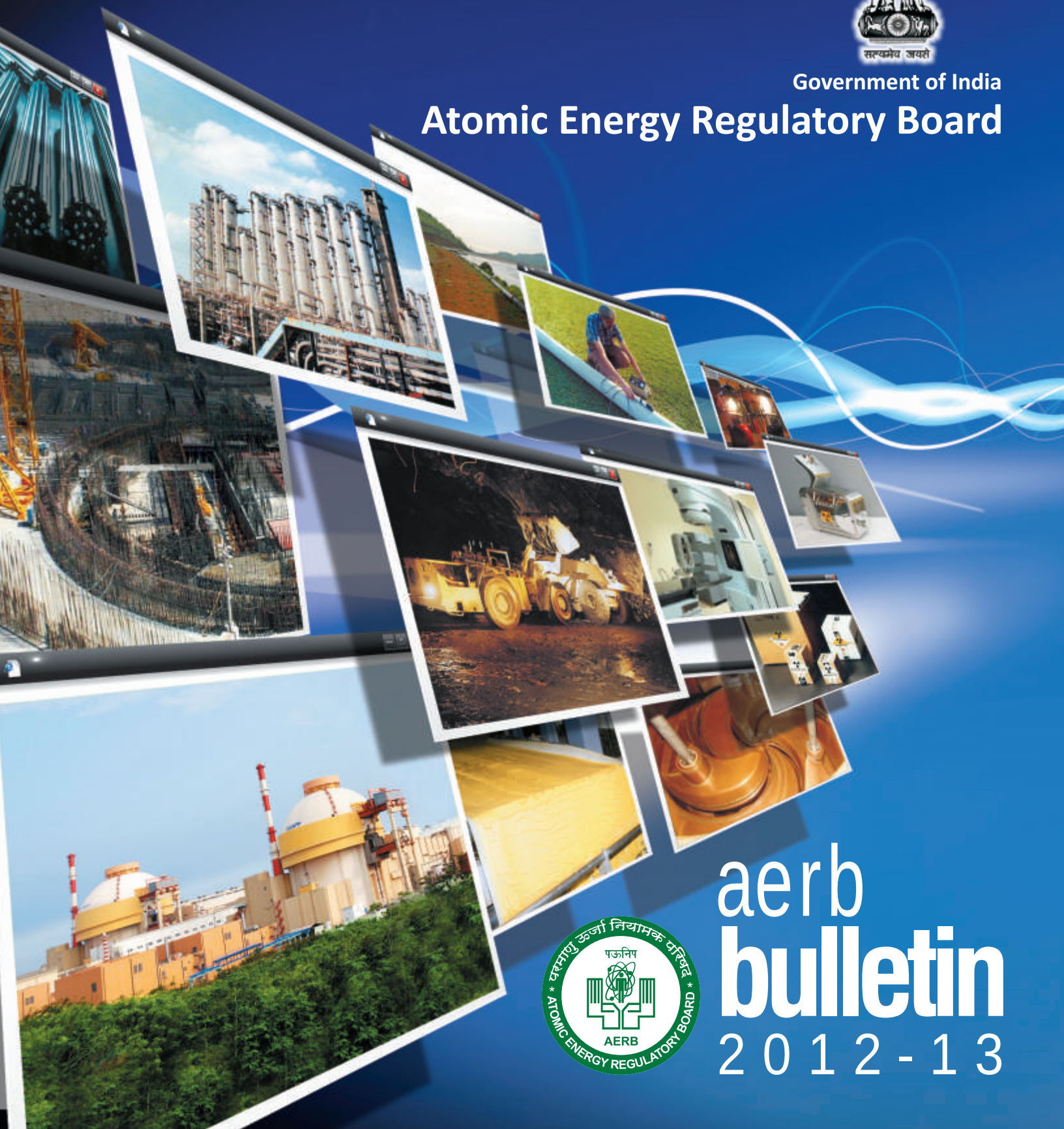
Government of India

Atomic Energy Regulatory Board



aerb bulletin 2012-13

Functions of Atomic Energy Regulatory Board

AERB enforces the following Rules issued under the Atomic Energy Act, 1962:

Atomic Energy (Radiation Protection) Rules, 2004

Atomic Energy (Working of Mines, Minerals and Handling of Prescribed Substances) Rules, 1984

Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987

Atomic Energy (Factories) Rules, 1996

Develop safety policies in both radiation and industrial safety areas.

Develop Safety Codes, Guides and Standards for siting, design, construction, commissioning, operation and decommissioning of different types of nuclear and radiation facilities.

Grant consents for siting, construction, commissioning, operation and decommissioning, after an appropriate safety review and assessment, for establishment of nuclear and radiation facilities.

Ensure compliance with the regulatory requirements prescribed by AERB during all stages of consenting through a system of review and assessment, regulatory inspection and enforcement.

Prescribe the acceptance limits of radiation exposure to occupational workers and members of the public and acceptable limits of environmental releases of radioactive substances.

Review the emergency preparedness plans for nuclear and radiation facilities and during transport of large radioactive sources, irradiated fuel and fissile material.

Review the training program, qualifications and licensing policies for personnel of nuclear and radiation facilities and prescribe the syllabi for training of personnel in safety aspects at all levels.

Take such steps as necessary to keep the public informed on major issues of radiological safety significance.

Promote research and development efforts in the areas of safety.

Maintain liaison with statutory bodies in the country as well as abroad regarding safety matters.

Review the nuclear safety aspects in Nuclear Facilities under its purview.

Review the safety related nuclear security aspects in Nuclear Facilities under its purview.

Atomic Energy Regulatory Board

The Atomic Energy Regulatory Board (AERB) was constituted on November 15, 1983 by the President of India by exercising the powers conferred by Section 27 of the Atomic Energy Act, 1962 (33 of 1962) to carry out certain regulatory and safety functions under the Act. The regulatory authority of AERB is derived from the rules and notifications promulgated under the Atomic Energy Act, 1962 and the Environmental Protection Act, 1986.

The mission of AERB 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.

AERB's safety regulatory requirements are brought out in a set of Codes and Guides; more than 140 such documents have been developed over the years. Nuclear and radiation facilities and practices require consents from AERB for various stages viz., siting, construction, commissioning, operation and decommissioning. These consents are granted after ensuring that the regulatory requirements are met. At each stage a comprehensive review in a multi-tier structure of safety committees is carried out.

Currently, the Board consists of a Chairman, five Members and a Secretary. AERB Secretariat has nine divisions and the AERB Safety Research Institute (SRI) at Kalpakkam. AERB is supported by the Safety Review Committee for Operating Plants (SARCOP), Safety Review Committee for Applications of Radiation (SARCAR) and Advisory Committees for Project Safety Review (ACPSRs). ACPSR recommends to AERB issuance of consents at different stages of plants of the Department of Atomic Energy (DAE), after reviewing the submissions made by the plant authorities, based on the recommendations of the associated Design Safety Committees. The SARCOP carries out safety surveillance and enforces safety stipulations in the operating units of the DAE. The SARCAR recommends measures to enforce radiation safety in medical, industrial and research institutions, which use radiation and radioactive sources. AERB also receives advice on codes and guides and on generic issues from the Advisory Committees. The administrative and regulatory mechanisms which are in place ensure multi-tier review by experts in the relevant fields available nation wide. These experts come from reputed academic institutions and governmental agencies.

Preface

Owing to the encouraging response to last year's AERB bulletin, which was published for the first time as an initiative by Atomic Energy Regulatory Board to enhance its transparency and public outreach, this year too AERB brings out the second issue of its bulletin. It attempts to present information contained in the Annual Report 2012-2013 in a simplified and attractive format for easy grasping.

During the year, AERB continued its regulatory safety oversight on all regulated installations and activities i.e the entire gamut of nuclear fuel cycle facilities, namely uranium mines and mills, thorium mines and mills, fuel fabrication facilities, heavy water plants, nuclear power plants and research reactors, as well as the large spectrum of facilities involved in the application of radiation in the field of medicine, industry, agriculture and research, the facilities processing Naturally Occurring Radioactive Materials and activities such as radioactive waste management and transport of radioactive material in public domain, following a graded approach to safety regulation in line with international regulatory practices.

One of the major highlights of this year was safety review and assessment of commissioning activities of unit-1 of Kudankulam Nuclear Power Plant. AERB had also organized a press conference to share with the public and media the safety aspects of Kudankulam Nuclear Power Plant and also the implementation status of post Fukushima safety upgrades. The safety review for this plant was challenged in many litigations and the courts eventually gave their verdict in favour of AERB. This bulletin features a special article on the same.

Another important area which AERB continues to strengthen is the regulation of large number of diagnostic X-ray units used in the country. This year about 73% of the queries received under the Right To Information Act pertained to the diagnostic X-ray units. In this regard, this bulletin features another special article on the steps taken by AERB in regulation of such widespread X-ray units. It is worthwhile to mention that till now AERB has signed Memorandum of Understandings with ten State Governments for establishment of Directorate of Radiation Safety (DRS) for regulation of the X-ray units in their respective state, of which DRS is now functional in Kerala and Mizoram. The massive work of implementation of user friendly web based online interactive system for regulation of radiation facilities (ELORA) is nearing completion and as a first step the system has been made operational for radiotherapy facilities.

AERB views public outreach as an essential element to build a long lasting trust and confidence with media and the public, at large. This annual bulletin is aimed to provide in a nutshell the major activities of AERB during 2012-13. Efforts have been made to include more visuals and to keep the technical content to bare minimum. AERB would be happy to elicit feedback on this attempt and suggestions for further improving this bulletin.

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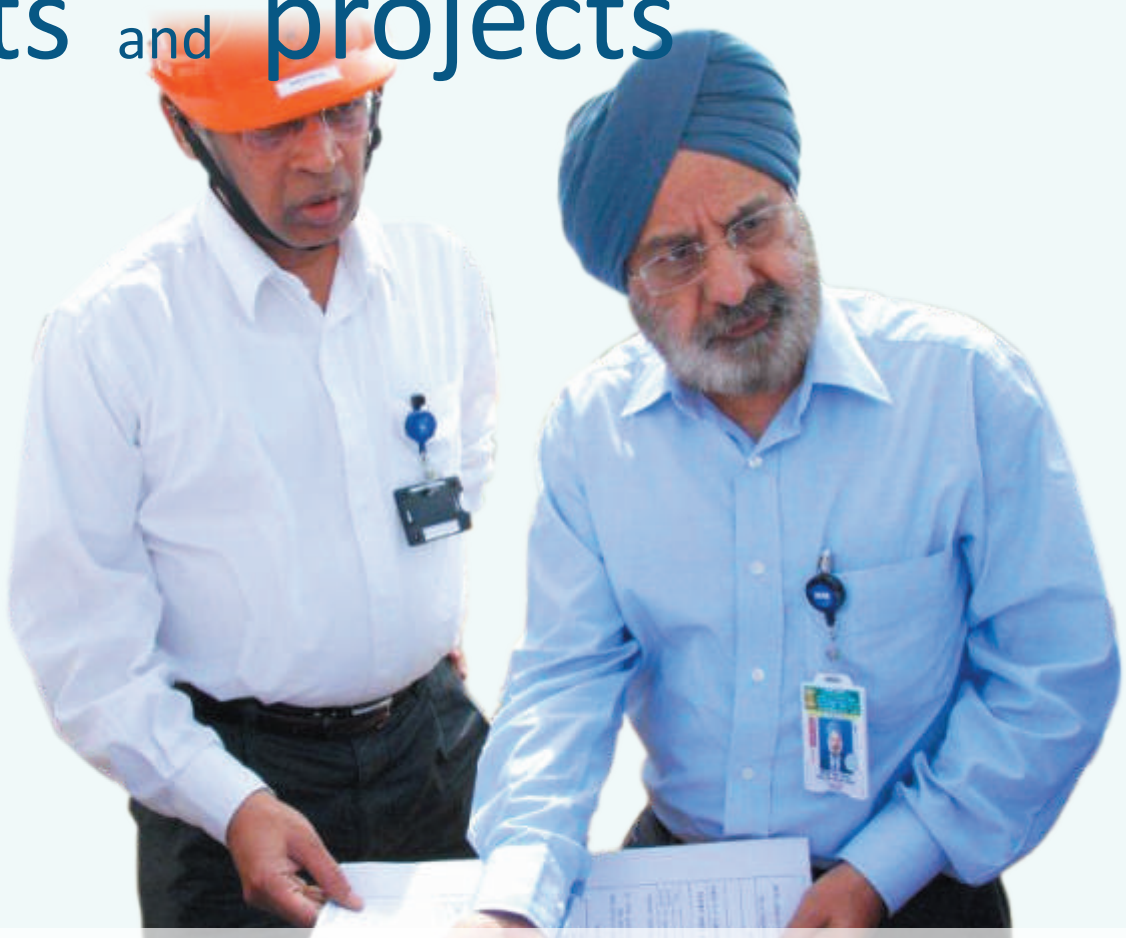


Chairman, AERB visits Kudankulam Nuclear Power Project

Nuclear Power Projects under SITING stage

Gorakhpur site, Haryana

Jaitapur site, Maharashtra

Nuclear Power Corporation of India Ltd. (NPCIL) has proposed to install progressively 6 units of European Pressurised Reactors (EPR), each of 1650 MWe PWR at Jaitapur site on the western coast of Maharashtra and 4 units of 700 MWe Pressurised Heavy Water Reactors (PHWRs) at Gorakhpur in Haryana.

Site Evaluation of Jaitapur Nuclear Power Project (6 x 1650 MWe EPRs) and Gorakhpur Haryana Anu Vidyut Pariyojna (4 x 700MWe PHWRS) is under progress.

Review w.r.t site excavation of 2 x 1000 MWe Kudankulam Nuclear Power Project 3 & 4 is in progress.

AERB has initiated the exhaustive process of site evaluation for both these sites wherein the impact of site on the plant including extreme earthquake, flood and meteorological conditions and also the impact of plant on the site under normal and accidental conditions are assessed. For this purpose, intensive review is being carried out of the reactor design as well as the site characteristics such as meteorology, hydrology, geology, topography, ecology, land and water use, demography etc. Deliberations are in progress on the radiological impact assessment, liquid and solid waste management and radiological dose apportionment. At this stage, AERB also assesses the compliance of the site selection and rejection criteria specified by AERB in its Safety Code on Siting.

NPCIL has proposed setting up of 4 more Russian design VVERs (KKNPP 3-6) of 1000 MWe each at Kudankulam site. Siting clearance for Units 3 to 6 was granted by AERB in February 2011. Infrastructure development for KKNPP 3&4 is in progress. Fencing was provided to segregate KKNPP 1&2 and KKNPP 3&4. In the wake of Fukushima accident, AERB had asked for additional information. Presently review is under progress for site-specific data, layout, geotechnical data, design basis ground motion etc related to excavation clearance stage.

Nuclear Power Projects under initial stages of CONSTRUCTION

Kakrapar Atomic Power Project- 3 &4

Rajasthan Atomic Power Project- 7 &8

Twin units of indigenously designed 700 MWe PHWRs are being set up at Kakrapar (KAPP 3&4) and Rawatbhata (RAPP 7&8) respectively. These reactors are similar in design except for site specific changes.

AERB granted clearance for "First Pour of Concrete" for KAPP 3&4 in November 2010 and for RAPP 7&8 in July 2011. Subsequently, AERB is continually reviewing the progress of the construction activities and have issued various permissions for intermediary stages.

With regard to KAPP 3&4, safety review for the next construction sub-stage i.e. "Erection of Major Equipment" is in progress. Seismic analysis and design reports of Induced Draft Cooling Tower (IDCT) was reviewed and accepted, following which construction of IDCT commenced. Design details of foundation of Diesel Generator and its chimney were reviewed and accepted. AERB revisited the flood protection aspects for KAPP site in view of revised flood calculations for dam-break scenario submitted by NPCIL. Based on review, the flood level protection measures were found adequate and acceptable.

With regard to RAPP 7&8, safety review of seismic analysis and design of identified safety related structures was completed. Construction of inner containment wall and other safety related structures commenced after satisfactory review of the identified documents.

Review of design details and seismic analysis for construction of important safety related structures for twin units of 700 MWe PHWRS (KAPP 3&4 at Gujarat and RAPP 7&8 at Rajasthan) is in progress.

Nuclear Power Projects under advanced stage of CONSTRUCTION

Kudankulam Nuclear Power Project- 2

AERB continued its regulatory supervision on 1000 MWe unit-2 of Kudankulam Nuclear Power Project which is in the final stage of construction.

All civil construction works, reactor equipment erection works, turbine generator boxing up, common services system like chilled water, fire water, refuelling machine erection works are completed for the Russian design KKNPP unit-2. Open reactor flushing was also completed. Pre-commissioning works were under progress on various systems with periodical safety review by AERB.

Technical Specifications for Operation was reviewed and approved.

Out of the 17 recommendations of AERB Expert Committee to review safety of NPP in light of Fukushima Accident, 2 items related to computational analysis were identified as long term items (i.e to be completed within 2 years) and the progress status of the same is being periodically reviewed and followed up. For the remaining 15 items, all the recommendation have been implemented at site.

Prototype Fast Breeder Reactor

Civil construction, erection of equipment and components were in progress for indigenously designed sodium cooled PFBR project. Core loading was completed with dummy subassemblies. Commissioning review related to pre-operational activities has been taken up by AERB.

The adequacy of Diverse Safety Rod (DSR) design to drop within the required time during seismic events has been verified by analysis and found to be acceptable. Detailed study on the effect of control power supply failure on the entire plant was carried out and reviewed. Results of experiments to confirm natural circulation in the sodium loop etc were reviewed and accepted.

Post Fukushima Safety assessment of PFBR design was carried out and the assessment has identified certain minor modifications needed in the systems in case of beyond design basis external event. Further review is under progress.

AERB granted clearance for in-situ concreting of Roof Slab and rotatable plugs for Prototype Fast Breeder Reactor which is in its last phase of construction in December 2012.

Kudankulam Nuclear Power Project- 1

The commissioning activities in unit-1 of Kudankulam Nuclear Power Project, which remained suspended since October 13, 2011 due to local agitation by the public, was resumed on March 18, 2012.

AERB carried out in-depth review of the ongoing commissioning activities to verify whether the performance of systems and components meets the design intent. Results of commissioning trials were checked and found to be acceptable. Wherever deviations were observed, further tests were recommended. An observer team of AERB was stationed at the site to witness the commissioning tests and results. Only after satisfactory review, regulatory clearances and permissions for various sub-stages and intermediate stages were issued.

Please refer the special feature article for further details.

Step wise regulatory clearances granted by AERB

Permission was granted for opening top head of Reactor Pressure Vessel (RPV), dummy fuel removal and RPV inspection on May 10, 2012.

Clearance was issued for Initial Fuel Loading (IFL) on August 10, 2012 subject to fulfillment of various prerequisites.

Permission was granted for Initial Fuel loading (IFL) on September 18, 2012.

Permission was granted for Closure of RPV Top Head on October 20, 2012.

Permission was granted for Post-IFL Heat-up of Reactor Coolant System on December 5, 2012.

Concurrence for conduct of Hydro Test, Heat up of Reactor Coolant System (RCS) and Associated Test was issued on January 24, 2013.

Clearance for First Approach to Criticality (FAC) was granted on July 4, 2013.

Final permission for FAC based on satisfactory compliance checking of various stipulations was granted on July 11, 2013.

There are 20 nuclear power plants presently under operation in our country with an installed capacity of 4780 MWe.

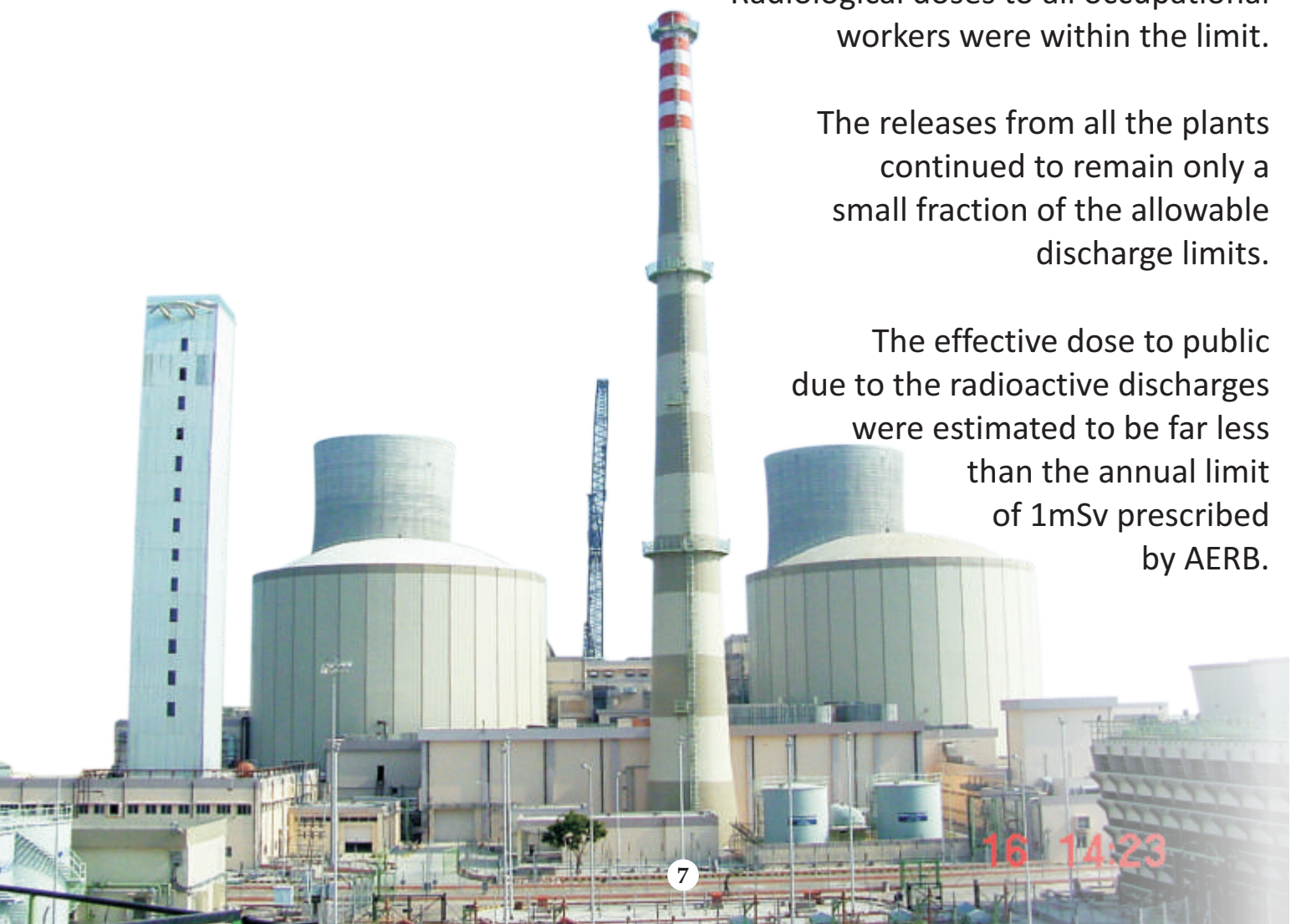
All the 20 NPPs operated safely during the year.

Madras Atomic Power Station (MAPS) - 1&2 @ Kalpakkam, Tamilnadu
Narora Atomic Power Station (NAPS) - 1&2 @ Narora, Uttar Pradesh
Kakrapar Atomic Power Station (KAPS) - 1&2 @ Kakrapar, Gujarat
Rajasthan Atomic Power Station (RAPS) - 1 to 6 @ Rawatbhata, Rajasthan
Tarapur Atomic Power Station (TAPS) - 1 to 4 @ Tarapur, Maharashtra
Kaiga Generating Station (KGS) - 1 to 4 @ Kalpakkam, Tamilnadu

Radiological doses to all occupational workers were within the limit.

The releases from all the plants continued to remain only a small fraction of the allowable discharge limits.

The effective dose to public due to the radioactive discharges were estimated to be far less than the annual limit of 1mSv prescribed by AERB.






Renewal / Extension of license for operation of Nuclear Power Plants

Unlike many other countries, in India, AERB does not grant an operational license for design life of a plant but grants it for a limited period which is not more than 5 years. Over a period, this practice has become one of the cornerstones in the regulation of operating nuclear power plants in India and has proved to be a very powerful tool in assessing and enhancing safety of NPPS.

Operating plants undergo continuous safety review through periodic reports and regulatory inspections supplemented by exhaustive five yearly reviews which take place during review of application for renewal of license. This review involves detailed safety review of safe operation of NPP as per its design intent, safety systems performances, improvements in safety, etc.

In addition to this, a periodic safety review (PSR) is carried out once in ten years, which is a much more comprehensive safety review and includes additional factors like advancement in technology, feedback of operating experience from India as well as from other countries, comparison of safety standards, cumulative effects of plant ageing, probabilistic safety assessments etc.

Based on these reviews, license for operation of NPPs were either renewed or extended.

Licenses issued/renewed/extended in 2012-13

Renewal of License for operation of KGS-1&2

Extension of License for operation of RAPS-3&4

Extension of License for operation of TAPS-1&2

Extension of License for operation of TAPS-3&4

Extension of License for operation of MAPS-1&2

Permission for 19th, 20th and 21st irradiation campaign at FBTR, IGCAR

Clearance for regular operation of Additional Away From Reactor (AAFR), Tarapur for storage of spent fuel from TAPS 1&2

License for regular operation of Interim Fuel Storage Building at IGCAR for storage of fresh fuel for fast reactors.

226 operators in various positions were licensed in different Nuclear Power Plants and associated facilities.




Implementation status of Post Fukushima Safety Upgrades in Operating NPPs

Post Fukushima nuclear accident, AERB had carried out safety re-assessment of the operating Nuclear Power Plants (NPPs) and has approved implementation of identified safety enhancements in a time bound manner in all operating NPPs. These safety enhancement measures were categorised into short term, medium term and long term, with respect to time frame for implementation. AERB is closely monitoring the progress of their implementation in all operating NPPs.

Short Term

External hook up points for addition of water: The work of providing external hook-up points are being taken up during long outage or BSD (biennial shutdown or BSD) of NPPs These provisions have been made in at least one of the two units of the station and the remaining hook-up points would be made during the BSD of respective units. This upgrade is expected to be completed by the end of 2013 at all stations.

Additional emergency lighting backed up by solar cells: Action is in progress for providing solar powered lights for emergency purpose. These have been installed at MAPS and will be provided at other stations by the end of year 2013.

Review and revision of Emergency Operating Procedures: This activity has been completed at all stations.

Training and mock-up exercises of operating personnel: This activity has been completed at all stations.

Medium Term

Introduction of seismic trip where it does not exist: AERB has reviewed and approved the scheme for implementation. Stations are in the process of implementing the scheme. The scheme is expected to be implemented at all stations by the end of year 2013.

Provision of additional backup DGs (air cooled mobile/fixed at higher elevation): It has been decided to provide 200 KVA air cooled DG sets at all NPP sites. Air cooled DGs have been installed in MAPS, TAPS-1&2, TAPS-3&4, NAPS & KAPS-1&2 and at RAPS & KGS it is in progress.

Strengthening provision for monitoring of critical parameter under prolonged loss of power: Provisions along with detailed procedures have been made at all NPPs for monitoring critical parameters under prolonged loss of power.

Provision of diesel driven pumps for transfer of water from deaerator storage tank to steam generators: Provisions are being made for transfer of deaerator water to steam generators during emergency at all NPPs. At MAPS this will be achieved by operating emergency boiler feed pumps powered from air cooled DGs.

Additional mobile pumps and fire tenders: The adequacy of existing pumps and fire tenders has been reviewed by all NPPs. Based on this review, additional fire tenders are under procurement at NAPS and MAPS. Additional diesel driven pumps are also under procurement at RAPS-3&4 and MAPS.

Steps for augmentation of onsite water storage, wherever required: The availability of water in seismically qualified tanks has been reviewed for each NPP. Review indicated that sufficient water is available in onsite seismically qualified structures/tanks for meeting the emergency need at KGS-1 to 4 & RAPS-3 to 6. Based on this review NPCIL has decided to build seismically qualified water pools at MAPS, NAPS, KAPS and TAPS-3&4.

Long Term

Enhancing Severe Accident Management programme: Detailed analysis of severe accident and its management is under progress. An interim guideline has been issued by NPCIL for handling severe accident by using newly created hook up points.

Strengthening hydrogen management provisions: NPCIL has decided to install Passive Autocatalytic Recombiners (PAR) at all NPPs. Procurement action and analysis for installation of PAR is in progress.

Provision for venting of containment: Design basis report for providing hardened vent at each NPP is under review in NPCIL.

Creation of an emergency response facility capable of withstanding severe flood, cyclone & earthquake etc: AERB has constituted an Advisory Committee to develop the guidelines for creation of such a facility at all NPP sites.

Operational Safety Review Team (OSART) Mission to RAPS 3&4

An international team of nuclear safety experts lead by the IAEA carried out a review of safety practices followed at RAPS 3&4 from October 29 to November 14, 2012 on the request of the Government of India.

The OSART was led by the IAEA's Division of Nuclear Installation Safety and comprised experts from Canada, Belgium, Finland, Germany, Romania, Slovakia and Sweden and the IAEA. This was the 171st mission of the OSART programme, which began in 1982 and the first OSART mission for Operating NPPs of India. As per the protocol, AERB also participated in the briefings made by OSART before starting the mission and after completion of review of RAPS 3&4.

The team identified a number of good practices followed at RAPS 3&4. These will be shared in due course by the IAEA with the global nuclear industry for consideration. OSART also made a number of recommendations and suggestions that need to be considered for further improvement of the operational safety of the RAPS 3&4. , such as

i) The plant should enhance actions to maintain electrical cable conditions at a high standard;

ii) The fire doors inspection and maintenance programme should be enhanced to identify and correct fire door function;

iii) Certain aspects of the plant's surveillance testing programme should be further enhanced

The plant should enhance root-cause analyses to systematically identify all learning opportunities.

The team has submitted the final report to the Government of India. RAPS 3&4 and NPCIL are taking actions to address the areas for improvement brought out in this report. After completion of these actions, IAEA will be invited for a follow-up visit to review these actions. Based on the report of OSART mission to RAPS 3&4, AERB has also initiated certain actions for improvement in the regulatory practices.

Good Practices observed by OSART

The power plant's safety culture cultivates a constructive work environment and a sense of accountability among the power plant personnel, and gives its staff the opportunity to expand skills and training;

The power plant's Public Awareness Programme provides educational opportunities to the local community about nuclear and radiation safety;

The power plant has a Management of Training & Authorization system for effective management of training activities;

The power plant uses testing facilities and mock-ups to improve the quality of maintenance work and to reduce radiation doses.

OSART meeting in Progress

Safety Surveillance of Front end Fuel Cycle facilities

Chairman AERB & Secretary AERB visit Uranium Mine and Mill

Uranium exploration, mining and milling

AERB continued its safety surveillance on the exploration sites of Atomic Minerals Directorate for Exploration and Research (AMD) located at southern, northern, western, eastern, central and south-central regions of India. All the six operating uranium mines (Jaduguda, Bhatin, Narwapahar, Turamdih, Banduhurang and Bagjata) and two operating mills (Jaduguda and Turamdih) of Uranium Corporation of India Ltd. (UCIL) in the Singhbhum belt of Jharkhand operated safely.

The Tummalapalle mine in the Cuddapah basin of Andhra Pradesh, which was under development for the last few years, was issued operating license by AERB this year. Safety review of the other mines under development at Mohuldih, Jharkhand and Gogi, Karnataka continued. Regulatory review and assessment for the capacity expansion of Turamdih mine was completed with special focus on the mine ventilation aspects to control the internal exposure to occupational workers, waste management aspects and the radiological impact on the surrounding environment.

One of the major milestones in the front end fuel cycle facilities attained this year was the commissioning of Tummalapalle mill. This mill, which is located closed to the Tummalapalle mine, was under commissioning trials with inert ore to assess the performance of various systems and components as per their design intent. After successful completion of trial runs with inert ore, AERB carried out a detailed review of the commissioning results and only after satisfying itself with the compliance of the required regulatory requirements, AERB granted the consent for commissioning of the mill with actual ore this year.

> "Tummalapalle mill is the first uranium processing plant in India adopting alkaline leaching route"

Thorium mining and milling

All the three operating thorium mining and mineral separation plants at Chavara, Manavalakurichi and Chatrapur and the two thorium processing plant at Udyogamandal and Chatrapur of Indian Rare Earths Ltd. (IREL) operated safely.

Review of the commissioning of upcoming 10,000 tons per annum Monazite Processing Plant (MoPP) at Chatrapur, continued. Proposals pertaining to relocation of certain equipment, modification in the design of solid waste tranches etc were reviewed. AERB has recommended to retain the FRP lining in the solid waste trenches.

IREL has proposed to upgrade the monazite concentration to +96% in all the three mineral separation plants which will be used as feed for the MoPP plant at Chatrapur. Detailed safety review with regard to the addition of new equipment, change in layout, spillage control measures during bulk transfer of monazite enriched streams and the impact on occupational exposure was carried out.

Retrieval and processing of previously stored thorium concentrates in concrete silos at IREL Udyogamandal for recovery of uranium and thorium values under the THRUST project has been successfully completed. IREL has now proposed to utilise some of the existing buildings to process the rare earth chlorides, that would be generated from MoPP plant at Chatrapur, for production of high purity rare earths such as yttrium, gadolinium, samarium etc. Detailed review of the proposal with regard to process safety, risk assessment, industrial and fire safety, quality control etc are in progress. The existing license of IREL Udyogamandal was extended for another one year.

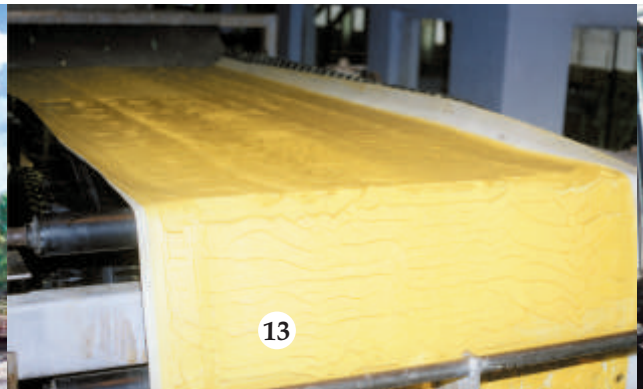
Meanwhile, IREL Udyogamandal has also undertaken processing of secondary sources of uranium as crude potassium di uranate, crude sodium di uranate, uranium bearing crucible skull and slag discs generated in various DAE units. AERB has granted permission for processing these materials after satisfactory review of the associated radiological safety issues.

Fuel fabrication facilities

All the fuel fabrication plants at Nuclear Fuel Complex (NFC), Hyderabad and Zirconium Complex, Pazhayakayal operated safely.

Proposal for renewal of license for operation of NFC, Hyderabad was reviewed by AERB and pending compliance of certain recommendations, the license was extended for one year with time bound stipulations.

One of the important steps in production of zirconium sponge is chlorination of zirconium oxide. NFC has set up a new chlorination facility for this purpose. During review of the ventilation and scrubbing system of this facility, AERB had asked for installation of additional scrubber to conform to the stack limit specified by State Pollution Control Board for discharge of chlorine. Only after satisfactory review of the compliance of recommendations, clearance for commissioning and operation of the facility was issued by AERB.


Heavy water plants

Heavy Water is now being produced only in four Heavy Water Plants (HWP) at Kota, Manuguru, Hazira and Thal. All these plants operated safely during the year. HWP-Kota is under extended major turnaround for thorough inspection since January 2013.

Heavy Water Plants at Baroda, Tuticorin and Talcher, where heavy water is no longer produced, are now being used for production of various other diversified products such as elemental boron, tri-butyl phosphate solvent and other organic solvents. Safety review of these ongoing diversified projects continued. Regulatory consents were issued for commissioning and operation of a versatile solvent synthesis pilot plant at HWP-Tuticorin and siting and construction for 200 Amp Sodium cell test facility at HWP- Baroda.

In a Pressurised Heavy Water Reactor, the heavy water of moderator and the primary heat transport system builds up appreciable tritium activity over time. In order to detritiate them, a heavy water clean up facility **(HeWaC)** is being set up at Kota. Commissioning activities of cryogenic system and construction of oxidation plant of HeWaC facility is under review by AERB. AERB has granted permission for conducting trial runs of the oxidation plant of HEWAC facility with virgin heavy water for a period of one year.

89 operators of Heavy Water Plants and **30** operators of Nuclear Fuel Complex were licensed / re-licensed this year

NORM Industries

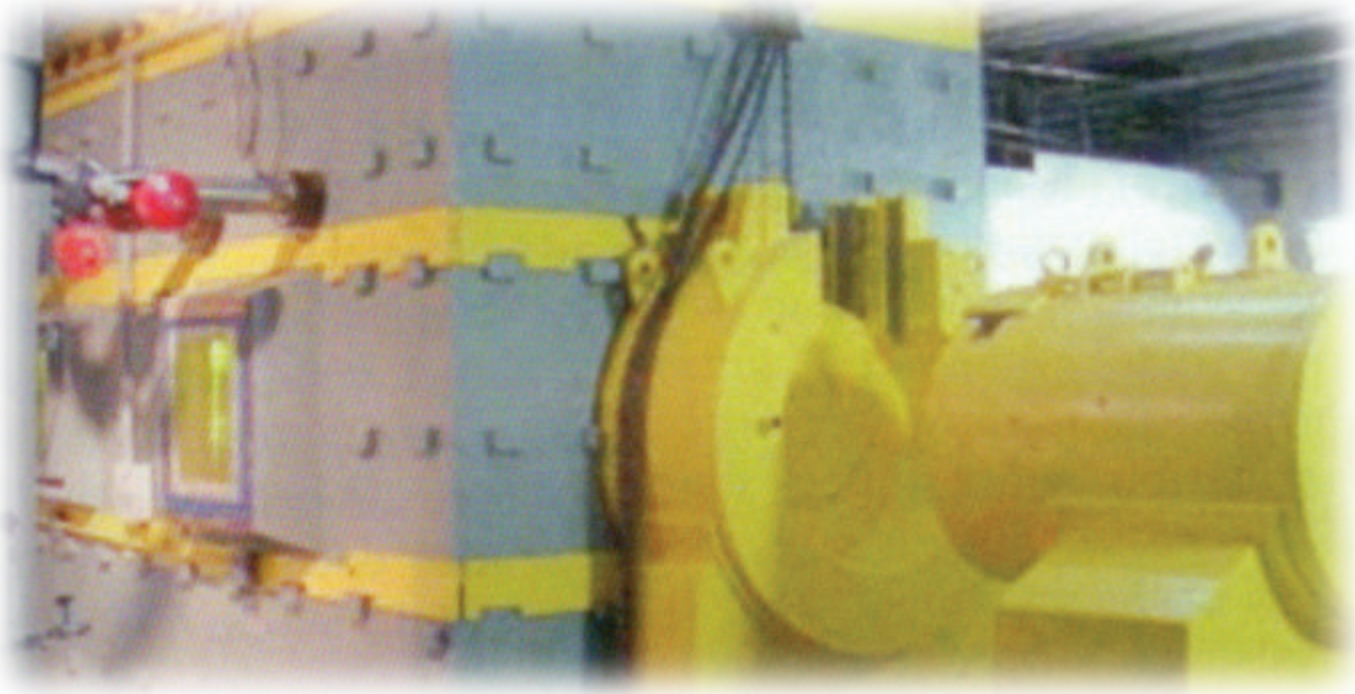
AERB continued its radiological safety surveillance on the industries handling Natural Occurring Radioactive Materials (NORMs), namely the facilities processing beach sand minerals to recover heavy minerals other than monazite, facilities processing columbite-tantalite ore and facilities processing rock-phosphate fertilisers to obtain phosphoric acid and resulting in generation of phosphogypsum.

This year, license for operation was issued to two mineral separation plants of M/s Industrial Minerals Company located at Tamilnadu. With this, the total number of licensed beach sand mineral facilities by AERB stands at 24.

Safety review for processing of columbite-tantalite ore by M/s Metallurgical Products (India) Pvt. Ltd at Taloja, Maharashtra was carried out with regard to occupational exposure and waste management aspects and accordingly, certificate of registration was issued by AERB.



Safety Surveillance of back-end fuel cycle facilities



CORAL (Compact Reprocessing of Advanced fuels in Lead Cells)

This facility was constructed as an R&D facility to develop technology for reprocessing of fast reactor fuel. AERB had permitted reprocessing of spent fuel subassemblies at CORAL on a campaign basis. This year, the application seeking permission for regular operation of the facility was reviewed. Pending completion of the detailed safety evaluation, AERB has granted permission for reprocessing of six FBTR spent fuel assemblies in the next one year.

Demonstration Fast Reactor Fuel Reprocessing Plant (DFRP)

DFRP is a fore-runner of the reprocessing facility FRFCF (Fast Reactor Fuel Cycle Facility) to close fuel cycle of PFBR, being setup by IGCAR at Kalpakkam. It is divided into 2 concrete cell facilities called Head End Facility (HEF) and Process Plant Facility (PPF). Construction and equipment installation in PPF has been completed. Civil construction and equipment erection activities of HEF are in progress and under periodic review by AERB.

Fast Reactor Fuel Cycle Facility (FRFCF)

Fast Reactor Fuel Cycle Facility is an integrated fuel cycle plant being set up at Kalpakkam to facilitate closure of fast reactor fuel cycle. There are five dedicated plants with common services and utilities. AERB has completed the review of the design specification and design methodology of safety related structures towards grant of construction clearance.

Safety Surveillance R&D centres and Industrial plants

AERB's Safety Committee Visits DAE's Medical Cyclotron Project which is under construction at Kolkata

Raja Ramanna Centre for Advanced Technology, Indore

INDUS-1 is a storage ring where electron beam of energy 450 MeV at 100mA current is stored. The electron beam while circulating in the storage ring emanates low energy synchrotron radiation which is tapped through 5 licensed beam lines for various experimental studies. The operational safety aspects of the machine are being periodically reviewed by AERB.

INDUS-2 is a synchrotron cum storage ring and is under commissioning trials with beam energy at 2.5 GeV and stepwise increase of beam current from 100mA. The safety aspects are being periodically reviewed by AERB. Five beamlines of INDUS-2 have already been authorised by AERB for carrying out experiments.

Safety surveillance of other operating accelerators at RRCAT, namely 750 keV DC accelerator and 10MeV Linear Accelerator(LINAC) continued. AERB renewed the license for 10MeV LINAC. Status of ongoing accelerator projects such as Free Electron Laser (FEL)-LINAC, Infra red FEL-LINAC, Agricultural Radiation Processing Facility at Choithram Mandi, Indore as well as laser projects are being periodically reviewed.

Variable Energy Cyclotron Centre, Kolkata

The room temperature (k-130) cyclotron, which was issued license for regular operation last year, operated safely delivering alpha and proton beams at various energies. On recommendation of AERB, VECC has initiated the programme for authorisation of the operating personnel.

The commissioning activities of super conducting cyclotron, which aims at acceleration of heavy ions under liquid helium temperature, continued with periodic safety review by AERB. For the first time, a HAZOP study of the cryogenic system of the cyclotron was carried out on the recommendation of AERB. Installation of the components for Radioactive Ion Beam facility including construction of a new building is under progress with periodic regulatory supervision by AERB.

DAE is setting up a medical cyclotron at Chakgaria, in Kolkata. This cyclotron will have three beam lines for production of radioisotopes which will be used for preparation of radiopharmaceuticals. In addition, there will be two experimental beam lines for material science and liquid metal target studies. Design basis of various systems is under review by AERB.

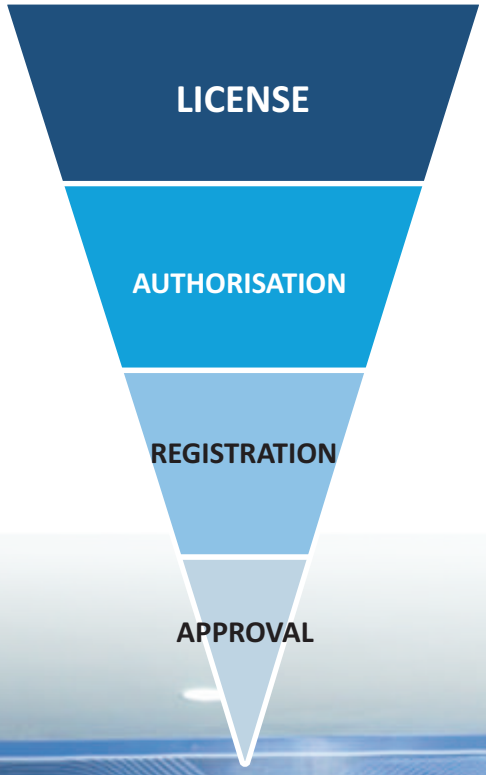
Electronics Corporation of India Limited, Hyderabad

All the manufacturing units of ECIL operated safely . The Thermal battery Division, which is under renovation following a fire in 2009, was granted permission to restart operation this year after thorough safety assessment.

A full fledged fire fighting system is being set up at ECIL. AERB reviewed the hydrant system, fire station works and fire brigade and has recommended commissioning of the fire hydrant along with the fire pump house.

Safety Surveillance of Radiation Applications in industry, medicine and research

Applications in society and the Graded approach to AERB Consenting



In the modern age, radiation sources (i.e. radioactive isotopes and radiation generating equipment are being used in multifarious and ingenious ways to achieve over all societal health and prosperity. Hence, it is not an overstatement to say that the use of radiation sources is concomitant with the country's progress and development.

Even so, there is an inherent hazard involved in handling of these sources. Proper design, handling and disposal methodologies offset these hazards and ensure safe and intended use of these radiation sources. The Atomic Energy Regulatory Board regulates the use of these radiation sources so that they do not cause any undue harm to the radiation workers, general public, patients and the environment.

As per the Atomic Energy (Radiation Protection) Rules, 2004 promulgated under the Atomic Energy Act, 1962, the radiation sources are classified as **LICENCE, AUTHORISATION and REGISTRATION** categories, based on their hazard potential. Accordingly, the statutory requirements are graded and may require multiple stages of approval to address the hazard, before final issuance of consent to operate the facility/ equipment.

Chairman AERB inaugurates the National Conference of Medical Physicists

"LICENSE CATEGORY" in Radiation Applications in Medicine

Radiotherapy

Radiation therapy uses high-energy radiation to kill cancer cells by damaging their DNA. The radiation used for cancer treatment may come from equipment that either use radioactive sources or generate x-rays such as Linear accelerators.

Safety issues

The radiation produced during operation pose worker safety issues. Linear accelerators produce x-rays. X-rays can be an external radiation hazard to those who work in close proximity to an accelerator. One of the benefits of accelerators is that, unlike radioactive sources, they only produce radiation when they are operated. However, radioactive waste is produced during their operation.

AERB Safety surveillance:

AERB ensures safety right from site & layout planning, design & construction to routine surveillance.

28 Licenses/Renewal
07 Type approvals
174 Radiation Safety Officer approvals
07 Permissions for source replenishment and 15 Permissions for source procurement
02 Design & construction approvals / 82 layout plan approvals
02 Design approvals
65 Facility inspections

Interventional Radiology

Interventional radiology utilizes minimally-invasive image-guided procedures to diagnose and treat diseases in nearly every organ system.

The IR equipment (also Cath lab) generates X-ray to diagnose and treat patients using the least invasive techniques in order to minimize risk to the patient and improve health outcomes.

Safety issues

The radiation produced during operation of the equipment poses safety issues to the interventionists such as cardiologist, neurologist, etc; As the interventional procedures are long, complicated and in close proximity, the surgeons and the allied medical professionals are likely to receive higher doses.

AERB Safety surveillance:

It involves Licencing process, design approval and awareness programs to the interventionists and allied medical personnel.

135 Licences/Renewal
05 Type Approvals
14 Radiation Safety Officer approvals
07 Permissions for source replenishment
02 Design & construction approvals/115 layout plan approvals
02 Design approvals

"LICENSE CATEGORY" in Radiation Applications in Medicine

Medical Cyclotron

The medical cyclotron produces radioactive isotopes called positron emitters. Which are transformed into positron-emitting radiopharmaceuticals (PERs) within the facility and are used for patient imaging procedures in positron emission tomography or PET.

Safety issues

They create very little radioactive waste as a result of their operation. However, they pose a radiation hazard to the workers and public near the equipment.

AERB Safety surveillance:

AERB ensures safety right from design and construction including site & layout planning, and routine surveillance.

01 Licenses/Renewal
2 Site approvals
14 Radiation Safety Officer approvals
07 Permissions for source replenishment
02 Design & construction approvals
02 Design approvals

Computed Tomography

Computed tomography (CT), is a noninvasive medical examination that uses X-ray equipment to produce cross-sectional images (Slices). These slices are used for a variety of diagnostic and therapeutic purposes on every region of the body.

Safety issues

CT equipment generate moderately high radiation field. The workers are safe if they follow the basic safety protocols. CT procedures should be used with discretion especially on children.

CT equipments are sometimes refurbished & sold without proper safety protocols or Quality Assurance resulting in higher doses. Sometimes such equipment could give poor image quality, leading to misdiagnosis.

AERB Safety surveillance:

AERB approves the design of these equipment and issues License for operation. Periodic QA of these equipment is mandatory.

233 Licenses/Renewal
12 Type approvals
07 Permissions for source replenishment

PET-CT/SPECT CT

This equipment is a combination of PET technology and CT for precise imaging, early and accurate detection of cancer and detecting certain diseases of the heart and brain.

107 Licences/Renewal

"LICENSE CATEGORY" in Radiation Applications in Industry

Radiation Processing Facilities

Radiation processing is controlled application of gamma rays, accelerated electrons and X-rays to enhance certain desirable properties of the product. Radiation processing is used for sterilization of medical and packaging products, insect disinfestations of food products, increasing shelf life, delay in ripening of fruits, cross-linking of polymers etc.

Safety issues

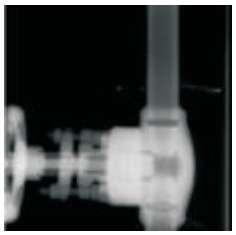
Both the radiation produced during operation and the radioactive waste created from operation pose worker safety issues. During operations, accelerators produce x-rays. X-rays can be an external radiation hazard to those who work in close proximity to an accelerator. One of the benefits of accelerators is that, unlike radioactive sources, they only produce radiation when they are operated. However, radioactive waste is produced during their operation.

AERB Safety surveillance:

AERB ensures safety right from site & layout planning, design & construction to routine surveillance.

08 Licenses/Renewal	03 Design & construction approvals
02 Site approvals	02 Design approvals
14 Radiation Safety Officer approvals	19 Facility inspections
07 Permissions for source replenishment	

Industrial Radiography



Industrial manufacturers use a testing method called "radiography" to check for defects in metal parts and welds to ensure safety /durability in the products in a Non-Destructive manner. Testing on gas /oil pipelines in the field is called "open field radiography". Industrial radiography uses either x-rays or gamma rays. X-ray radiography is used in a fixed location. Here, radiation is present only when these machines are turned on. Portable industrial radiography devices are smaller, and use radioactive source as a "sealed source" to provide gamma rays. There is an inbuilt shielding to protect workers from the radiation.

Safety issues

Potential for exposure from the radiation sources exists when the equipment is mishandled, source is removed by unauthorized persons or theft. The high gamma source has the potential of causing severe burns when handled without any protection.

AERB Safety surveillance:

AERB ensures safety of the design and operation by stage-wise issuance of consents and extensive training programs for radiographers.

290 Licenses/Renewal	02 Design & construction approvals
02 Site approvals	02 Design approvals
189 Radiation Safety Officer approvals	130 Facility inspections
1032 Permissions for radioactive source procurement	

"AUTHORISATION CATEGORY" in Radiation Applications in Medicine and Research

Gamma Irradiation Chambers

One type of Gamma irradiation chamber is the Blood Irradiator. Irradiation of blood & blood products by gamma rays is a proven and safe method to eliminate risk of post transfusion graft vs host disease. Gamma Irradiation Chambers are used extensively in academic institutions for research and analysis.

Safety issues

The built-in design safety to a great extent ensures safety.

AERB Safety surveillance:

Post-Mayapuri incident, AERB has strengthened its continuously monitoring program related to the disposal aspects of sources in universities & other institutions.

17 Authorisations/ 07 layout approvals
04 Type approvals
14 Radiation Safety Officer approvals
06 Permissions for source replenishment
16 Facility inspections

Brachy Therapy

Brachytherapy applies to radiation therapy applied over a short distance with low or high dose. Brachytherapy is used to treat cancers of the breast, eye etc.

Safety issues

Source getting stuck can pose an important safety issue while operating this equipment. Source loading and unloading should also be carried out as per procedure.

AERB Safety surveillance:

The authorisation for use of Brachytherapy equipment is issued only after design and layout approvals, source handling permissions, presence of qualified radiation workers.

08 Licenses/Renewal
02 Site approvals
14 Radiation Safety Officer approvals
214 Permissions for source procurement
19 Facility inspections

Nuclear Medicine Laboratories

Nuclear medicine is an integral part of patient care and is extremely valuable in the early diagnosis of a number of medical conditions. Nuclear medicine uses very small amounts of radioactive materials (radiopharmaceuticals) to diagnose and treat disease.

AERB Safety surveillance:

Layout plans are scrutinized with respect to preparation, administration and disposal of radiopharmaceuticals.

08 Licenses/Renewal
02 Site approvals/58 layout plan approvals
529 Permissions for source procurement
70 Radiation Safety Officer approvals

Safety issues

Spillage / loss / theft of radioactive material, management of dead patients administered with therapeutic quantity of radioactivity & mis-administration of radiopharmaceutical are few safety related issues.

"REGISTRATION CATEGORY" in Radiation Applications in Medicine, Industry & Research

Radioactive Traces In Research

A radioactive tracer, is a chemical compound in which one or more atoms have been replaced by a radioisotope. The decay of the isotope helps towards the objective of the study.

Safety issues

Although radiation hazards are very low, care should be taken during handling and disposal of the radiation source.

AERB Safety surveillance

26 Registrations
233 Permissions for source procurement

Nucleonic Guages In Industry

Nucleonic Gauges are extremely versatile, because of provision of on-line, non-contact, non-destructive measurement and are used for monitoring of following parameters; level, density, thickness, moisture, elemental analysis, static elimination, well-logging etc. Different radio nuclides are used for different purposes.

Safety Issues

Loss / Theft of sources

AERB Safety surveillance

37 Registrations
33 Type Approvals
220 Radiation Safety Officer approvals

Medical Diagnostic X-ray Equipment

X-ray equipment such as General purpose Radiography, fluoroscopy, C-Arm Mammography, Dental equipment are extremely invaluable for medical diagnosis.

Safety Issues

Hazard potential of these equipments are very low. Please refer the special feature article for further details.

AERB Safety surveillance

1558 Registrations
56 Type approvals
599 Radiation Safety Officer approvals (including for CT and Cath Lab)
372 Facility inspection
02 Design & construction approvals
02 Design approvals

Radio-immuno Assay Kits

Radioimmunoassay (RIA) is a very sensitive in vitro assay technique used to measure concentrations of antigens (for example, hormone levels in the blood) by use of antibodies. For carrying out the assay known quantity of radioactive isotope such as I-125 is used.

Safety issues

Very low hazard potential.

AERB Safety surveillance

36 source procurement permissions
02 Site approvals
14 Radiation Safety Officer approvals

Radiation applications in Consumer Goods

Consumer products are classified as those radioactive products which have extremely low quantities of radioactivity or like the x-ray baggage system which generates very low energy x-rays. The typical consumer products are Ionization Chamber Smoke Detector (ICSD), Electron Capture Detector (ECD), Ion Mobility Spectrometer (IMS), [Explosive detectors], Static Charge Eliminator Device, Others (like watches/research associated products etc).

Safety issues

These are of extremely low radiation hazard potential. Only the manufacturers / suppliers are issued with the requisite regulatory consent.

Thorium Gas Mantles

Gas mantles are usually sold as fabric items which, because of impregnation with metal nitrates, form a rigid but fragile mesh of metal oxides when heated during initial use. These metal oxides produce light from the heat of the flame whenever used. Thorum dioxide is commonly a major component.

X-ray Baggage Scanners

X-ray inspection systems with their high image quality are vital factor in the search for explosives, weapons and contraband in baggage, mail and freight., thus playing a vital roles in aviation security and customs inspections.

AERB Safety surveillance

2 Inspections
18 Permission for procurement of Thorium oxide/ nitrate
217 Number of consumer products issued with Import permission

AERB Safety surveillance

05 Type Approvals
01 Regulatory inspection

Smoke Detectors

An ionization smoke detector uses a radioisotope such as Americium-241 to produce ionization in air; a difference due to smoke is detected and an alarm is generated.

Regulatory Inspections of

"Regulatory Inspections are carried out to ensure compliance

Nuclear and Radiation Facilities

with the AERB safety requirements and stipulations"

Facilities	No. of Inspections
Operating Nuclear power plants and associated facilities	26
Nuclear Power Projects and associated facilities	24
Nuclear Fuel Cycle Facilities, R&D units and industrial plants of DAE	38
Radiation Facilities	967

Special Inspections

Nuclear Power Plants	17
Monthly industrial safety inspections of nuclear power projects under construction	44
Quarterly industrial safety inspections of fuel cycle projects under construction	8
Special electrical safety inspections of fuel cycle facilities	14
Radiation facilities	30

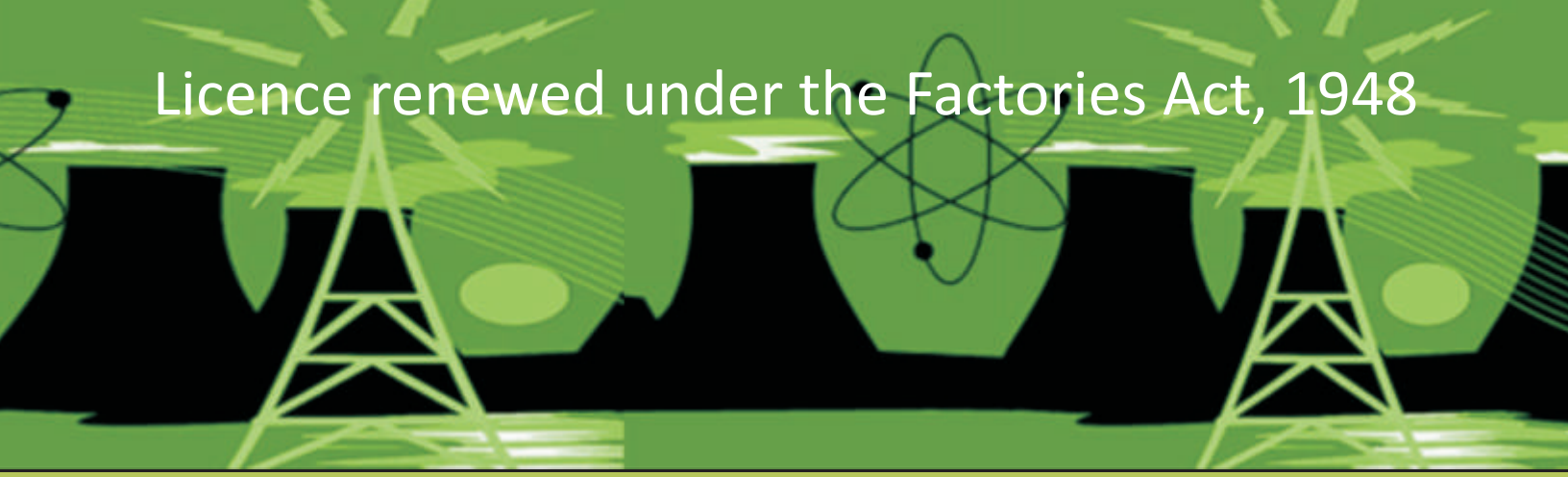
Additional Security Related Inspections

Operating Nuclear Power Plants	5
Nuclear Power Projects	7
Fuel Cycle facilities	2

About 80-95% of major observations of last year's inspections have been complied in nuclear facilities. Remaining are in progress as per schedule.

Industrial Safety in DAE units

AERB is entrusted to administer the provisions of the Factories Act, 1948 in the units of Department of Atomic Energy (other than BARC & BARC facilities) under its purview.



Licence renewed under the Factories Act, 1948

Unit	License Validity
Tarapur Atomic Power Station 3 & 4	Five years
Kaiga Generating Station 1 & 2	Five Years
Rajasthan Atomic Power Station 3 & 4	Five Years
Nuclear Fuel Complex	Extended for One year
Indian Rare Earths Limited, Udyogamandal	Extended for One year

Designation of Competent Persons

Competent Persons are designated for the purpose of carrying out tests, examinations and inspections of lifting machineries, tackles, lifts and hoists, ventilation system, civil construction and structural works, operation of dangerous machines, pressure plants, for supervision of handling of hazardous substances and dangerous fumes.

75 persons were designated as **Competent Persons** in different DAE units this year.

Appointment of Certifying Surgeons

Certifying Surgeons are appointed for carrying out duties and responsibilities related to occupational health safety of workers such as pre medical examination of workers and periodical examinations of workers as per specified frequency.

3 new medical doctors were appointed as **Certifying Surgeons** in various units of DAE this year.

Industrial and Fire Safety Review & Inspection

Industrial & Fire safety inspection of Fire Water Pump House

Important Safety Review

Fire Hazard Analysis Reports of KKNPP-1&2, FRFCF and PFBR

Quantitative Risk Assessment and Hazard & Operability (HAZOP) studies of new projects

Safety assessments of NFC and HWPS with respect to natural external events

Residual Life Assessment of critical equipment at hydrogen sulphide based Heavy Water Plants at Manuguru and Kota

Code of Practice for In-service Inspection for all HWPs based on current codal requirements and practices

Job Hazard Analysis for drilling operations at AMD sites

Units	Inspection Frequency
Nuclear Fuel Cycle Facilities (other than mines) under operation	Twice in a year
Nuclear Power Plants under operation	Once in a year
Nuclear Power Projects under construction	Once in a month
Fuel Cycle and R&D Projects under construction	Once in a quarter

***141** regulatory inspections were carried out, which include **44** special monthly inspections at construction sites of nuclear power projects and **8** quarterly inspections of construction sites of fuel cycle facilities.*

Following the last year year's electrical flash over incident at NFC, 14 additional Special inspections focusing on electrical safety were carried out in fuel cycle facilities.

Safety in Transport of Radioactive materials

The widespread use of ionizing radiation has brought in the necessity of voluminous transport of the radioactive material from one place to another, many a times through public domain.

The transportation of radioactive material (including that of nuclear material from nuclear facilities), is governed by regulations specified by AERB in Safety Code for the transport of radioactive materials and is line with the International requirements specified by IAEA for safe transport of radioactive material.

The design of the radioactive package should be such that during the entire process of transport, it is ensured that the radioactive material remains contained and shielded to avoid unacceptable radiation exposure to cargo handlers and public. As the activity and nature of radioactive material to be transported varies over a wide range i.e. from few kBq (few µCi) to few PBq (thousands of Ci), a graded approach is used in selection of the packaging. “Type A packages”, are used for of transport radioactive material of activity not exceeding the specified limits and need to be registered with AERB. “Type B packages” are subjected to a stringent approval procedure and are required to fulfill the safety standards.

During 2012-13, five packaging design approval was issued for Type A package and one for Type B(U)/(M) package.

Radioactive Waste Management in Nuclear and Radiation Facilities

The disposal of radioactive wastes is governed by the Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987 promulgated under the Atomic Energy Act, 1962.

The rules require that for disposal of any radioactive waste, an authorization has to be obtained from AERB. The radioactive wastes can be disposed/transferred only in accordance with the terms and conditions specified in this authorization.

Further regulations for safe management of radioactive wastes are laid down in the Safety Code on Management of Radioactive Waste. AERB has prepared various Guides on radioactive waste management which provide guidance on implementation of the regulatory requirements of the Safety Code.

Waste generated from nuclear facilities are in the form of gaseous, liquid and solid. The public dose limit of 1mSv is apportioned among the various facilities located at a given site in a conservative manner. This apportioned dose is further subdivided among atmospheric, aquatic and terrestrial pathways and also among radionuclides which are specific to the installation.

Gaseous Emissions from Nuclear Power Plants

Tritium:
1.35 -7.56% of the Technical Specifications limit

Argon-41:
0.00-36.86% of the Technical Specifications limit

Fission Product Noble Gasses
0.2-14.55% of the Technical Specifications limit

Iodine-131
0.01-2.30% of of the Technical Specifications limit

Liquid effluent discharges from Nuclear Power Plants

Tritium:
0.35 -11.51 % of the Technical Specifications limit

Gross beta:
0.00-22.92 %of the Technical Specifications limit

Disposal of spent radioactive sources

All the radioactive sources must be safely disposed off once they reach the end of their useful life. These sources are disposed off at different disposal sites such as Board of Radiation and Isotope Technology (BRIT), Bhabha Atomic Research Centre (BARC), Central Waste Management Facility (CWMF), Kalpakkam, Electronics Corporation of India (ECIL), Hyderabad and Narora Atomic Power Station (NAPS). The sources are also exported back to the original supplier abroad, in case of imported sources.

During 2012-13, approvals were issued for disposal of 534 radioactive sources in facilities within the country and 438 sources for exporting back to the original supplier.

Radioactive wastes are being handled carefully in all nuclear and radiation facilities in accordance with AERB's directions. Samples of surface water, ground water, soil, vegetation, dairy products, meat etc around operating facilities are periodically monitored to assess the public dose and no adverse impact has been observed due to disposal of radioactive wastes.

Emergency Preparedness in Nuclear and Radiation Facilities

Nuclear Power Plants (NPPs) are designed with defence-in-depth philosophy which includes various safety barriers and systems to guard against any possible nuclear accident. In spite of all these, if any emergency situation arises due to an accident, well defined plans are laid down as required by AERB to tackle such situations.

Types of emergency situations

Emergency standby	Abnormal plant conditions with potential to develop into accident situations, if timely preventive actions are not taken.
Personnel emergency	Emergency involving serious injury and/or excessive contamination of personnel involving radioactive/toxic chemicals or exposures to radiation and toxic chemicals.
Plant emergency	Accident situations due to release of hazardous chemicals/radioactive materials, fire/ explosion in the plant but with consequences confined within the plant boundary.
Site emergency	Accident situations in the plant involving radioactivity transgressing the plant boundary but confined to the site, or involving release of hazardous chemicals/ explosion/fire, whose effects are confined to the site, with off-site consequences expected to be negligible.
Off-site emergency	Accident situations with excessive release of radioactivity or release of large amounts of hazardous chemicals/explosion/fire, with consequences likely to extend and transgress public domain, calling for intervention.

AERB requires Nuclear Power Plants to conduct Site emergency exercise once in a year & off-site emergency exercise once in 2 years

Training of National Disaster Rapid Force (NDRF)

During 2012-2013, six site emergency exercises. One off site emergency at KKNPP was conducted. For further details please refer the special feature article.

Site emergency exercise (once in six months) and Off-site emergency exercises (once in a year) were also carried out at hydrogen sulphide based Heavy Water Plants at Manuguru and Kota.

Emergency training are also imparted to radiation facilities with emphasis on loss or theft of source.

Review of Emergency Preparedness Plans

The emergency preparedness plans of operating nuclear power plants are periodically updated and reviewed by AERB. During 2012-13, four plant emergency preparedness plans, three site emergency preparedness plans and one off-site emergency preparedness plan were reviewed. In addition, emergency preparedness plans for under construction sites at Rawatbhata and Kakrapara were also reviewed.

Guidelines on Emergency Preparedness Plans

AERB in co-operation with National Disaster Management Authority (NDMA) assessed the existing guidelines for emergency preparedness in view of the lessons learnt from Fukushima nuclear accident. Based on these assessments together with the recent publication of IAEA on criteria for use in preparedness and response for a nuclear or radiological emergency, AERB has undertaken revision of its existing guidelines on off-site emergency preparedness.

Strengthening of provisions for managing nuclear emergencies

Onsite emergency support centres at NPPs

Post Fukushima safety assessments recognized that a beyond design basis external event may disable the facilities available at the NPP site for monitoring and control of important reactor parameters. It may also result in physical isolation of the site such that it may not be possible to receive outside help for a considerable period of time. In view of this, the provision of an On-Site Emergency Support Centre is being considered for all NPP sites from where the actions required for managing the accident will be coordinated.

AERB has constituted an Advisory Committee to develop the guidelines for creation of such a facility at all NPP sites.

Decision support system

AERB recognizes the importance of an enhanced real time Decision Support System (DSS), to provide comprehensive and timely information to facilitate the emergency management and response actions. DSS developed by BARC and IGCAR have been installed at Narora and Kalpakkam site on experimental basis. AERB also organized a one day Discussion Meet on “Online Decision Support System for Nuclear and Radiological Emergencies” to seek opinion of experts from various facilities on the requirements of DSS.

AERB constituted a special committee of experts to bring out requirements of DSS for NPP Sites.

AERB’s nuclear and radiological emergency monitoring cell

The actions to be taken during a nuclear or radiological calls for coordination between regulatory body and various other agencies. In order to strengthen the provisions for monitoring of progress of emergencies and review of actions taken by the involved agencies, a Nuclear and Radiological Emergency Monitoring Cell (NREMC) is being established at AERB.

Safety Statistics: Occupational Exposure

AERB prescribes a dose limit of 30 mSv in year for occupational radiation exposure, with the condition that it should not exceed 100 mSv in a span of 5 years. This limit is more stringent than the ICRP recommended limit followed around the world. The specified annual limit for radiation exposure to temporary worker is 15 mSv.

Nuclear Power Plants

Radiation Doses Received by Workers in NPPs

NPP	Number of monitored persons	Average dose for monitored person (mSv)	No. of persons received dose	Average dose among dose receivers (mSv)
TAPS 1&2	1783	2.84	1538	3.29
Older NPPs*	2359	1.08-2.39	1873	1.23-3.27
Pre standardize NPPs of PHWR type**	2879	1.64-1.95	2222	2.21-2.43
Standardize NPPs of PHWR type***	7420	0.35-1.48	5040	0.66-2.12

*Older plants consist of RAPS 1&2 and MAPS 1&2
**Pre-standardized NPPs consist of NAPS 1&2 and KAPS 1&2
***Standardized NPPs consist of KGS 1-4, RAPS 3-6, TAPS 3&4

During 2012, 14441 occupational workers were monitored of which around 74% received radiation exposure, with their average dose ranging between 0.66-3.29mSv.

The doses of all occupational workers were within the prescribed annual dose limit of 30mSv.

Fuel Cycle Facilities

Radiation Doses Received by Workers in Fuel Cycle Facilities

Type of Facilities	Number of Exposed Persons	Average Dose for Exposed Persons (mSv)	Maximum Dose of Exposed Persons (mSv)
Uranium mines	4833	2.29-6.94	14.68
Uranium mill	601	2.26	11.29
Thorium mines and mineral separation	458	0.49-2.85	11.05
Thorium mill	335	2.06	8.37
Fuel fabrication facilities	1024	0.87	9.53

During 2012, no occupational worker in any of the fuel cycle facilities exceeded 30 mSv.

Radiation Facilities

Radiation Doses Received by Workers in Medical, Industrial and Research Institutions

Type of facilities	No. of Monitored Persons	Average Dose for Monitored Persons (mSv)	No. of Exposed Persons	Average Dose for Exposed Persons (mSv)
Diagnostic X-rays	50868	0.38	20745	0.78
Radiation Therapy	9270	0.29	3761	0.45
Nuclear Medicine	1989	0.49	1173	0.84
Industrial Radiography & Radiation Processing	7253	0.58	2610	1.16
Research	4139	0.10	1045	0.38

During 2012, 73,519 occupational workers were monitored in radiation facilities of which around 40% received radiation exposure, with their average dose ranging between 0.38-1.16 mSv.

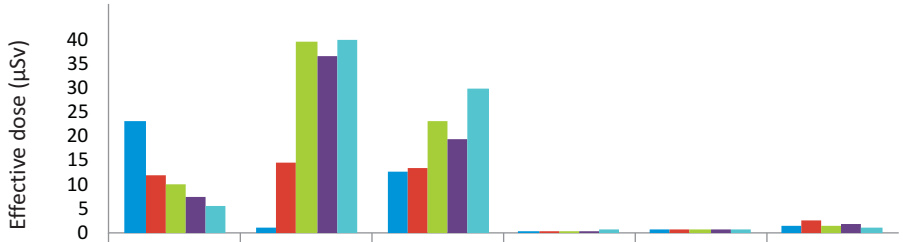
Safety Statistics: Public Exposure

AERB imposes limits on radioactive liquid and gaseous discharges from operating nuclear and radiation facilities. These limits are decided by experts and are very conservative such that there is no adverse effect on health of public or environment. Apart from prescribing limits AERB verifies conformance to these limits.

Radiation dose to members of the public near the operating plants is estimated based on measurements of radionuclide concentration in items of diet, i.e., vegetables, cereals, milk, meat, fish, etc and through intake of air and water.

During 2012, the liquid and gaseous waste discharge from the operating NPPs continued to remain only a small fraction of the allowable discharge limits. The effective dose to public due to the radioactive discharges were estimated to be is far less than the annual limit of 1 mSv (1000 micro-Sievert) prescribed by AERB.

AERB Prescribed Annual Limit is 1000 micro-sievert



	Tarapur Site	Rawatbhata Site	Kalpakkam Site	Narora Site	Kakrapara Site	Kaiga Site
2008	23.00	1.26	12.80	0.48	0.79	1.31
2009	11.82	14.60	13.20	0.30	0.60	2.48
2010	10.15	39.60	22.93	0.42	0.75	1.47
2011	7.42	36.30	19.50	0.48	0.88	1.90
2012	5.52	39.88	29.88	0.56	0.78	1.24

Estimated Public dose at exclusion zone boundary of NPP sites

All operating NPPs maintain an exclusion zone boundary at 1.6km radius within which no habitation is allowed. The doses beyond this point (fence post) are estimated and found to be only a fraction of public dose limit (1000 micro-siverts) prescribed by AERB.

Perspective of Doses

Threshold for Mortality 2,000,000
Radiation Sickness Appears 1,000,000
First Signs of Radiation Effects 500,000
Emergency Worker Dose Limit/yr 250,000
Risk of Health Effects insignificant 100,000
Thyroid Scan 43,000
Thallium Cardiac Stress Test 36,000
Occupational Dose Limit/yr 30,000
One Chest CT Scan 7,000
Natural Background/yr 2,400
Public Dose Limit/yr 1,000
One Chest X-ray 100
One 10 hr. Air flight 50
Actual Annual Radiation Dose From Operation of NPPs at Exclusion Boundary < 15

All Values in Micro-Sievert

Statistics: Industrial Safety

Reportable Injury

Injuries resulting in absenteeism for 48 hours

There were 46 reportable injuries in 2012 as compared to 31 in 2011.

Frequency Rate

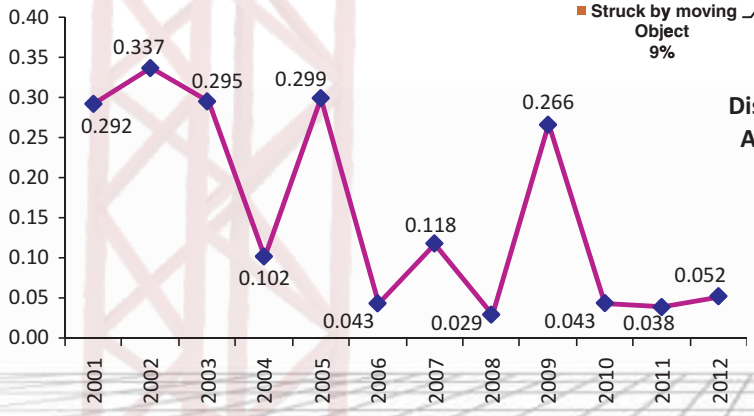
No. of reportable injuries divided by million man-hrs worked

The frequency rate has decreased to 0.33 in the year 2012 after being almost constant at 0.50 since 2007.

Severity Rate

No. of man-days lost man-days lost divided by million man-hrs worked

The Severity Rate (SR) for 2012 was 157 as compared to 166 in 2011.



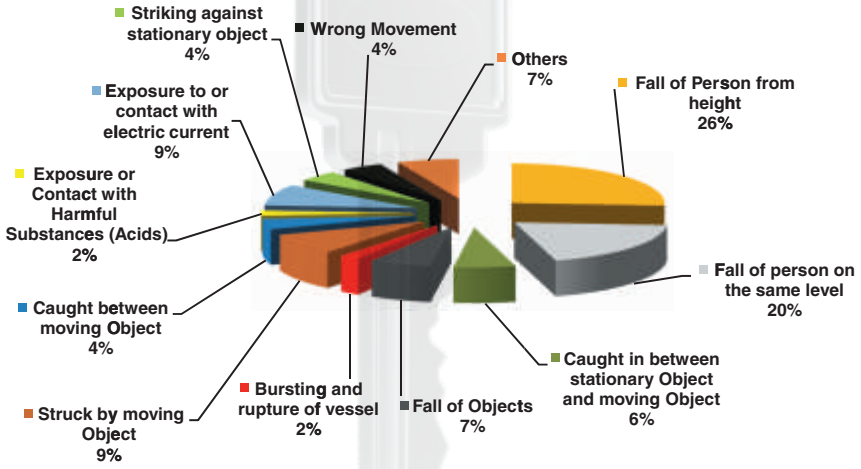
Injury Index: Product of the Frequency Rate and the Severity Rate

Near Miss Accidents

In 2012, 269 Near Miss Accidents were reported from different units of DAE. 29 % of the reported near miss accidents were due to "Fall of Objects" from height and 12 % were due to "Exposure to Electricity and fall of persons on the same level".

Occupational Health

No occupational diseases were reported from any of the DAE units during 2012-13.



Distribution of Injuries with respect to Type of Accidents causing Injuries in DAE units-2012

Fatal Accidents

There were four fatal accident during the period April 2012-March 2013 which occurred at IREL - OSCOM, UCIL - Tummalapalle and KKNPP 1 & 2.

Fatalities at IREL - OSCOM and UCIL - Tummalapalle took place due to fall from height. AERB suspended all the construction work at Tummalapalle mill site for 3 months.

Two fatalities happened at KKNPP due to electrocution. AERB suspended the construction work at KKNPP (Unit-2) site for about 20 days.

These accidents were investigated by AERB and were reviewed in the Fatal Accident Assessment Committee (FAAC) in detail. These accidents were also reviewed in the Apex committee of AERB and by the Board of AERB. Measures to prevent recurrence of such incidents in future were recommended and conveyed to the sites for compliance.

The compliance status of the recommendations was checked during the regulatory inspections of these sites.

AERB communicated the lessons learnt from the accidents to all DAE Units.

Industry Type	Incidence Rate	
	Fatal	Non-Fatal
Heavy Water Plants (2012)	0	0.58
Manufacture of Chemicals & Chemical products (2007)	0.09	1.25
Nuclear Fuel Complex (2012)	0	2.01
Manufacture of Fabricated Metal Products except Machinery and Equipment (2007)	0.04	2.34
Nuclear Power Plants (2012)	0	0.37
Electricity, Gas, Steam and Hot water supply (2007)	0.05	0.46

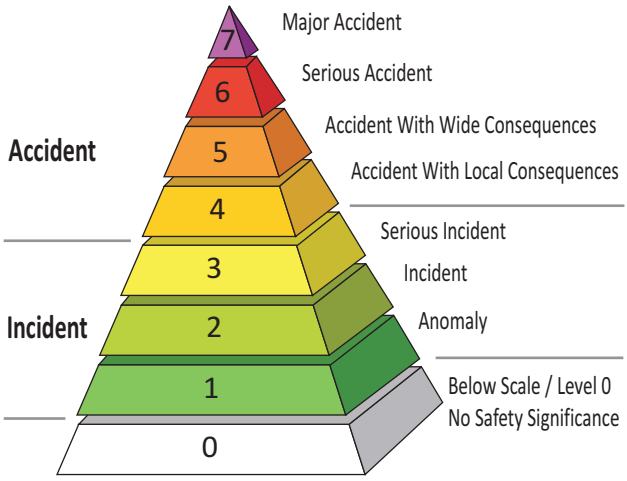
Comparison of Incidence Rates of DAE Units (2011) with Equivalent Non-DAE Industries (2007)
(Data Source - Pocket Book of Labour Statistics 2010 and 2011)

Statistics: Significant Events

AERB requires NPPs to submit detailed report for every significant event that takes place. The reporting criteria is provided in the Technical specification for operations. These reports are reviewed and categorized based on International Nuclear & Radiological Event Scale

INES Rating

The INES system of the International Atomic Energy Agency (IAEA) rates events at seven levels (1 to 7) depending on their safety significance.



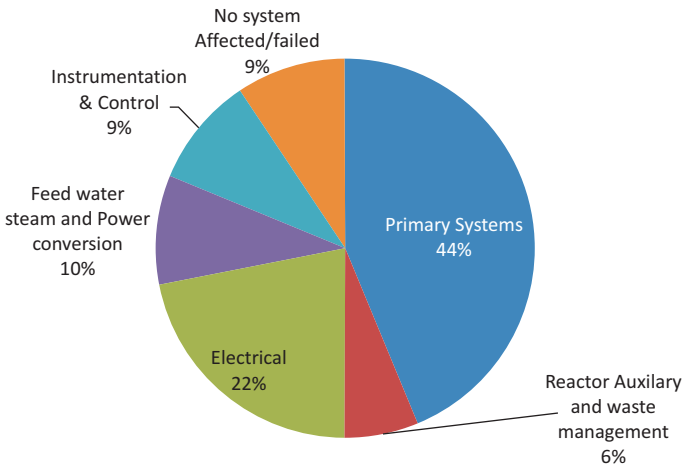
INES levels	2008	2009	2010	2011	2012
0	22	23	33	36	30
1	2	0	1	1	2
2	0	0	0	1	0
3	0	0	0	0	0
>3	0	0	0	0	0
Total	24	23	34	38	32

INES Rating of Significant Events in NPPs during the last five years

The accidents at Chernobyl NPP in former USSR (now in Ukraine) in April 1986 and Fukushima NPPs in Japan in March 2011 were rated at level 7 on INES. These accidents involved core meltdown with the consequences of off-site radioactivity release to environment.

Out of 32 significant events in 2012, 30 significant events were rated at level 0 on INES while significant event at NAPS-2 and RAPS-5 were rated at level 1 on INES respectively.

In the year 2012, 32 significant events were reported from the operating Nuclear Power Plants of which 30 were of level 0 and 2 were of level 1.



Classification of the Significant Events based on affected systems

Significant Events in Nuclear Facilities

Incident in NAPS-2 (INES Level-1)

On May 21, 2012, the operator, after completion of Emergency Core Cooling System (ECCS) monthly test, by mistake, initiated the ECCS while the reactor was in cold shutdown state. The ECCS heavy water injection to Primary Heat Transport (PHT) system did not terminate as per logic and this led to entry of nitrogen gas into the PHT system. As a result of nitrogen ingress, core cooling flow in some of the coolant channels was disturbed. Plant Operator immediately took corrective actions to degas the PHT system and for restoration of normal flow through the core. This event was analysed in detail by a special investigation team set up by AERB. It was understood that there was no impact on reactor safety due to this event as the reactor was under cold shutdown for about 8 days.

Incident in RAPS-5 (INES Level-1)

On June 23, 2012, during biennial shutdown of RAPS-5, thirty eight workers got internal tritium exposure above the investigation level (4-MBq/l) due to increase in tritium-in-air concentration in various areas of reactor building. The tritium-in-air concentration in the reactor building increased following a job involving creation of an opening in the moderator system for carrying out an engineering retrofit job, identified during post Fukushima safety reviews. The workers, unaware of the change in tritium in air concentration, continued to perform their normal duties in the reactor building and got internal tritium exposure.

One contract worker received internal tritium exposure of 18.94 m Sv. His total dose for year 2012 was accounted as 20.39 mSv which was higher than the prescribed dose constraint of 15 mSv for contractor workers.

Unusual Occurrences in Radiation Facilities

Industrial radiography units:

There were two unusual events in Industrial radiography. First incident was about theft of two devices at M/s Triveni Structurals Limited (TSL), Naini, Allahabad. The reason was attributed to lack of proper security measures. As an enforcement action AERB did not issue regulatory clearance to the company. Second incident was related to non-receipt of consignment containing IGRED model by M/s Neo Testing services. It was found out that during consignment booking of the above IGRED by M/s Neo Testing services, it was declared as electronic goods. As an enforcement action AERB withdrew certification of RSO and site-in-charge of the institute for a period of six months.

Radiotherapy units:

There were two unusual events in radiotherapy units. First incident was about the loss of Sr-90 Check source reported from Barnard Institute of Radiology & Oncology Govt. General Hospital, Chennai. The reason for same was attributed to lack of frequent verification of source inventory. AERB directed to hospital check the source inventory at regular intervals. Second incident was related to source stuck in transit position during treatment in telecobalt unit at Gurugobind Singh Hospital, Jamnagar, Gujarat.

It was found out that during patient treatment, coins fell from the patient's pocket into the source collimator resulting in this incident. AERB observed that no over exposures occurred in this incident and recommended for future awareness programs to incorporate about possibility of such an incident.

Radioactive contamination in the scrap metal and the finished products exported from India:

Over the years, several cases of radiation contamination in recycled metal products have come to the light. Generally, the radioactivity level of contaminations in finished steel products is significantly low. However, its presence is undesirable and has large economic impact on the industries using the contaminated scrap.

Once contaminated material gets detected, AERB advises segregation, isolation, safe storage and disposal of the contaminated items. Additionally, AERB has taken up various initiatives in interaction with different governmental agencies/departments/ministries and professional associations to prevent the radioactive contamination.

These include installation of portal monitors at all sea/air entry ports of India for compulsory checking of all imported consignments for any presence of radioactive contamination, obtaining certificate from an accredited agency in the exporting country that the imported metal scrap is free from radioactivity, conducting awareness programs by AERB with the help of industry associations, advising all concerned industries in India to carry out a thorough radiation check on incoming metal scrap as also on the finished and packaged products before releasing them for export, etc.

A total of 12 sea ports and 14 airports have been surveyed by inter ministry teams including DAE, Home Ministry, Ministry of Shipping and Civil Aviation and an integrated scheme has been worked out.

Development of Regulatory Safety Documents

AERB develops safety documents, which include Safety Codes (SC), Safety Standards (SS), Safety Guides (SG), Safety Manuals (SM) and Technical Documents (TD) for nuclear and radiation facilities and related activities.

New Safety Documents Published

AERB Safety Guide 'Protection against Internally Generated Missiles in Pressurised Heavy Water Reactor Based Nuclear Power Plants' [AERB/NPP-PHWR/SG/D-3] provides detailed guidance on protection of structures, systems and components important to safety from the effects of missiles resulting from failure of plant equipment.

AERB Safety Guidelines 'Siting, Design, Construction, Commissioning, Operation and closure of Tailing management Facilities for Uranium Ore Processing' (AERB/FE-FCF/SG-4) provides requirements and guidance on siting, design, construction, commissioning, operation, maintenance, closure and monitoring of the tailings management systems for uranium ore processing.

*The total number of safety documents published by AERB stands at **143***

Documents Translated in Hindi

- Hydrological dispersion of Radioactive Materials in relation to Nuclear Power Plant Sitting
- Design Basis Flood for Nuclear Power Plants on Inland Sites
- Design Basis flood for NP Plants at Coastal sites
- Quality Assurance in Siting of Nuclear Power Plants
- Staffing Recruitment, Training, Qualification & Certification of Operating Personnel of NPPs
- Preparedness of the operating organization for handling Emergencies at Nuclear Power Plants
- Emergency Electric Power Supply System for Pressurized Heavy Water Reactor Control of Airborne Radioactive Materials in Pressurised Heavy Water Reactors
- Ultimate Heat Sink and Associated Systems in Pressurised Heavy Water Reactor
- Safety guide for Quality Assurance in the Design of Nuclear Power Plants
- Safety Guide for Quality Assurance during Site-Construction of Nuclear Power Plants
- Near Surface Disposal of Solid Radioactive Waste
- Management of Radioactive Waste from mining and milling of Uranium and Thorium
- Safety Manual for Decommissioning of Nuclear Facilities
- Regulatory Inspection and Enforcement in Nuclear Fuel Cycle Facilities and Related Industrial Facilities other than Nuclear Power Plants and Research Reactors
- Personal Protective Equipment
- Safety in Thorium Mining and Milling
- Safety Manual on Data Base Management for Accidents/Diseases happening due to occupation and implementation of the same in the Department of Atomic Energy
- Intervention levels & derived intervention levels for off site radiation Emergency
- Safety Manual-Handbook for Medical Management of Persons Exposed in Radiation Accidents

Experts in AERB reviewed 9 Draft Documents and 7 Document Preparation Profiles of IAEA & offered valuable suggestions to IAEA

Safety Studies and

Safety studies and R&D activities at

AERB recognizes the importance of safety research in support of its regulatory work as it helps in obtaining deeper insights into the issues concerning nuclear and radiation safety to arrive at scientifically sound regulatory decisions. Safety analysis activities to support the regulatory decisions are being carried out at AERB headquarters in Mumbai as well as in Safety Research Institute, Kalpakkam which was primarily set up in 199 to carry out safety research studies of regulatory interests. Various studies were undertaken during 2012-2013 in the f following areas:

Hydrogen Distribution & Mitigation Studies

Large amounts of hydrogen could be generated and released into the containment during severe accident conditions in a nuclear power plant. Combustion of hydrogen may jeopardize the integrity of containment. Detailed modelling studies of containment thermal hydraulics were carried out to predict the local distribution of hydrogen inside the containment.

Probabilistic Safety Assessment (PSA) Studies

PSA is a complementary safety assessment tool to deterministic safety analysis and is useful in quantifying the risk. Models were developed for independent verification and to perform the review of various utility submissions on Level-1, 2 and external events PSAs.

Reactor Physics Studies

Reactor physics studies were carried out to assess the start-up procedures for VVERs, to improve the understanding of core behavior for VVERs and PFBRs and to gain insights in the physics behavior of the new designs such as EPRs.

Thermal Hydraulic Studies

The thermal hydraulic studies were taken up at AERB as part of independent verification and developmental activities. Models were developed for 700 MWe and 540 MWe reactors to carry out independent verification. Thermal-hydraulic and 3-D reactor physics codes were coupled for more accurate predictions under reactivity feedbacks & reactor power under accident conditions.

Safety studies Funded by AERB

AERB continued to fund project proposals from academic and research institutions for research in nuclear and radiological safety. the following 8 new research projects were sanctioned during the year 2012-2013.

- Development of Thermal Hydraulics Model and Coupling of 3D Kinetics Code at IIT Kanpur
- Effect of Radiolytic Products and Metal Nitrates on Red Oil Forming Reactions in Fuel Reprocessing at CLRI, Chennai
- Survey of Effective Dose Received by Pediatric Patients from Digital Radiography at Various Hospitals in South India at Bharathiar University, Coimbatore
- Fabrication of Nano oxide based Sensor on Stabilized Nano Zirconia for Detection of H2S at Rajalakshmi Engineering College, Chennai
- Markov Approach for Reliability Assessment of Safety Critical Software at Dept. of Mathematics, SSN College of Engg, Kalavakkam
- Image Quality/Patient - Staff Dose Studies & Development of Dose Audit Procedures in Interventional Cardiology at PSG College of Technology, Coimbatore
- Reliability assessment of the passive systems and its integration in to PSA at IIT Bombay
- Thermo luminescence Characterization of Phosphors used in Display Devices for Possible use in Accident Dosimetry at Vasavi College of Engg, Hyderabad

Research activities

SRI, Kalpakkam and Mumbai Headquarters

AERB recognizes the importance of safety research in support of its regulatory work as it helps in obtaining deeper insights into the issues concerning nuclear and radiation safety to arrive at scientifically sound regulatory decisions. Safety analysis activities to support the regulatory decisions are being carried out at AERB headquarters in Mumbai as well as in Safety Research Institute, Kalpakkam which was primarily set up in 199 to carry out safety research studies of regulatory interests. Various studies were undertaken during 2012-2013 in the f following areas:

Structural Safety Assessment & Core Material Studies

Structural safety studies were carried out to assess the failure probability for PFBR systems, develop a model for prediction of creep damage and develop database for future metallic fuel of FBRs.

Radiological Assessment Studies

Various studies with respect to radiological protection of the environment were carried out such as impact due to atmospheric, aquatic releases.

Fire Safety Studies

Establishing the fire rating criteria for cable fire based on net heat flux/incident heat flux using CFD approach.

Seismic Safety Studies

Seismic studies were carried out to identify structures, systems and components of FBTR with inadequate seismic capacity

Geo Technical Studies

Geotechnical Investigations were carried out at Kalpakkam to assess impact of Tsunami protection wall on beach morphology and to develop models for prediction of variation in water table.

Experimental Studies

A test facility is built at IIT Bombay to conduct experimental studies on critical heat flux (CHF) in horizontal channels similar to PHWRs, under low pressure and low flow conditions. The objective is to study the mechanism of transient CHF, compare it with CHF at steady state conditions and to develop a correlation for predicting the CHF in transient conditions.

Safety studies with National and International Collaboration

AERB has participated in several national and international collaborative problem exercises in severe accident analysis, thermal hydraulics, hazard assessment, structural integrity assessment etc.

- IAEA International Collaborative Standard Problems on integral PWR design natural circulation flow stability and thermal-hydraulic coupling of containment and primary system during accidents
- Independent verification of severe accident analysis results as part of AERB-IRSN collaboration and IAEA Coordinated Research Project
- Round Robin Exercise on Improving the Robustness assessments methodologies for structures Impacted by missile (IRIS-2012) for missile impact on concrete slab
- National Round Robin exercise on Tsunami Modeling for Vizag Site (simulation and validation of numerical models used for tsunami analysis using the data obtained from 2004 Indian Ocean tsunami)
- International round robin analysis program organized by BARC to assess ultimate load capacity (ULC) of containment test model

International Co-operation

AERB accords top priority in the area of international co-operation by maintaining regular technical interactions with regulatory bodies of other countries for the exchange of information in the field of regulation of nuclear activities for peaceful purposes.

AERB continued its cooperation activities with international organizations such as International Atomic Energy Agency (IAEA), Nuclear Energy Agency (NEA), regulatory fora such as CANDU reactors forum and VVER reactors forum and with regulatory bodies of France (ASN), Russian Federation (Rostechnadzor) and United States of America (USNRC).

Multinational Design Evaluation Programme (MDEP)

AERB became a full member of MDEP of NEA, which is a multinational initiative to develop innovative approaches to leverage the resources and knowledge of national regulatory authorities who are, or will shortly be, undertaking the review of new reactor designs.

As a full member, AERB will contribute to the Programme's strategic decisions in the MDEP Policy Group and the MDEP Steering Technical Committee. Besides, AERB will play an active role in design specific working groups such as on EPR and issue specific working groups such as Codes and Standards Working Group (CSWG), Digital Instrumentation and Control Working Group (DICWG) and Vendor Inspection Co-operation Working Group (VICWG).

New bilateral arrangements with regulatory bodies

During the year, AERB entered into arrangement with regulatory bodies of Romania and Ukraine for exchange of technical information and co-operation in the field of regulation of nuclear activities for peaceful purposes.

Mr. Ph. D. Constantin POPESCU, President, CNCAN and Mr. Satinder S. Bajaj, Chairman, AERB after signing MoU

Shri S. S. Bajaj, Chairman, AERB and Mrs. Olena A, Mykolaichuk, Head of the State Inspectorate for Nuclear Regulation of Ukraine, signing the MoU in the presence of the Prime Minister, Dr. Manmohan Singh and the President of Ukraine, Mr. Viktor Yanukovych, in New Delhi

Convention on Nuclear Safety

Contracting Parties to the international Convention on Nuclear Safety (CNS) of IAEA decided to hold an Extraordinary Meeting to review actions taken post Fukushima accident in August 2012. In this regard, National report of India was prepared which brings out the actions taken by AERB, NPCIL and DAE and future action plan for further enhancement of safety against extreme external events in Indian nuclear power plants. The National report was submitted to CNS organizers.

Conventions on Early Notification of Nuclear Accidents and Assistance

India is signatory under these IAEA Conventions. Under these conventions, India has agreed to provide notification of any nuclear accident that occur within its jurisdiction that could affect other countries and any assistance can be provided in the case of a nuclear accident that occurs in another state that has ratified the treaty. The Crisis Management Group of Department of Atomic Energy (CMG-DAE) is the national contact point for India for these conventions. Periodic exercises are conducted by IAEA for training and preparedness of the involved agencies. AERB participates in these exercises through CMG-DAE.

USNRC delegation visits AERB

A delegation of nuclear safety experts from United States Nuclear Regulatory Commission (USNRC) visited AERB during May 16-17, 2012. This was the twelfth meeting under this co-operation program. One and a half day technical workshop was conducted which provided an opportunity to share the action plans taken by both the countries to strengthen the safety features of the nuclear power plants after the nuclear accident at Fukushima NPP. During the meeting USNRC expressed its interest in sharing the experience on Periodic Safety Review (PSR) carried out for all Indian NPPs after every 10 years. AERB expressed its interest in technical co-operation in the areas of digital instrumentation and control and ageing management.

Meeting with USNRC delegates in May 2012

Meeting with USNRC delegates in October 2012

Subsequently, another delegation of nuclear regulatory experts from USNRC led by Commissioner Ms. Kristine Svinicki visited AERB on October 1, 2012. USNRC Commissioner informed that a time frame has been fixed for implementation of different action points, which have been identified for safety upgradation in various NPPs after the nuclear accident in Fukushima in March 2011. It was recognized that the post Fukushima recommendations for safety upgradation are almost similar in most of the countries including India, USA, France, etc. and this is the outcome of a very close interaction amongst all nuclear operators and regulators at different forums around the world.

International seismic safety centre

AERB is a participant in the activities of International Seismic Safety Centre of IAEA in the following working areas:

Work Area - 3	Seismic safety evaluation
Work Area - 5	Tsunami hazard
Work Area - 7	Engineering aspects of protection of nuclear installations against sabotage
Work Area - 8	Site Evaluation and External Events Safety Assessment

As part of IAEA ISSC's activities of work area 5, a safety report on Tsunami and seiche hazard assessment is being prepared. AERB is one of the contributing authors to this IAEA safety report. Specific areas drafted by AERB include: Impact of 2004 tsunami on Indian NPPs; Typical case study for tsunami hazard assessment of NPP site located along the West coast of India, adopting the methodology proposed in the safety report.

IAEA is developing a TECDOC on 'benchmarking of hazards induced by recent extreme tsunamis' to address aspects of validation and user qualification. AERB has been identified as one of the contributing authors, specifically on "development of far field benchmark problem specification using data from 2011 Japan tsunami".

AERB participated in the working group meetings of work area 7, and offered its comments for development of a safety report on engineering aspects of protection of nuclear installations against sabotage.

AERB hosted the meeting of work area 8, to discuss the safety of multi-unit sites against natural external events. AERB also contributed to the development of safety reports on this aspect, as part of work area activities.

International Generic Ageing Lessons Learned (IGALL) programme

AERB is one of the Indian participants to the IAEA's IGALL programme. AERB has contributed in the development of member-state database on ageing management of NPPs, contributed in development of different ageing management programs (AMPs) and time limited ageing assessment (TLAAs) besides review of the IGALL report and providing write-up on Indian practice of ageing management of NPPs.

Safety promotional activities

AERB Safety Awards

AERB has annual safety award schemes to promote industrial safety, fire safety and environment protection in DAE units

Safety Award Winners for 2012

Industrial Safety Award:
TAPS 3&4 and HWP, Thal (production group)
KAPP 3&4 (construction group)

Fire Safety Award:
HWP,Kota and KAPS 1&2 (high risk group)
IGCAR (low risk group)

Environment Protection Award:
IREL, Chavara and NAPS (operating units and mines group)
KAPP 3&4 (construction projects group)

Monograph on "Hazardous Chemicals &Emergency Preparedness and Emergency Medicine" being released during the meet.

DAE Safety & Occupational Health Professionals Meet

AERB organizes DAE Safety and Occupational Health Professionals Meet every year which provides a platform to the safety professionals of DAE for sharing of experiences on safety related matters. Last year the Meet was jointly organized by Atomic Energy Regulatory Board, Mumbai and NPCIL and HWB at Rawatbhata, Kota during December 17-19, 2012. The themes for the meet were "Emergency Preparedness for Chemical Industries and Emergency Medicine". Shri B. Bhattacharjee, Member, NDMA was the Chief Guest of the Meet.

In addition, AERB organized several awareness programmes on various topical issues on radiation safety aspects

Public Communication and Outreach activities

Press Conference

Press conference was held on September 13, 2012 to address public concerns regarding Kudankulam NPP. Media coverage was provided by leading news agencies such as DD news, Aaj Tak, ANI, The Hindu, Times Now, Sakal, CNN IBN, IBN-7, India Bulls, ETV, PTI, Times of India and Indian Express.

Post Fukushima safety enhancements in KKNPP were explained, among other matters.

Annual bulletin

AERB for the first time published its annual bulletin as an initiative to reach out to public more effectively. It is an attempt to present information contained in the Annual Report in a simplified and attractive format for easy grasping. It has also been translated to Hindi, Marathi and Tamil.

Annual Report/Newsletters/Website

AERB has been maintaining a website with all relevant and updated information, issuing press releases on contemporary issues, publishing Annual Reports and newsletters once in every six months. These contain information on various activities carried out by AERB as well as the nuclear and radiological safety status of regulated plants and activities.

Participation in Science and Technology Fairs

AERB continued to participate in science and technology fairs: an initiative which started last year with an aim to expand the public outreach activity. This year, AERB displayed its exhibits during the Nuclear Energy Summit held at Mumbai and also during the Safety and occupational Health Professionals Meet held at Kota in December 2012.

Four press releases were issued providing information on important events and activities of AERB

Ninety Six parliament questions were responded

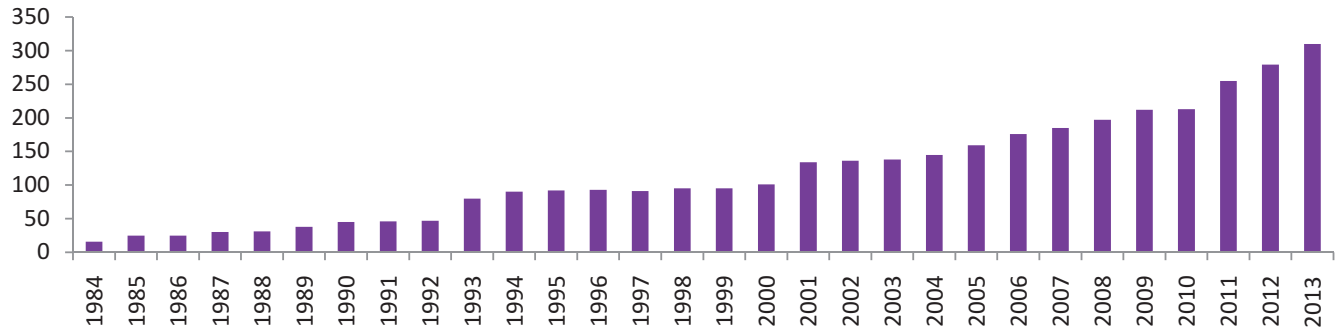
Sixty three queries under Right To Information Act were replied

Steps taken for strengthening Inhouse Competence

Human Resource Development

To meet the regulatory challenges arising out of expansion of nuclear and radiation facilities, AERB has augmented the technical manpower substantially by direct recruitment, inducting postgraduates through AERB Graduate Fellowship Scheme (AGFS) at IIT-Bombay and IIT-Madras, and through training schools of BARC, IGCAR, NPCIL and NFC.

AERB increased its staff strength from 286 to 344 during the last two years, 2011-2012.



Year wise Manpower Augmentation in AERB

During the year 2012-13 AERB recruited 15 officials through direct recruitment in various grades, out of which 4 candidates belongs to SC and 4 to OBC category. AERB has inducted 1 ST and 3 OBC Stipendiary Trainee (Category-I) to be absorbed as Scientific Assistant/B in the year 2013. Action has also been initiated to fill the reserved vacancies (SC, ST, OBC) in the grades of SA (B), UDC & Steno.III.

Knowledge management

As a part of competence development, AERB continued to train its staff by organizing various training programmes, workshops, on the job training at nuclear facilities etc. AERB Orientation Course for Regulatory Processes (OCRP-2012) was conducted at AERB, Mumbai during September 12, 2012 to January 11, 2013. Forty participants from various technical divisions of AERB were benefitted by the course.

Publications/Paper presentations
Journals: 13
International Conferences: 05
National Conferences: 24

Eight stipendiary trainees (Cat-I) from the panel of Nuclear Fuel Complex, Hyderabad, joined AERB on July/October 2012 after receiving one-year training course in AERB.

During the process of regulatory review, several important topics emerge out which require consultation with the experts. In order to have a better understanding of the subject and to resolve issues on the topic, AERB organizes theme specific discussion meets and workshops wherein experts, representatives from utilities and concerned officials from AERB participate. The important discussion meets/workshops organized this year are as follows:

- Periodic safety review of NPPs, research reactors and fuel cycle facilities
- Online decision support system for offsite emergency conditions
- Design of safety related concrete structures of nuclear facilities

IAEA international workshop on the safety of multi-unit nuclear power plant sites against external natural hazards:

AERB hosted an IAEA workshop to share information among the international nuclear community on the scientific and technical issues related to the safety of multi-unit NPP sites against external natural hazards that need to be addressed following the Fukushima Daiichi nuclear accident. The workshop also highlighted the activities undertaken by the IAEA and its member states to meet the challenge of ensuring the safety of multi-unit sites against multiple external hazards.

The workshop covered topics such as lessons learned from past earthquakes affecting NPPs; assessment of external natural hazards at a site housing multi-unit NPP(s) and other nuclear installations; external event probabilistic safety analysis (EE-PSA); risk integration; and external event site safety assessment.

Participants of IAEA international workshop on the safety of multi-unit nuclear power plant sites against external natural hazards

About 80 participants including 30 from overseas attended the workshop. The discussions provided direction for development of guidance material for safety assessment of NPP sites, especially multi-unit sites, in relation to external events.

Services rendered to other organisations

Bureau of Indian Standards (BIS)

Secretary, AERB is a member of Occupational Safety & Health and Chemical Hazards Sectional Committee of BIS as well as convener of its Sub-Committee and is involved in review and revision of BIS documents.

Ministry of Environment and Forests

Secretary, AERB is a member of environment appraisal committees of Ministry of Environment and Forests for both, Civilian Nuclear Facilities as well as Strategic Nuclear Facilities.

National Disaster Management Authority (NDMA)

Secretary, AERB is a member of Committee on Chemical Safety Analysis of projects undertaken by NDMA. AERB prepared a training manual on "Radiation Protection & Radiation Emergency Procedures in Nuclear Power Plants" for National Disaster Response Force (NDRF) personnel on the request of NDMA. AERB also provided expertise to NDRF in organizing training programs for its personnel on radiation protection procedures and response actions during nuclear and radiation emergency.

Guidance to Engineering Interns

AERB has provided guidance to young engineering students to share its expertise in the fields of Quantitative Risk Assessment, Hazard Assessment and Operability (HAZOP) studies, Fire Hazard Analysis/Modeling, Probabilistic Safety Analysis, Core Dynamic Studies, Plant Dynamics, etc. during summer internships of engineering students from various institutions like IIT-Bombay, IIT-Kanpur, BITS-Pilani, BITS-Goa, etc.

Quality Management System

AERB has obtained certification under ISO 9001 standard by Bureau of Indian Standards (BIS) for its consenting activities, regulatory inspection and preparation of regulatory documents in November 15, 2006 and was re-certified as per new ISO 9001:2008 standard in November 2009. During the year internal audits were conducted. To enhance awareness level on QMS requirements and improve competence of AERB personnel in performing QMS functions, a workshop on 'Promotion of Awareness on ISO 9001:2008 QMS was organized in May 11, 2012. Similarly, training on QMS at AERB was conducted for the new recruits in AERB.

Special Feature:
Kudankulam Nuclear Power Project (KKNPP)

...Commissioning review of India's first PWR

Location:	Capacity:	Type:
Kudankulam, Tamilnadu	1000MWe per unit	VVER (Russian design)

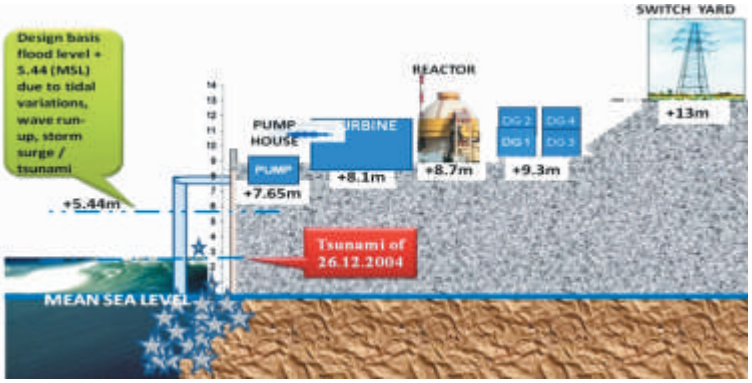
KKNPP 1&2 are one of the advanced designed reactors among the existing operating Nuclear Power Plants (NPP) currently in the world. These units are categorized as 'Generation III Plus' Plants, meaning there by that they have the latest safety features (improvement over the currently standardized NPPs which are categorized as Generation II). This includes some of the advanced features in a NPP like:

Passive system of residual heat removal (PHRS)
Passive system of core flooding in case of loss of coolant accident
Passive system of quick boron injection to shutdown the reactor
Passive catalytic hydrogen recombiners (PCHRs)
Passive system of creating vacuum between containment walls with filters.

Other important salient feature of KKNPP 1&2 design is incorporation of 'FOUR-TRAIN-SAFETY SYSTEM' each capable of performing safety function independently. This feature increases the reliability of the safety systems. There is a provision of Engineered Safety Features (ESFs) to cater for the Design Basis Accidents (DBA), Beyond Design Basis Accidents (BDBA) and systems catering to Anticipated Transients Without Scram (ATWS). These systems are part of mitigatory functions in the case of unlikely postulated events which are of very low probability. These ESFs are built-in the design as part of Defense-in Depth (DID) concept.

In case of an extremely rare event of simultaneous loss of grid power supply and failure of DG sets to start (Station Blackout-SBO), reactor would get shutdown automatically and core cooling would be achieved by natural circulation of primary coolant system water through SGs. The heat removal from SGs would take place through Passive Heat Removal System (PHRS). The heat exchanger of PHRS are cooled by atmospheric air.

Impact of tsunami



The plant is constructed 7.65 meter above sea level. It is to be noted that when tsunami struck in 2004, the tides rose upto 2.5 meter only and as per scientific studies the maximum level upto which tides may rise is only 5.4 meter. The pumping place in KKNPP is located above 7.65 meter, the turbine at 8.1 meter, the nuclear reactor at 8.7 meter, emergency diesel generators at 9.3 meter and power distribution units at 13 meter. Kudankulam nuclear power plant is very well protected from a possible tsunami or other natural disasters.

Post Fukushima Safety Assessment

Although KKNPP design already has several advanced safety features including those for ensuring safety against external events of natural origin and for management of design basis as well as beyond design basis accidents, still as a matter of abundant caution a review was done in the wake of the Fukushima accident to identify further improvements, if any. Seventeen recommendations in this regard were approved by AERB for implementation in a phased manner. These recommendations were essentially additional back up measures by way of abundant precaution in relation to (a) water, (b) power and (c) analysis. Out of the 17 recommendations, 15 have already been implemented and the remaining 2 recommendations which related to analysis and identified as long term items (i.e to be completed within 2 years) are in progress. The progress status of the same is being periodically reviewed and followed up by AERB.

The submarine faults capable of generating tsunamis are located at very large distances of more than 800km from the Indian coast. Thus, unlike in the Fukushima case, the possibility of simultaneous occurrence of an earthquake and a tsunami at our NPPs, is almost non-existent.

Waste Management at KKNPP

The exhaust gases from main plants will be passed through charcoal / High Efficiency Particulate Air (HEPA) filters and discharged to the atmosphere through respective 100 m stack of each reactor. Liquid effluents generated from operation of KKNPP will be collected and evaporated. The evaporator vapors will be condensed and purified by passing through filters & ion exchange columns and recycled back to the main plant. The evaporator's residue will be immobilized in cement matrix. Solid wastes will be collected and packed in disposable bags and containers depending upon the activity level and physical nature. The solid wastes will be stored in specially constructed engineering facilities. Radioactivity content in the wastes will be continuously monitored before discharging to the environment. The public dose limit at Exclusion Zone boundary of Kudankulam site is 1 mSv/year. Out of this, Units 1 & 2 have been allocated a limit of 0.25 mSv/year of which 0.16 mSv/yr is apportioned for radioactive releases via air route and 0.04 mSv/yr is for water route. 0.05mSv/year has been apportioned for terrestrial route. Accordingly limits have been specified for gaseous, liquid and solid wastes.

Environmental monitoring programme covering upto 30km radius under routine operational conditions, similar to other operating nuclear power plants, has been established for KKNPP to demonstrate compliance with the radiation exposure criteria set for member of public and to ensure no adverse impact on the environment.

Quality Assurance (QA)

AERB Safety Code on Quality Assurance in Nuclear Power Plants provides the basic requirements for establishment, implementation and continual improvement of Quality Assurance programme for all stages (siting, design, construction, commissioning, operation and decommissioning) of the nuclear power plant. Quality checks were implemented by NPCIL based on approved quality plans.

The equipment/ components history dockets (called as Passports) covering the process of manufacturing/fabrication along with associated QA checks, material checks, were audited on sample basis during the AERB regulatory inspections. In addition, the commissioning test reports at each stage are being subjected to multi-tier safety review as part of regulatory review process of AERB before granting clearance for next stage. Important commissioning tests are witnessed by AERB representatives.

In addition to the above overall review, in response to concerns expressed recently about possibility of quality issues with equipment from specific source, additional re-verification has been carried out to check that the quality aspects of the safety related equipment in KK NPP from this source have not been compromised. In this regard, AERB Observers Team (AOT) re-verified the implementation of QA requirements from initial stage of manufacturing up to final receipt of the component/ equipment at Kudankulam.

Further as part of regulatory review process, for the subsequent operation phase, periodic surveillance checks and in-service inspections programme have been formulated taking into account findings from design and pre-operational reviews as well as pre-service inspections.

Emergency Preparedness

In India, Emergency Planning Zone is up to 16 km radius around NPP and divided into 16 sectors as specified in the AERB Safety Guide on ***'Preparation of off-site emergency preparedness plans for nuclear installations (AERB/SG/EP-2)'.*** As a regulatory requirement, emergency plans are prepared and tested by conducting exercise prior to the reactor operation at each NPPs. Periodic exercises (Off site exercise once in two years) are conducted in the EPZ to test the emergency plans with particular emphasis on the co-ordination of the many interphasing components of the emergency response, procedures and emergency personnel/agencies. An exercise starts with a simulated/postulated event or series of events in the plant in which an unplanned release of radioactive material is postulated. Based on the meteorological conditions affected sector (from among 16 sectors) is simulated for the protective actions. In the last 30 years in older plants all the 16 sectors have been covered during the exercises.

An offsite emergency exercise of KKNPP-1&2 was carried out on June 9, 2012. Observers from AERB and NPCIL were present during the exercise and feedback session. The observations of the emergency exercise were considered prior to issue of the clearance for initial fuel loading.

The commissioning clearance issued to unit -1 of KKNPP for initial fuel loading was challenged in Writ Petition in the Madras High Court. The contention of the petitioner was that unless all the 17 post Fukushima safety enhancements recommended by Atomic Energy Regulatory Board are implemented, AERB should not have granted the clearance for initial fuel loading.

Judgement of Hon'ble Madras High Court

''As AERB is an expert body, as held by the Hon'ble Apex Court, having being created under the Atomic Energy Act, 1962, it has got a statutory character and it consists of scientists and experts and one such regulatory body requires compliance of 17 recommendations, we are of the view that it is not for the court to look into that with suspicion. When the statutory body acts something in accordance with law, the presumption is always in favour of the body unless it is established that there is a malafide intention or illegality. On perusal of the 17 recommendations, we do not see any illegality on the face of it and in any event, this Court does not have any expertise to come to a conclusion as to whether these requirements are necessary either for the purpose of initial fuel loading or for the purpose of its subsequent operation. When once the AERB, as an expert, has initiated all these measures, it is not for this court to substitute its view with that of the regulatory body. Law is well settled that when two views are possible and the authority who is an expert has taken one view, it is not for the Court to substitute it with another view under any circumstance. In such view of the matter, we are of the view that the impugned Press Release does not warrant any interference by this court and accordingly the writ petition is dismissed. It is made clear that as per the undertaking given by AERB, the recommendations which are to be complied with are to be complied with by NPCIL in accordance with law and NPCIL shall scrupulously follow the same. No costs.'

The judgement of Madras High Court was further challenged in a Special Leave Petition filed in the Hon'ble Supreme Court of India. After detailed hearing, the verdict of the Madras High Court was upheld by the Hon'ble Supreme Court of India. The Supreme Court judgment quoted extensively from AERB Codes while directing AERB to continue its regulatory oversight over KKNPP.

Special Feature:
Medical Diagnostic X-ray

...Challenges in regulation & the way ahead

We all know that there are a large number of X-ray diagnostic centres operating in the country. X-rays are ionising radiations which have a certain hazard potential and need to be regulated effectively. So, how is AERB regulating the use of these equipment and what are the action plans for the future. To answer these questions, it is first imperative that one understands the actual hazard involved in the use of these equipment.

What are the actual hazards involved in operating the x-ray equipment for medical diagnosis?

First of all, let us understand that medical x-ray equipment for diagnosis is an entire gamut, right from the Cath Lab or Interventional Radiology equipment, to the Dental IOPA equipment. (refer Table overleaf), posing a graded hazard potential to different sets of people (i.e. patients, operators and general public). So, one cannot assume that all these equipment are equally hazardous to all sets of people.

Next, we should under stand the workload of the centre where the equipment is operating. Workload has different connotations as far as X-ray equipment operation is considered. It roughly means the time and the

exposure parameters that were used for diagnostic purposes per week. Thus, hazard potential is higher for centres with more workload, i.e. more number of patients coupled with diagnosis requirements using higher exposure parameters, i.e., time mA. and kV. To get things in perspective, the time required for each exposure of a typical x-ray examination such as chest x-ray is in milli-second. This means that the "ON" time i.e. when the equipment is really generating radiation, is less than few minutes in a day for the general purpose x-ray equipment. Now, this situation is not the same for the Fluoroscopy equipment where in the "ON" time is higher. Cath-Labs or interventional Radiology equipments have higher exposure parameters, including time and hence are of higher radiation hazard potential.

All x-ray equipment are not equally hazardous.

The same type of modality varies in its hazard potential due to its Workload.

Another important aspect of these equipment are they are radiation generating equipment, which means that these equipment do not pose any hazard if they are not operating. This is unlike the radioactive isotope, which continues to emit radiation/ radioactive particles. Thus, there is very little danger of accidents or incidents of radiological significance with these equipments.

70-75% of the x-ray equipment in the country are of low hazard potential such as general purpose radiography and dental equipment.

Now to understand the set of people who receive radiation exposures. The patients, invariably receive radiation dose, (primary radiation). Patient exposure has two aspects to it. On one hand, the patients are receiving radiation dose as a MEDICAL EXPOSURE. i.e. the benefit in terms of a diagnosis more than compensates the risk due to radiation dose. On the other hand, if the patients receive radiation dose either due to bad design of the equipment or wrong operational parameters, then the radiation received by them is undue.

The second set of people receiving radiation dose are the operators of the X-ray equipment. Normally, these operators do not receive the primary radiation. They receive what is known as the scatter radiation i.e. the radiation scattered from patient body, while undergoing the exposure. The scatter radiation (a fraction of the primary radiation) along with leakage radiation from x-ray equipment (also a fraction of primary radiation for good design equipment) contribute to the radiation received by the operator. The definition of "Operator" differs from modality to modality. The Table- 1 explains the same. The third set of people who are likely to receive radiation are the general public, who are either the relatives, employees or other patients. They are also likely to receive the scatter and leakage radiation, because they are around the X-ray equipment room.

The fluoroscopy equipment has a very specific purpose and is not used extensively.

The Cath-Labs are used for life-saving procedures in the Operation theaters.

Table : Different X-ray facilities with increasing radiation hazard potential

<table>
<tr><th rowspan="2">Modality</th><th colspan="2">Safety of operator</th><th rowspan="2">Safety of people around the utility</th><th rowspan="2">Safety of patient</th></tr>
<tr><th>Identified Radiation worker</th><th>Minimum Safety accessories required</th></tr>
<tr><td>Dental–IOPA</td><td>a) Dentist
b) Dental technician</td><td>0.25mm lead (eq) apron</td><td>Not Applicable</td><td rowspan="9">Identified Quality Assurance Tests and Protective Accessories as required</td></tr>
<tr><td>Dental OPG/ CBCT</td><td>a) Dentist
b) Dental technician</td><td>0.25mm lead (eq) apron/ Exposure from behind a barrier</td><td>X-ray equipment in a dedicated room</td></tr>
<tr><td>Mobile Radiography</td><td rowspan="3">X-ray technologist/ Radiologist if he handles the equipment</td><td rowspan="2">0.25mm lead (eq) apron</td><td rowspan="2">Ensure minimum occupancy around patient</td></tr>
<tr><td>Portable Radiography</td></tr>
<tr><td>Fixed Radiography</td><td>0.25mm lead (eq) apron/ exposure from behind a barrier (MPB or brick wall)</td><td>X-ray equipment in a dedicated room. No permanent seating around the radiography room</td></tr>
<tr><td>Mammography</td><td>X-ray technologist</td><td>0.25mm lead (eq) apron/ exposure from behind a barrier</td><td>X-ray equipment in a dedicated room.</td></tr>
<tr><td>Fluoroscopy</td><td>a) Doctors/
b) X-ray technologist</td><td>0.25mm lead (eq) apron and exposure from behind a barrier (MPB or brick wall)</td><td rowspan="3">X-ray equipment in a dedicated room. No permanent seating around the room</td></tr>
<tr><td>Computed Tomography</td><td>CT technologist/Radiologist</td><td>Working from a separate control room.</td></tr>
<tr><td>C-Arm

Interventional Radiology (Cath-Lab)</td><td>a) x-ray technologist
b) Doctors / surgeons operating the equipment
c) Nurses assisting them through the process</td><td>a) 0.25mm lead (eq) apron- sufficient numbers for doctors and nurses
b) For X-ray technologist control room outside</td></tr>
</table>

From the Table it is understood that the operators for all modalities are safe by using minimum radiation safety accessories. The general public around the utility are also safe, if the x-ray equipment is placed in a room with shielding as per AERB guidelines. In most cases a medium sized room with normal brick wall, serves the purpose. Radiation safety of the patient which we define as the optimum dose that is to be received for diagnosis, is ensured by proper design and calibration of the equipment.

The need for regulations in this practice?

From the table, the radiation hazard potential pattern of the X-ray equipment operators and general public is understood. For the radiation workers, minimum protective accessories will ensure radiation safety. The general public are most of the time any way a moving population and are unlikely to continuously be exposed to radiation.

Despite the over all low radiation hazard potential, there is a definite need for fulfillment of AERB requirements towards radiation safety by the stakeholders owing to (a) Widely spread X-ray equipment in the country (b) Increasing number of examinations (c) Increasing number of high dose procedures (d) Pediatric patients.

Medical exposures to patients are considered "justified" and AERB does not stipulate dose limits to patients for undergoing medical examinations.

Why is extra caution required for children?

This is because they are biologically more vulnerable and due to rampant "unfavorable" conditions in the practice, which they may be subjected to. The biological vulnerability is owing to several reasons. The biological effects of ionizing radiation in children are higher because of their radio-sensitivity, their life expectancy and the amount of radiation exposures received over a time period. Thus the lifetime risks are expected to be higher in a child than in an adult. The following are the "unfavorable" conditions because of which children receive higher doses.

- Using unsuitable Automatic Exposure systems in imported equipment which are not customized to Indian demography before use.
- Following adult exposure protocols for children
- Using sub-standard equipment, which has not been design approved (AERB Type Approved) and not subjecting the equipment to periodic quality control tests
- Not using all the dose-minimising features that the machine provides.
- Radiographs taken by unqualified personnel, who do not fully appreciate the implication of their actions.
- Not considering alternate means of diagnosis (MRI, USG etc).
- Not asking for previous x-ray records, for the same ailment.
- Expecting best quality images, even if there is no additional gain in terms of diagnosis.

The child may receive doses, more than required for a good diagnosis, because:-

- Unsuitable design
- The operator may not be aware of the use of child protocols provided in the equipment
- Other options of diagnosis were not considered.

What are the Regulatory requirements to stakeholders?

AERB Stake holders are the Manufacturers of X-ray equipment, Suppliers of X-ray equipment, Service agencies involved in servicing of the equipment and QA service providers and the utilities using the equipment.

Proper design of the equipment is of paramount importance as it ensures radiation safety to the patient (by giving optimum dose for image) and to the radiation worker and public (by minimal radiation leakage). Thus, many requirements are primarily directed towards the Manufacturer of the equipment. The indigenous manufacturer is required to obtain Type approval, or the design approval of the prototype of the equipment and also obtain License for commercial production. In case the equipment is procured from abroad, the Supplier of the diagnostic X-ray equipment should obtain the Type Approval for each model.

The many x-ray utilities in the country, are required to obtain AERB regulatory consent to operate the X-ray equipment. This is to ensure that they are using properly calibrated, Type approved equipment and that the minimum safety protective accessories, along with qualified and trained operators are in place. To facilitate the utilities to obtaining the requisite consent, AERB has recently launched the e-Licensing of Radiation Applications (e-LORA), an e-governance software. Depending on the hazard potential, the equipment are divided into the Licence category (CT and Cath lab) facilities and the Registration category (all the other equipment), and are required to comply with AERB stipulations accordingly.

Actions initiated by AERB

AERB has approached the Directorate General for Foreign Trade (DGFT) for policy changes with regard to import of X-ray equipment and X-ray tubes. Once the change is instituted, all imports of X-ray equipment and tubes will require prior approval of AERB. This will ensure that only Type Approved equipment and standard designs of X-ray tubes (which are a vital component of the X-ray equipment) are brought into the country.

AERB has also spread the requirement through its advertisements in the newspapers. Further AERB has asked the supplier to suitably inform his customers on AERB requirements of a consent. Another major step in progress is the accreditation of independent Quality Assurance providers to ensure that all equipment are of proper design and are periodically calibrated. Service agencies are also being recognised by AERB, so that they can carry out servicing of the equipment with full knowledge of the radiation safety aspects of the equipment.

Further actions

De-centralising the regulatory control is another effective manner to regulate the wide-spread X-ray facilities. Towards this AERB has signed MoU for formation of Directorate of Radiation Safety (DRS) in many states and has also established two Regional Regulatory Centres (RRCs). Revision of AERB Safety Code on Regulation of Medical diagnostic radiology incorporating all the requirements, is in an advanced stage of completion.

Conclusion:

Good design and good operational practices will ensure to a large extent, radiation protection in this practice. AERB has also been taking persistent efforts to disseminate information on radiation safety. AERB has put out several advertisements, conducted public awareness programs and updated its website. With all these actions in place, the regulation of medical diagnostic x-ray equipment will be further strengthened, thus ensuring radiation safety to all concerned.

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