Vol. 18 No. 2-3
April-September 2005

AERB Newsletter

ATOMIC ENERGY REGULATORY BOARD

CONTENTS

Editor :-
Smt. Sutapa Bhattacharya, AERB,
sbhattacharya@aerb.gov.in

Editorial Consultant :-
Dr. S.R. Dwivedi, Ex-BARC

From the Chairman's Desk

Consequent to India ratifying the Convention on Nuclear Safety (CNS) an Indian delegation attended the third review meeting of the contracting parties to CNS, held during April 11- 22, 2005 in Vienna, as observers. There was substantial representation from AERB in this delegation. We benefited significantly from this experience and this would help us a great deal in preparing our country report for presentsation in the next review meeting, which is scheduled for April 2008.

AERB gives high importance to training of its staff for efficient functioning of the organisation. As AERB manpower is being augmented at various levels, an in-house AERB training course was conducted in June 2005 to familiarise our new colleagues with the regulatory work methodology of AERB. Thereafter they were deputed to various training centres attached to utilities for on-the-job training.

During April to September 2005, AERB had a busy schedule of reviewing proposals for various clearances from different units. The significant authorizations issued by AERB during this period were: permission for beam injection into Indus-2 at the Centre for Advanced Technology, Indore, authorisation for commencement of development work of Bagjata mine of Uranium Corporation of India Ltd., authorisation for Phase-C Commissioning i.e. 90% power production of Tarapur Atomic Power Project Unit-4 and permission for restart of construction of Nuclear Island Connected Building Raft of Prototype Fast Breeder Reactor, Kalpakkam.

An International workshop was conducted at the AERB's Safety Research Institute, Kalpakkam on "Flooding Hazard at NPP sites" during the week starting 29th August 2005. This was jointly organised by the IAEA, AERB and NPCIL. Various aspects of flooding at the NPPs, including flooding that can be caused by tsunamis were presented by experts from different parts of the world. The deliberations were of high technical order and the participants derived significant benefit from this workshop.

AERB organised a discussion meeting on August 26, 2005 to address its concern about fatal accidents at construction sites. The meeting stressed on industrial safety while working at heights and emphasised the importance of training, availability of proper access to work-spot, various safety measures needed and good supervision. It was agreed that all construction sites will implement the recommendations arising from the discussions in the meet and AERB will conduct special regulatory inspections to confirm compliance.

In September 2005 the sixth discussion meeting was held at Washington D.C. under the AERB-USNRC nuclear safety co-operation. The topic covered in this discussion meeting included severe accident analysis and accident management guidelines, seismic systems reliability evaluation and long-term performance of concrete structure. Substantial progress has been made under this co-operation and now it has been proposed to expand the scope of work by exploring possibilities of working on analysis of some standard problems and inter-comparison of results. It has also been agreed that USNRC will host two engineers of AERB for a period of 6-8 months beginning around April 2006.

With this newsletter a new series is being started to depict safety and its enforcement by AERB in different facilities of DAE. We are starting with the field of mining and milling of uranium, the starting material for nuclear power generation.

(S. K. Sharma)

Convention on Nuclear Safety

After the ratification of the Convention on Nuclear Safety (CNS) by India on March 31, 2005, an Indian delegation attended the third review meeting of the CNS contracting parties, as observer, during April 11 – 22, 2005 at the IAEA's Head Quarters in Vienna, Austria. The delegation was led by Shri S.K. Chande, Vice-Chairman, AERB.

The aim of the CNS is to legally commit participating States operating land-based nuclear power plants to maintain high level of safety. The obligation covers provision of adequate financial and human resources, assessment and verification of safety, quality assurance and emergency preparedness. The convention is an incentive instrument and is designed to ensure fulfillment of obligations by the contracting parties through their common interest to achieve high levels of safety to be developed and promoted through discussion in regular meetings of the parties. The convention obliges parties to submit reports on the implementation of their obligations and subject it to 'Peer Review' at meetings of the parties that are held every three years. The contracting parties who ratify the CNS at a date that is less than three months before the meeting attend the review meeting as observers and are not required to submit their report for that meeting. Accordingly India did not submit any report for the review meeting. The participation of the Indian delegation in this 'Peer Review' meeting was very useful in acquainting themselves with the review process and will be helpful for presentation in the next Review Meeting to be held in April 2008.

The CNS was adopted on June 17, 1994 and entered into force on October 24, 1996. As on today, there are 65 signatories to the convention and 55 contracting parties including countries like USA, Russia, UK, France, Germany, Japan and Canada. ●

Right to Information Act, 2005

AERB has designated Shri S.K.Chande, Vice Chairman, AERB as Appellate Authority, Dr. Om Pal Singh, Secretary, AERB as Public Information Officer and Shri A. Ramakrishna, ITSD, AERB as Assistant Public Information Officer as required under sub-section 1 and 2 of section 5 and sub-section 1 of section 19 of Right to Information Act, 2005. Their contact details are given below:

Appellate Authority	Shri S.K. Chande Vice-Chairman, AERB Niyamak Bhavan, Anushaktinagar, Mumbai-400094	Telephone : 022-25574024 (O) Email: vc@aerb.gov.in
Public Information Officer (PIO)	Dr. Om Pal Singh Secretary, AERB & Director, ITSD, AERB Niyamak Bhavan, Anushaktinagar, Mumbai-400094	Telephone : 022-25576255 (O) Email: ompal@aerb.gov.in
Assistant Public Information Officer (APIO)	Shri A. Ramakrishna ITSD, AERB Niyamak Bhavan, Anushaktinagar, Mumbai-400094	Telephone : 022-25572989 (O) 2316 (Ext.) Email: aramakrishna@aerb.gov.in

The AERB Fire Safety Award for 2004 was won by Heavy Water Plant Kota. Chairman AERB presented the trophy during a workshop held at AERB on the Fire Safety Day, April 14, 2005. ●

Press Release :

AERB Authorises Power Operation of Tarapur UNIT-4 (May 12, 2005)

After authorisation by Atomic Energy Regulatory Board (AERB), the First Criticality of the indigenously designed 540 MWe Tarapur Atomic Power Station Unit-4, was achieved on March 6, 2005. Subsequent to the reactor criticality, a series of commissioning tests were conducted over a period of about two months. The results of these were reviewed by the Project Design Safety Committee and subsequently by the Advisory Committee for Project Safety Review following the multi-tier safety review process established in the AERB. Based on these reviews, AERB authorised Nuclear Power Corporation of India Ltd. (NPCIL) on May 12, 2005 to operate the reactor upto 50 % of Full Power. Authorisation for raising of Reactor Power beyond 50 % full power would be granted in stages after satisfactory review of the performance of the unit at each stage. ●

Authorisations Issued By AERB

1. Permission for stage 2 of Indus-2 commissioning involving extraction of 700MeV beam from Indus-1 Booster Synchrotron and its transfer to Transport Line –3 up to the beam dump of Indus-2, at the Centre for Advanced Technology, Indore (April 15, 2005).
2. Permission for Installation of Main Steam Lines and their Supports for RAPP Unit-5 (April 19, 2005).
3. Authorization for development of Bagjata mines of Uranium Corporation of India Ltd. (April 21, 2005).
4. Permission for Restart of Construction of Nuclear Island Connected Building (NICB) Raft of Prototype Fast Breeder Reactor, Kalpakkam after its rehabilitation from the damage caused by flooding due to the tsunami event of 26 December 2004 (April 25, 2005).

5. Authorization for Phase-C Commissioning of Tarapur Atomic Power Project Unit-4 (May 12, 2005).
6. Authorisation for Postponement of the start of the simultaneous extended Outage of TAPS-1&2 for carrying out safety up-gradation work by three months (June 24, 2005).
7. Authorisation for Modification of Spent Fuel Bay Design of TAPP-4 (June 27, 2005).
8. Authorisation for Erection of Major Equipment for RAPP unit-6 (July 15, 2005).
9. Permission for Construction of Perimeter wall around Nuclear Island Connected Building (NICB) and certain safety related buildings and structures viz., Diesel Generator Building (DGB), Sea Water Pump House (SWPH) and foundation structure of Horton Sphere for Nitrogen Storage for Prototype Fast Breeder Reactor (August 11, 2005).
10. Renewal of Authorisation for Operation of RAPS Unit-2 (September 1, 2005).

●

AERB - USNRC Discussion Meeting

The sixth meeting under the AERB-NRC nuclear safety cooperation was held in the Washington D.C. at the NRC head quarters. A seven member Indian delegation led by Shri S.K.Chande, Vice Chairman, AERB participated in this discussion meeting during September 26-30, 2005. The team also visited a few U.S. nuclear facilities. The topics covered during the meeting were 'severe accident analysis and accident management guidelines', 'passive system reliability evaluation' and 'long term performance of concrete structure'. The Indian delegation presented information on severe accident studies for Indian pressurised heavy water reactors, accident analysis and vessel integrity assessment in the prototype fast breeder reactor and containment structures and on high performance concrete and reliability evaluation of passive systems. Discussions at preliminary stage were also held on possibilities of including analysis of standard problem on thermal hydraulics and severe accidents. It was agreed that subject to the availability of resources the standard problem exercises would be initiated in the area of thermal hydraulics, area for severe accident analysis and containment safety margin for assessment of ultimate load capacity of pre-stressed concrete containment structure. The proposal for deputation of two AERB engineers to NRC was also processed and it is expected that the assignment may commence after the first quarter of 2006.

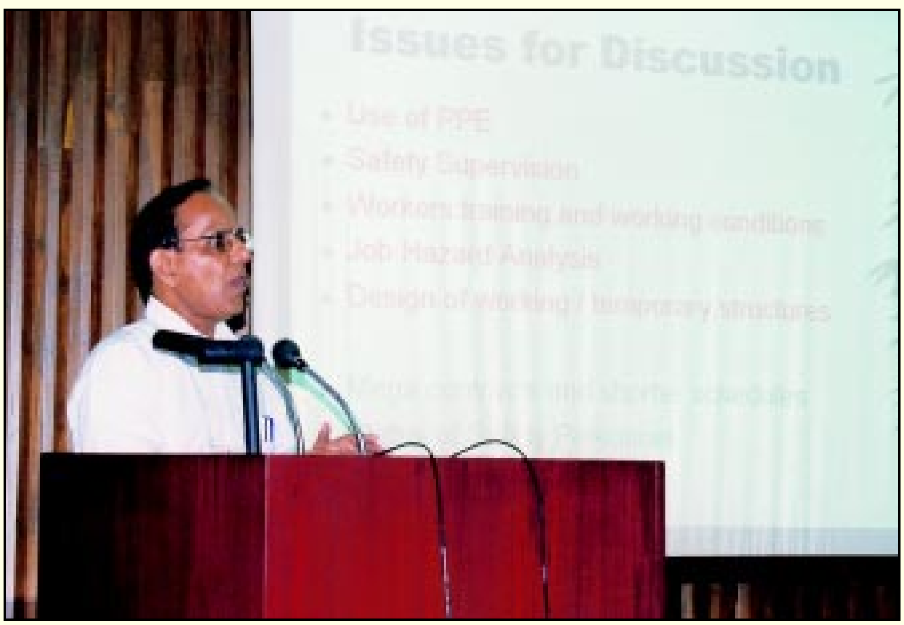
●

Discussion Meeting on Industrial Safety With A Focus on Fatal Accidents

Keeping in view the large number of fatal accidents that occurred in the recent past at various DAE units especially at the construction sites, the Atomic Energy Regulatory Board organised a discussion meeting on Industrial Safety at Niyamak Bhavan, Mumbai on August 26, 2005. The statistics on fatal accidents and their analysis, the root causes of these accidents and the issues which needs special attention based on the accident investigations were presented by officers of Industrial Plants Safety Division of AERB. Senior executives from Nuclear Power Corporation of India, which has major construction sites and from Uranium Corporation of India Limited, Indian Rare Earths Limited, Nuclear Fuel Complex and Heavy Water Board, expressed their views on improvements that need to be adopted. After the presentation a panel discussion was held where the topics of Job Hazard Analysis (JHA), design of working platforms and temporary structures, use of personal protective equipment, improved supervision, workers training and safe working condition were discussed. The panel discussion brought out the importance of ensuring safe and engineered working condition and proper access to reach work-spot while working at height. Identification of jobs, which requires JHA and use of JHA to develop appropriate procedures/ checklist for the execution of job was stressed. Action in terms of inclusion of specific industrial safety requirements in tender document while awarding contract for any job to be carried out by outside agencies; strengthening of safety organisation at corporate level and

Discussion meeting on Industrial Safety on Aug 26, 2005, sitting in the audience on the first row from left CMD, IREL; DyCE,NFC; CMD, UCIL; CMD, NPCIL and Chairman AERB.

Discussion meeting on Industrial Safety on Aug 26, 2005, Shri. S. K. Jain, CMD, NPCIL making a point during discussion. Standing on dias Shri. P. K. Ghosh, Director IPSD.



Discussion meeting on Industrial Safety on Aug 26, 2005, Shri S. K. Charde, Vice Chairman AERB, addressing during panel discussion.

proper knowledge in-terms of qualification for safety personnel as notified by AERB were the other important aspects that were emphasised during this discussion. At the end of the meet, it was agreed that all units will incorporate the improvements as identified during the discussions and AERB will conduct special inspections to check and verify the adequacy of the improvements made. ●

World News:

U.S. President Bush Calls For Law Change To Encourage N-Plant Investors :

US president George Bush has asked for changes in the law to reduce uncertainty in the nuclear plant licensing process and provide federal risk insurance that will protect investors in new nuclear power plants. Mr. Bush told a small business conference in Washington on 27th April 2005 that if the US is to become less dependent on foreign energy it must start building nuclear power plants again. But he said one of the greatest obstacles the US faces to building new plants is regulatory uncertainty, which discourages new plant construction. "Since the 1970s, more than 35 plants were stopped at various stages of planning and construction because of bureaucratic obstacles," said Mr. Bush. "No wonder – no wonder – the industry is hesitant to start building again." Mr. Bush said he had already asked the Department of Energy (DOE) to work on changes to the law that would make it less risky to invest in new nuclear power plants. "We must provide greater certainty to those who risk capital if we want to expand a safe, clean source of energy that will make us less dependent on foreign sources of energy," he said. Mr. Bush also said that if the US is to become less dependent on foreign sources of energy, a national strategy is needed. "And I submitted a national strategy to the United States Congress. And it has been stuck." Mr. Bush said now is the time for Congress to pass the legislation necessary for the US to become less dependent on foreign sources of energy. The US, said Mr. Bush, has not ordered a new nuclear power plant since the 1970s. He said France, by contrast, has built 58 plants in the same period and today gets more than 78% of its electricity from nuclear power. "It's time for America to start building again. That's why, three years ago, my administration launched the Nuclear Power 2010 Initiative." Mr. Bush said this is a seven-year, 1.1 billion US dollar (USD) effort by government and industry to start building new nuclear power plants by the end of this decade. Mr. Bush said he had also asked Congress for USD 500 million over five years to help move advanced technology vehicles from the research lab to the dealership. "To help produce fuel for these cars, my administration has launched a Nuclear Hydrogen Initiative, an effort to develop advanced nuclear technologies that can produce hydrogen fuels for cars and trucks. My budgets have dedicated USD 35 million over the past three years and will continue this effort." He said the US will explore ways to work with like-minded countries to develop advanced nuclear technologies that are safe, clean and protect against proliferation. "With these technologies, with the expansion of nuclear power, we can relieve stress on the environment and reduce global demand for fossil fuels." Meanwhile, the Nuclear Power 2010 Initiative was the focus of a Senate committee hearing this week, with a nuclear industry executive testifying that the time has come to create the business conditions to build new nuclear power plants. Constellation Energy vice-president and president of the Constellation Generation Group Michael Wallace called for support for the initiative. "Limited federal investment in a limited number of new plants for a limited period is necessary and appropriate to overcome the financial and economic hurdles," Mr. Wallace told the Senate Energy and Natural Resources Committee on 26th April 2005. "Federal investment protection is necessary to manage and contain the one type of risk that we cannot manage – namely, the risk of a regulatory failure, including court challenges, that delays construction or commercial operation." Mr. Wallace said building new nuclear power plants will help maintain the fuel and technology diversity that is the core of the US electric supply system. "New nuclear plants can provide future price stability and can play a leading role in meeting US clean air goals and reducing greenhouse gas emissions." Testifying before the same committee, US Nuclear Regulatory Commission (NRC) chairman Nils Diaz said the NRC has a solid process in place to licence new nuclear power plants in the US, but could face challenges in assigning resources to handle a possible influx of licence applications. Components of the NRC's licensing structure for new reactors – design certification, early site permits and the combined construction and operating licence – "are providing a means to enhance safety for nuclear power generation in the future," Mr. Diaz told the committee.

.......*The White House / Constellation Energy/ NRC Editor: David Dalton* - NucNet.

Safety Research Institute of AERB hosts 'IAEA International Workshop on External Flooding Hazards at NPP Sites'-Jointly Organized by Atomic Energy Regulatory Board and Nuclear Power Corporation of India Ltd.:

The International Atomic Energy Agency (IAEA), AERB and NPCIL jointly organized an "*International Workshop on External Flooding Hazards at NPP sites*" at the Safety Research Institute (SRI) of AERB at Kalpakkam, Tamilnadu during August 29 to September 2, 2005. Dr. Anil Kakodkar, Chairman, Atomic Energy Commission inaugurated the workshop and Shri S.K. Sharma, Chairman AERB presided over the inaugural session. Mr. Ken Brockman, Director, Division of Nuclear Installation Safety, IAEA represented the IAEA at the workshop.

The Workshop was an expert meeting in the field of safety of Nuclear Power Plant (NPP) against external flooding with emphasis on tsunami. The main objective was to share experience of the regulatory bodies, designers, and nuclear facilities from point of view of hazard assessment in connection with the external flooding. The workshop aimed at directing protective measures, monitoring and warning signals and compilation and sharing of good practices and lessons learned from external flooding. The workshop also identified future work to be undertaken for external flooding hazard with emphasis on tsunami hazard.

Around 80 experts participated in the workshop, 44 from India, 4 from UN/IAEA and 32 from 15 other IAEA Member States. The technical sessions covered experiences and case studies on external flooding hazards, current methodologies and techniques for tsunami warning systems, emergency planning and preparedness, and regulatory requirements. The panel discussion towards the conclusion of the event focused on 'methodologies and techniques for tsunami hazard assessment' and 'tsunami warning systems and NPP operational safety'.

The technical deliberations during the workshop brought out the necessity of conducting periodic review of external flood hazards in view of recent events, need for revision of existing safety guides on external flooding hazard, and development of a unified procedure on tsunami hazard evaluation. It was noted that there is good scope for global and regional cooperation in the area of tsunami hazard assessment like data collection on global and local scales, modeling/ simulation, validation of computer models/codes, estimation of probable maximum tsunami for a given site and characterisation of tsunamigenic earthquakes. ●

Permission for Restart of Construction of Nuclear Island Connected Building (NICB) Raft of Prototype Fast Breeder Reactor (PFBR), Kalpakkam

During the tsunami event of December 26, 2004, the partly constructed NICB raft of Prototype Fast Breeder Reactor (PFBR), Kalpakkam got adversely affected because of flooding of NICB pit with seawater. Hence, AERB had put a hold on further construction of the raft and had asked site to submit detailed report on the impact of the event, the rehabilitation measures proposed to be taken and the design changes required, if any. Subsequently, a detailed incident report covering impact assessment, action plan for corrective measures and application for restart of construction of NICB raft was submitted by PFBR and reviewed by PDSC-PFBR and CESC, and then by ACPSR-FBR. Based on these reviews, AERB granted permission for restart of construction of NICB Raft on April 25, 2005. ●

Modification of Spent Fuel Storage Bay Liner Design of TAPP-4

The various NPCIL proposals to modify the design of Spent Fuel Storage Bay (SFSB) of TAPP-4, with a view to avoid sub-soil water coming in contact with the stainless steel liner of the bay were reviewed and AERB granted permission for the modification of SFSB liner design on June 27, 2005. ●

Medical Cyclotrons commissioned

In addition to the medical cyclotron already operating at Radiation Medicine Centre, Parel, Mumbai, two more medical cyclotrons were commissioned – one in government sector at AIIMS, New Delhi and one in private sector at Apollo Hospitals, Hyderabad. AERB has reviewed the Preliminary Safety Analysis Reports of these Cyclotrons and was present as observer during the commissioning. Four more medical cyclotrons are in the planning stages at -R & R Hospital, Delhi, INMAS, Delhi; Healthcare Global Advanced Imaging Private Limited, Bangalore; and IBA Molecular Imaging India (Pvt) Ltd., Noida.

Medical cyclotrons are used for production of positron emitters such as ^{11}C, ^{13}N, ^{15}O and ^{18}F, mainly through p-n reactions. These radionuclides are short lived, having half-lives of the order of minutes. Thus these radionuclides are produced at the site of their utilization using a medical cyclotron. Application areas of these radioisotopes in positron emission tomography (PET) are oncology, neurology, cardiology, vascular studies, etc for nuclear imaging of organs. ●

Authorization for operation of Turamdih Mine

Uranium mine located at Turamdih in the Jharkhand district, after initial exploration by Atomic Mineral Division was closed and sealed in May 1992 . Uranium Corporation of India Ltd.(UCIL) applied to AERB for mining of uranium ore from Turamdih underground mine and Transportation to Jaduguda Mill in July 2001. The Safety Committee for UCIL after review decided that the authorisation of Turamdih mine would be given in three stages namely 'Opening of mine seals and dewatering', 'Development of the mine to operate', & 'Mining and ore transportation to mill'.

Turamdih ore deposit contains three superimposed ore horizons viz. upper horizon, intermediate horizon and lower horizon at approximate depths of 70 m, 120m and 180m from surface and with a potential to operate upto 250mtre underground. Presently, working at upper and intermediate horizon are planned.

Turamdih is a fully mechanized mine using vehicles for transporting man to all operating points and mechanized drilling and mucking machines. Access to Turamdih underground mine is through a decline and vertical shaft. Major equipment used are Drill Jumbo, Load, Haul & Dump (LHD), Low Profile Dump Truck (LPDT), Motor Grader etc. The ventilation provision of the mine is through two large openings from surface to the underground with exhaust fan at the surface, located at central and western end of mine which is sufficient for production capacity of 550 TPD production.

After appropriate review, authorizations for stages 1 and 2 were issued to UCIL during December 2001, December 2002. The final authorization for 'Mining and ore transportation to mill' was issued in August, 2005 for a maximum rate of 550 Tons per day. The stipulations for the authorizations were mainly on radiological monitoring, that is providing personal dosimeter to all workers, restricting average dose to the workers by controlling the occupancy time and improved ventilation, use of PPEs in high dust area, transportation of ore and tailings with adequate free board in the transport vehicles and appropriate cover etc. ●

Authorization of Accelerator at CAT, Indore

Charged particles emit electromagnetic radiation when they are accelerated forcing them to follow a curved path in a magnetic field. In synchrotrons and storage rings, electron bunches at relativistic energies are forced to traverse curved paths by the bending magnets. The radiation emitted during bending, referred to as synchrotron radiation, has several important characteristics including high intensity, broad spectral range, natural collimation, high polarization, pulsed time structure and small source size. Any or combination of these properties makes synchrotron radiation an important scientific tool for a wide variety of research in materials science, molecular biology, geology, chemistry and medicine.

A high power accelerator, named as Indus-2, using Synchrotron Radiation Source (SRS) with output electron beam energy of 2.5 GeV and beam current upto 300 mA, is being setup at Centre for Advanced Technology (CAT), Indore. This SRS facility will produce electromagnetic radiation from infra-red to hard X-rays for various experimental purposes. The electron beam for Indus-2 will be fed from a Booster Synchrotron, of 700 MeV. The 700 MeV booster synchrotron named as Indus-1 receives electron from a microtron source of 20 MeV.

The design and safety aspects of Indus-2 has been submitted to AERB, and an in depth review has been carried out by the AERB Safety Committee for CAT. The Safety committee has decided to review the proposal for Indus-2 in six stages. The first stage was increasing the output of beam energy of Booster Synchrotron of Indus-1 from 450 MeV to 700 MeV, the second stage was transporting the beam upto the crossroads of Indus 2 which is a tunnel. The third stage is the input of the beam to the Indus-2 ring and its acceleration up to 2 GeV energy and 50 mA beam current.

The third stage for authorization was forwarded to the Safety Review Committee for Operating Plants (SARCOP) of AERB for review and SARCOP agreed for authorization on August 10, 2005 for the beam, injection to Indus 2, The recommendations for the permission were related to prevention of inadvertent beam injection during Indus-1 operation into Indus-2, modification in search and scram system of the accelerator and preparation of document from safety point of view. ●

SAFETY AND ENVIRONMENTAL ASPECTS IN PROCESSING OF URANIUM

Sutapa Bhattacharya, Industrial Plants Safety Division, AERB

1.INTRODUCTION

Uranium Corporation of India Limited (UCIL) presently carries out extraction of Uranium ore in India from the four underground mines namely Jaduguda Mine, Bhatin Mine, Narwapahar Mine and Turamdih Mine located in the Singhbhum belt. Jaduguda is the first uranium mine opened in India in late 1950s and is the deepest of the presently operating underground mines. Narwapahar and Turamdih mines are the most modern mines in the country, highly mechanized with trackless vehicles used for movement of men and material. Two more mines in the same belt are under development by UCIL, one at Bagjata; an underground mine and one at Banduhurang, the first opencast uranium mine in the country. Proposals for two more mines one at Lambapur in Andhra Pradesh and the other at Tummalapalle in Karnataka are under consideration for development. The average ore grade in these mines is very low. Where Australia and USA extract ore at the level of >0.1 % U_3O_8 and in India it is < 0.1%. Relatively higher-grade ore source is available in Domiasiat in Meghalaya and this area will also be taken up for uranium mining at a later date.

2.ORE PROCESSING

The ore excavated from mines is transported by road to the ore processing plant i.e. the uranium mill at Jaduguda. The ore is crushed, wet ground, made in pulp, and than leached with acid in the presence of pyrolusite as oxidant. The liquid part containing uranium is separated by filtration, purified and concentrated using ion exchange process. The strong eluate with higher uranium concentration is reacted with magnesium oxide slurry to obtain the final product Magnesium- di-uranate that is commonly called the yellow cake.

3. TREATMENT OF WASTES

The ground ore after extraction of uranium in combination with the reagents added in processing at mill emerges as waste or tailings. The tailings comprise of solids and barren liquor from mill has radioactivity because of presence of radium and other radionuclides. This is treated with lime. The treated tailings are separated into coarse and fine fractions. The coarse fraction is sent to the mine for backfilling and fine fraction is sent to the tailings pond for impoundment.

The tailings pond is located in a naturally occurring embankment having hills on three sides. The fourth side is an engineered structure for impoundment of the tailings. The tailings pond receives the slurry containing the fine fraction from the mill. In the tailings pond the fines sands settles and the decanted water is directed through a channel to the Effluent Treatment Plant (ETP) for treatment.

The effluents from the tailings pond to the ETP are first clarified and part of water is reused in the mill. The rest of the effluent is treated with barium chloride and then with lime slurry to precipitate the radioactive and chemical pollutants, especially radium and manganese. The sludge from the ETP consists of Radium-Barium sulphate and manganese hydroxide, is sent to the tailings pond with the main tailings from the mill. The clear effluent is discharged to environment after ensuring that it conforms to regulatory limits.

Ventilation is provided in the mine by large exhaust fans located on the surface, which sucks out the polluted air causing fresh air to enter the mine through incline or shaft opening. Radon gas, which is a daughter product of naturally occurring uranium is generated during drilling and mucking operations. Other gases also generate from diesel equipment used inside mine. The mine exhaust, apart from these gases, contains radioactive particulate matter as dust. All the exhaust points are located well above the ground level and are inaccessible and isolated from public. The slightly radioactive emissions through the exhaust get diluted with atmospheric air within a few tens of metres from the adits such that their radioactivity reduces to near background levels.

Another form of waste generated is the overburden containing very low-grade ore excavated during mining process. The quantity of this extremely low-grade ore, which is below specified level for extraction of uranium is disposed off as solid waste in identified places in the mine area.

All run-off water from the ore storage yard in the mill is collected and is used for processing in the mill. The water collected from seepage inside the mine is used either in mining operation or in the mill and surface water run off from the mill area is treated in the Effluent Treatment Plant.

4.ENVIRONMENTAL MONITORING AND SURVEILLANCE

Uranium ore mining and extraction process generate chemical and radioactive wastes. Hence, comprehensive surveillance is maintained around the mines, mill and the tailings ponds to evaluate the effectiveness of control measures, assessment of the environmental impacts and to ensure compliance with regulatory limits.

The various limits followed for environmental as well as personal dose surveillance imposed by AERB and the average radiation background levels in the Jharkhand area and other parts of India are shown in Table 1:

TABLE –1 REGULATORY LIMITS & BACKGROUND RADIATION

Uranium in liquid discharge (mg/m3)	300
Radium in liquid discharge Bequerel/ m3 (Bq/m3)	900
Dose to Occupational worker milli Sievert/year (mSv/yr)	30
Dose to Occupational worker (mSv) in a block of 5 years	100
Dose to public (mSv/yr)	1
Uranium in Urine(Chemical Toxicity) microgram/litre	50
Average gamma background radiation in Jharkhand area (micro Gy/hr)	0.15
Average gamma background radiation in India (micro Gy/hr)	0.10
Average atmospheric Rn level in India (Bq/m3)	10

The radiation dose received by persons working inside the various uranium mines is assessed and is shown in Table 2.

TABLE 2 - AVERAGE ANNUAL RADIATION DOSE RECEIVED BY MINE WORKERS					
Mine	Individual effective dose (mSv)				
	1996-2000	2001	2002	2003	2004
Jaduguda	7.91	9.50	6.65	6.6	6.46
Narwaphar	6.03	6.57	5.3	16.85	7.41
Bhatin	7.50	10.44	6.71	6.77	5.93
Turamdih					7.30

The dose received by the mill workers is less than that received in mines. The dose received by public is also assessed and is found to be within specified limit.

The Health Physics Unit at site carries out the surveillance programme and reports its findings to AERB through quarterly reports and these reports are analysed in AERB and discussed in Safety Committees constituted by AERB for UCIL operations.

The radiation level at various locations in and around the tailings pond are shown in Table 3.

TABLE 3 - RADIATION LEVELS IN AND AROUND TAILINGS POND		
Location	Gamma-$\mu Gy/hr$	Radon – Bq/m^3
on the pond	0.8 to 3.3	90
on the bank	0.5	40
20m from bank	0.25 to 0.30	40
on the fencing	0.15	40

If a worker stands for 2000 hrs in a year near the Tailings Pond fencing the dose received from Tailings Pond would be 0.3 mSv from gamma radiation (external) and 0.3 mSv from Radon (internal) with a total of 0.6 mSv, whereas, the maximum dose prescribed for occupational worker by AERB is 30 mSv in a year.

Analysis of the liquid effluent discharge in the public domain for the last five years shows that uranium content in the effluent varies between 4- 45 mg/m^3 whereas the limit for discharge is 300 mg/m^3 and the range for radium content is 50-283 Bq/m^3 against the limit of 900 Bq/m^3.

The water bodies near mines and mill are the Gara River and the Subarnarekhha River. The analysis of the upstream and downstream of the mill water of these rivers shows uranium and radium content to be in the lower range confirming that the mill operations does not cause any significant environmental impact on the river water.

The gamma background and the Radon levels in the villages around Jaduguda are also measured regularly. Because of the presence of underground ore, the radiation levels do not decrease with distance from the mine/mill. It is more or less same in all the nearby areas around upto 25 km.

Transportation of ore from all the four mines is carried out by road transport using trucks. As the operations of loading and unloading are mechanised and the ore is of low grades the dose received by the drivers of trucks and the operators are very low. The dose that may be received by a driver if he operates 2000 hrs in a year will be 0.8 mSv, which is much less than the prescribed yearly dose limit of 30 mSv.

5. CONCLUSION

Mining and processing of uranium ore is being practised in India for more than four decades now. Appropriate regulations are in place and strict surveillance is maintained to ensure that these operations do not cause radiation exposure to the worker and the public beyond the prescribed safe limits. In practice, the exposures are found to be only a fraction of the laid down limits. Similarly, the environment is also appropriately protected through these measures and the radioactivity releases in the environment are also well below the prescribed limits.

In-House Training Course for new entrants to AERB

Towards catering to the regulatory requirements of the expanding nuclear power programme and significant increase in the number of radiation for the societal benefits, AERB manpower is being augmented at various levels through (i) direct recruitment of engineers from the industry, (ii) from the Training Schools of BARC and NFC and (iii) transfer of personnel from the NPCIL, BARC and IGCAR. To train these personnel, especially the directly recruited engineers, in regulatory activities of AERB and in particular nuclear science and engineering in general, a Training Programme was conducted during June 2005 to August 2005. Thereafter these personnel were deputed to Nuclear Training Centre (NTC), Kota for further training starting from September 2005 along with the 14th batch of Engineering Trainees of NPCIL. ●

AERB COLLOQUIA

- **Dr. P. C. Basu, Director, CSED, Atomic Energy Regulatory Board delivered a talk on "TSUNAMI AND ITS ASSOCIATED HAZARDS"** at AERB Auditorium on April 28,2005. The phenomenon called "tsunami" (soo-Nah-nee) is a series of traveling ocean waves of extremely long wavelength generated by disturbances associated primarily with earthquakes occurring below or near the ocean floor. Underwater volcanic eruptions and landslides in ocean can also generate tsunamis. He described the effect of the tsunami of 26 December 2004 that was generated by an earthquake of magnitude 9.3 on the Richter scale in the Indian Ocean causing havoc in Indonesia, Sri Lanka and parts of India. The death toll due to this event exceeded that caused by any other natural hazard in recent times. The talk addressed the causes of tsunami, its propagation mechanism, and its behaviour as the tsunami reaches shore. It also briefly covered the effect of recent tsunami on Indian nuclear power plants and coastal region of India. He also touched upon the safety prescribed in the AERB codes and guides to guard against coastal flooding including that caused by tsunami.
- **Dr. K. S. Parthasarathy, Former secretary, AERB delivered a talk on "ATOMIC ENERGY (RADIATION PROTECTION) RULES, 2004"** at AERB Auditorium **on April 21,2005.**
- **An AERB Colloquium on "Advances in Seismic Design and Requalification of Nuclear Facilities using Passive Control Devices" by Dr. G.R.Reddy, Reactor Safety Division, BARC was organized on September 30, 2005.** ●

Workshop on "Experiences in Implementation of Fire Safety Measures in operating Plants"

A workshop on "Experiences in Implementation of Fire Safety Measures in operating Plants" was organized on April 13- 14, 2005 at Niyamak Bhavan, Anushaktinagar, Mumbai. The AERB Fire Safety Award for 2004 was won by Heavy Water Plant Kota and Chairman AERB presented the trophy. Chairman AERB in his speech advised to use modern tools like fire hazard analysis, fire modeling etc. in addition to the existing systems for fire safety.

Discussions were held on the *"Experience in using fire safety audit checklist- difficulties faced, benefits gained while carrying out fire safety audit and suggestions for further improvement in the system"*. Participants from all DAE units, mainly Fire Officers and Heads of Industrial and Fire safety groups participated in the programme. A brief description of the various fire safety committees formed and their recommendations, documents published, and training programme arranged in connection with fire safety was presented.

The participants opined that the existing checklist is very exhaustive, elaborate and useful barring some areas like 'design'. Some delegates expressed that the checklist should be specific for specific units. However, the consensus was that the existing checklist should remain in vogue and should be used during regulatory inspection. Most of the participants emphasized the need for systematic training of fire personnel. Director, SRI informed that a full-fledged Fire-Training Center at SRI Kalpakkam is likely to be constructed within two years. ●

Workshop on Formation of Directorate of Radiation Safety (DRS) in the States of India

In order to have effective control on the use of medical diagnostic x-ray units, AERB has requested all the States of India to form Directorates of Radiation Safety (DRS) on the lines of such a Directorate existing in Kerala. As on September 30, 2005, eleven States have come forward to form DRS in their States. The formation of the Directorates is required for carrying out inspection and quality assurance tests of the medical x-ray units in their own States. For accelerating the process of formation of DRS in each State, a Work Shop on "Establishment of Directorate of Radiation Safety in the States" was organised at AERB on 11th July 2005. 26 participants from 20 States attended the workshop.

Chairman, AERB in the inaugural speech explained the need for the formation of DRS in connection with radiation safety in diagnostic X-ray procedures and assured the participants about full cooperation of AERB in terms of training. The lectures delivered in the workshop were on 'Historical Review of formation of DRS in States', 'Structure of DRS and Its Responsibilities', 'Facilities for Personnel Monitoring in India', 'Safety Requirements in Diagnostic X-Ray Installations and QA of Diagnostic Units'. A demonstration of QA kit for X-ray unit was also given. During the panel discussion, problems related to non-availability of physicists, designating junior physicists to Director's post, pay structure variation in different states, non-inclusion of physicists in safety committees, requirement of RSOs in diagnostic departments and their educational qualification, powers delegated to DRS and frequency of QA test, etc. were discussed.

Delegates of Directorate of Radiation Safety.

Chairman AERB, inagurating the workshop on Directorate of Radiation safety.

Work Shop on "Radiological Safety in Industries Manufacturing Consumer Products incorporating Thorium Compounds"

A workshop was arranged on "Radiological Safety in Industries Manufacturing Consumer Products incorporating Thorium Compounds", by AERB on July 14, 2005 to enhance safety in the use of thorium for manufacturing of gas mantles. Twenty six participants attended the workshop. Experts from AERB, Indian Rare Earths Limited, delivered lectures on Regulatory requirements for manufacture of consumer products incorporating radioactive material, processing & prospects of Thorium utilisation in India, radiation safety in gas mantle manufacturing industry and biological effects of radiation and radiation safety limits. The program also included practical demonstration on radiation detection and measurements of radiation doses. A panel discussion was held wherein all the participants interacted actively and requested for more such programs in future on use of thorium compounds.

Shri V. K.Verma, Director (Marketing), Indian Rare Earths Ltd., inagurating the workshop for Manufacturers of Thorium Gas Mantles.

A RENDEZVOUS WITH RADON

Soumen Sinha, Industrial Plants Safety Division, AERB

Greeting Radon

I can still very well recollect the memories of those days when as a student, I was new to the frontiers of science. The days were of acceleration, velocity, Archimedes principle, cell structure, chemical elements and symbols- Cl for chlorine, Na for Sodium, Pt for Platinum, Rn for Radon. (my first acquaintance with the word). Much later, I learnt that there are certain gases called inert or noble gasses, which are chemically inactive and do not react with other element -He, Ne, Ar, kr, Xe and Rn (my second encounter with it). In my graduation days (Chemistry Hon's.) when detailed chemistry of all other elements was taught, from Hydrogen to Silicon to even Xenon (examiner's favourite), Radon was hardly talked about. All what I had known by then was Radon belonged to the group 18 of periodic table and is the only radioactive noble gas with atomic number 86 and whose electronic configuration read –

Rn_{86} —$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 4d^{10} 4f^{14}\ 5s^2\ 5p^6\ 5d^{10}\ 6s^2\ 6p^6$

But it was during my training period in the BARC Training School, when I was exposed to the 'nobleness' of Radon. Not only it has an envious lineage (descendant of the much-treasured uranium) but also has an impressive family of daughters. Radon along with its daughters, together called radon progeny requires careful handling as far as radiation protection is concerned.

Exploring Radon

Speaking of Radon means the isotope Rn-222. (Other isotopes include Rn-219 known as Actinon and Rn-220 popularly called Thoron) Radon is an inert gas with liquification temperatures of -61.8°C. She is a naturally occurring decay product of Ra-226, which is the fifth daughter of Uranium-238. Since both uranium and radium occur in soils and rocks, the radon gas formed by their decay very easily escapes and dissolves in the surrounding air and water. Thus it is very obvious that Radon is universally present in the atmosphere due to continuous emanations from soil and water. These emanations vary diurnally as well as seasonally.

It was expected that Radon concentration in uranium mines would be high (upto 5kBq/m^3) as compared to other mines. But I was certainly taken aback to learn that even in some non-uranium mines high radon levels were observed due to the Radon being carried into the mine atmosphere by underground water, which dissolves appreciable amount of radon owing to pressure of the overburden. No wonder deep bore well waters sometimes have radon levels comparable to uranium mine waters. Radon dissolved in well waters and rivers is usually of low order since such water bodies lose radon to the atmosphere rapidly. In uranium mines the concentration of radon in mine waters is around 1000kBq/m^3 while in groundwater it is of the order of a few hundreds. Radon progeny are also present in the air in the dwellings. Their source is the underlying soil, building materials, water used routinely in the building and also the natural gas used in cooking. The concentration of Radon progeny in Indian dwelling is variable (0.02-0.09kBq/m^3) with a countrywide average of 0.04kBq/m^3. Studies have shown that it is advisable to keep the head away from wall while sleeping due to greater concentration of radon near walls.

Understanding Radon

Radon is radioactive. She is an alpha emitter (5.489 MeV) and has a half-life of 3.82days. The daughters of radon are Po-218 (Radium-A), Pb-214 (Radium-B), Bi-214 (Radium-C) and Po-214 (Radium-C'). These are very short lived radioisotopes with maximum half-life only 27 minutes compared to the fifth progeny Pb-210 (Radium D) with 22 yr half-life. Two of these daughters, Po-218 and Po-214 are strong alpha emitters (6.002MeV and 7.667MeV respectively). When inhaled, radon along with its daughters can irradiate the cells lining the lung airways thereby increasing the risk of lung cancer.

On one fine morning, attending the lecture in BARC training school, I came face to face with some amazing intricacies of her family. I had just started to feel at home with the units of rem, sievert, gray etc when I was introduced to terms like Working Level, Potential Alpha Energy etc (the units which later became an integral part of my work in AERB). Let me explain them. At any given time it is expected that radon will be present along with its daughter products. Although it is anticipated that the daughters being very short-lived should reach a secular equilibrium with their mother within 3-4 hrs but this does not happen due to ventilation, plate out effects etc. It is very rare to find the daughters to be in equilibrium with radon gas. Hence, the relative concentrations of the radon decay products are highly variable. To make things simpler the measured radon levels are multiplied by an equilibrium factor to correct the radon concentration for the disequilibrium and the reported radon levels are called Equilibrium Equivalent Radon (EER)

As such, it would be our folly if we use solely the alpha energy of radon. The daughters though short lived also contribute significantly. Taking cognizance of the contribution from daughters, the term Potential Alpha Energy (PAE) was coined which is the amount of alpha energy emitted by the short half-life daughters in equilibrium with 3.7 Bq of radon.

Holiday etal have coined special derived units to measure the concentration of Radon called Working Level (WL) which is defined as any combination of the short lived radon daughters in one litre of air that results in the ultimate release of 1.3 x 10^5 MeV of potential alpha energy. This also corresponds to a concentration of 3.7 kBq/m^3, of each of the radon daughters, in equilibrium with the parent gas. Exposure of a miner to a concentration of one WL for a working month of 170 hrs is defined as a Working Level Month (WLM)

Regulating Radon

To regulate and master the Radon family, it is essential to measure their levels accurately so that the dose received by workers in a radon environment can be judged correctly. The dose received by a worker can be estimated by knowing the concentration of the radon progeny in the environment and the time the worker spends there (occupancy factor). Such kind of dosimetry is called ambient dosimetry. To measure the levels of radon we have instruments using scintillation cell method, two-filter method, electret dosimeters etc. Such methods are only useful for spot sampling but to have an integrated measurement, personal dosimetry is advisable with SSNTD (Solid State Nuclear Track Detectors).

In keeping with the dose limits prescribed by AERB for occupational workers as 30 mSv in one year and 20 mSv/yr averaged over five years, there are operational limits for radon levels to check the internal exposure

(Contd. on page 12)

NEW APPOINTMENTS IN AERB DURING APRIL TO SEPTEMBER 2005

Name	Grade	Date of Joining AERB
Shri Neeraj Kumar	SO/E	20/04/2005
Shri Manas Pathak	SO/E	02/05/2005
Kum S. Hemrajani	Asst. Director (OL)	15/04/2005
Shri C. S. Varghese	SO/G	18/04/2005
Shri Sanjay Patel	SO/D	18/04/2005
Shri S.E. Kannan	SO/G	21/06/2005
Smt. Uma Sarma	SO/E	02/05/2005
Shri K. J. Vakharwala	SO/H	19/07/2005
Shri S. K. Ghosh	SO/F	19/07/2005
Shri Diptendu Das	SO/D	16/08/2005
Shri Ravi Katukum	SO/C	16/08/2005
Dr. D. S. Surya Narayan	SO/F	24/08/2005
Shri Subrata Bera	SO/C	01/09/2005
Shri Anjit Kumar	SO/C	01/09/2005
Shri Vikas Shukla	SO/C	01/09/2005
Shri Avinash Shrivastava	SO/C	01/09/2005
Shri Anup Prabhakaran	SO/C	01/09/2005
Shri Soujanya Mukherjee	SO/C	01/09/2005

Lauriston S. Taylor, Health Physics Pioneer Passes Away at the Age of 102

Lauriston S. Taylor, a pioneer in the field of radiation safety, emeritus member of ICRP passed away peacefully in his sleep on November 26, 2004, at the age of 102 in Madison USA.

Taylor after receiving his bachelor's degree from Cornell University joined the National Bureau of Standards in 1927 as the first federal employee to work in the rapidly growing area of X-ray applications in medicine and research and was associated with it till 1964. At a time when doctors, nurses and medical technicians were badly burned by overdoses of X-rays, Taylor prepared the earliest safety manual on X-rays. His work led to the establishment of the first national standard for X-ray exposure in 1934. For the next seven decades, he studied the health effects of long-term exposure to low levels of radiation and other issues of radiation science. During World War II, he was associated with operational research for the Ninth Air Force and eventually he served as colonel in the Ninth Bomber Command.

Discussion of the problems encountered in X-ray protection at the Second International Congress of Radiology in July 1928 led to the formation of the International Commission on Radiological Protection (ICRP), the world's most influential organization in the field of radiation protection. Taylor served as Secretary of the ICRP from 1937 to 1950. He was also the secretary of another equally important organization, the International Commission on Radiation Units and Measurements (ICRU) from 1934 to 1950 and its chairman from 1953 to 1969.

Taylor established and became the first president of the National Council on Radiation Protection and Measurements (NCRP), the counterpart in the U.S.A to the ICRP and the scientific body from which the US regulatory agencies seek guidance regarding radiological protection. Taylor's pioneering activities were on the measurement of X rays. In fact, he is credited with building the world's first portable radiation survey meter and first free-air ion chamber. He introduced the concept of guard wires in ion chamber and used pressurized ion chambers for measurements of low doses of X-rays.

Taylor combined a solid physics background with an outstanding organisational skill. He could enlist leading scientists in physics, medicine, biology and public health to work voluntarily in several of his expert committees. He worked for the US National Academy of Sciences from 1965 to 1972. After his retirement as president of NCRP in 1977, he continued professional consulting and writing until his late nineties. He wrote about 180 papers and all or part of 20 books, the last one at the age of 97. One of his monumental works "Organization for radiation protection: the operations of the ICRP and NCRP, 1928-1974" running to more than 2000 pages is virtually the history of radiation protection since the discovery of X-rays. His book "What You Need To Know About Radiation" available as on line version in the website of Health Physics Society and University of Michigan is very informative on radiation protection for the general reader.

……………………. A.R. Sundararajan, Formerly, Director RSD, AERB.

A RENDEZVOUS WITH RADON

(Cont from page 11)

The operating limits in uranium mines are
-Radon Concentration in air (EER) – 1kBq/m^3
Radon Progeny concentration – 0.3 WL

In addition, workers (level wise and trade wise) are provided with personal radon dosimeters, which include SSNTD to assess the exposure from radon progeny and TLD (Thermo Luminescent Dosimeters) for external gamma radiation.

Conclusion

Now if I draw a Venn Diagram where the three circles represent economic development, environmental development and societal development respectively, then the portion represented by the intersection of all these three circles represents sustainable development. If any of the circles is neglected or over used, then the sustainability is at risk. Nuclear energy has been hailed as a sustainable energy as it is economically viable, environmentally sound. But somehow, due to the inherent radiation risk, it had a weak societal acceptability. But with strict regulatory requirements, right from the inception of Atomic Energy Programme in India, and periodic surveillance by Atomic Energy Regulatory Board, radiation risk is very much under control. In the front end of the nuclear fuel cycle facilities especially mining activities, the greatest hazard to the health of workers is internal exposure due to inhalation of radon. With proper ventilation, improved operation and maintenance techniques and enhanced protective measures, the internal exposures of the miners have come down drastically over the years.

Printed and published by Shri P. K. Ghosh, Atomic Energy Regulatory Board, Niyamak Bhavan, Anushaktinagar, Mumbai-400094, Tel. & Fax 25516342 Res. No. 25584084. Designed, Processed & Printed by Printannia Offset Pvt. Ltd., Ph. : 24078866/7996.