have already obtained AERB Licence/Registration under the Atomic Energy (Radiation Protection) Rules 2004, should also declare the X-ray equipment details and record the Licence details in e-LORA.

For further guidance, please visit AERB website: www.aerb.gov.in






Home Page

Personnel Joined (July – December 2013)

Sr. No.	Name	Designation	Date of Appointment
1.	Shri Sandeep Alajpur	SA/B	02/07/13
2.	Shri Pavan Jadav	SA/B	02/07/13
3.	Shri N. Durga Prasad	SA/B	02/07/13
4.	Shri A. Raju Suryateja	SA/B	02/07/13
5.	Smt. Y. Shobhasri	SA/B	02/07/13
6.	Shri Tanay Walhekar	SO/C	11/07/13
7.	Shri Mahesh Kareti	SO/C	27/07/13
8.	Shri Rakesh Kumar	SO/C	24/07/13
9.	Smt. Arati R. Samant	UDC	01/08/13
10.	Kum. Ananya Mohanty	SO/C	01/08/13
11.	Kum. Purva Dhawan	SO/C	01/08/13
12.	Shri Suvadip Roy	SO/C	01/08/13
13.	Shri Amandeep Singh	SO/C	01/08/13
14.	Shri Karthik R.	SO/C (SRI)	01/08/13
15.	Shri Mallepula Madhu	SA/B	17/09/13
16.	Shri Lakshmanan Raj	SA/B	17/09/13
17.	Smt. Nalini Balachandran	APO	18/09/13
18.	Shri Mohd. Chand Pasha	SA/B	15/10/13
19.	Smt. Kayathiri R.	UDC (SRRC)	11/11/13
20.	Smt. Rhoshitha S. Nair	UDC	27/11/13

Personnel Retired (July – December 2013)

Sr. No.	Name	Designation	Retirement
1.	Shri V. S. Iyer	SO/E	30/11/13

Personnel Transferred (July – December 2013)

Sr. No.	Name	Designation	Date of Transfer
1.	Shri Sudhanshu Sekar Singh	SO/D	Transferred to SRI, Kalpakkam
2.	Shri S. V. Chavan	APO	Transferred to BARC on 19/09/13
3.	Smt. Vaibhavi Y. Lad	Assistant	Transferred to DAE on 08/11/13
4.	Kum. Saptaparna Sarkar	SO/C	Transferred from SRI, Kalpakkam on 02/12/13

Honours


Dr. A.U. Sonawane

Dr. A. U. Sonawane, Head, RSD, AERB has been honoured with "NDT Achievement Award-2013 for Training/Education" on September 20, 2013 by the India Society for Non-Destructive Testing (ISNT), Mumbai Chapter for his outstanding contribution in training, education and organizing awareness programme in NDT applications of radiation sources.


Dr. Pankaj Tandon

Dr. Pankaj Tandon SO/G, RSD has been awarded the Fellow of Indian College of Nuclear Medicine, an academic wing of the Society of Nuclear Medicine, in recognition of significant contributions to the advancement of Nuclear Medicine in India on December 13, 2013 during the 45th annual conference of Society of Nuclear Medicine, India at Nehru Science Centre .


Shri G. Sahani

Shri G. Sahani, Scientific Officer (E) was awarded Ph.D. (Science) in Physics by the University of Mumbai for his thesis on 'Studies on Effective Patient Dose Delivery Using Telecobalt Radiation Therapy Unit with Multileaf Collimators (MLCs)' carried out under the guidance of Dr. D.N. Sharma, Director, Health, Safety and Environment Group (HSEG), BARC.

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