सत्यमेव जयते

Government of India

Atomic Energy Regulatory Board

aerb bulletin 2011-12

The Functions of
The Atomic Energy Regulatory Board

- 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 the Board is to ensure that the use of ionising radiation and nuclear energy in India does not cause undue risk to health and environment.

AERB regulates 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.

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
- Atomic Energy (Control of Irradiation of Food) Rules, 1996

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

Over the last few years, there has been growing interest in the relationship between regulation and transparency. We are now living in a climate where parliamentary, regulatory and corporate bodies across the world are being urged to say more about things on which they have traditionally been silent and more so in a lucid and effective manner that can be easily comprehended by general public.

Atomic Energy Regulatory Board (AERB), which is entrusted with the responsibility of developing and enforcing nuclear and radiation safety regulations in the country, has the mandate to keep the public informed on radiation and nuclear safety related matters. AERB views public outreach as an essential element to build a long lasting trust and confidence with media and the public, at large.

Towards this, 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.

But that's not the end of it. AERB realizes that public communication in matters related to safety aspects of high end technologies such as nuclear energy, together with the philosophy of radiation protection is not so simple and easy. To simplify the technical nuances and yet retaining the basic essence that can be easily grasped by an uninitiated person is in itself a challenging task. There will be questions, followed by more questions. It requires persistent efforts and sustained interactions to answer these queries to satisfaction.

AERB for the first time proactively participated in science and technology fairs and displayed exhibits to create awareness among the school and college children and general public on the nitty-gritty of nuclear and radiation safety aspects, the robustness of regulatory regime followed by AERB and the basis of regulatory decision making process. These interactions were very encouraging and helped in dispelling several myths about the regulatory set up and framework. Such fora create informal opportunities for public inputs and dialogue.

This annual bulletin is yet another initiative by Atomic Energy Regulatory Board to enhance its transparency and openness and reach out to public more effectively. This is an attempt to present information contained in the Annual Report 2011-2012 in a simplified and attractive format for easy grasping. AERB would be happy to elicit feedback on this attempt and suggestions for further improving this bulletin.

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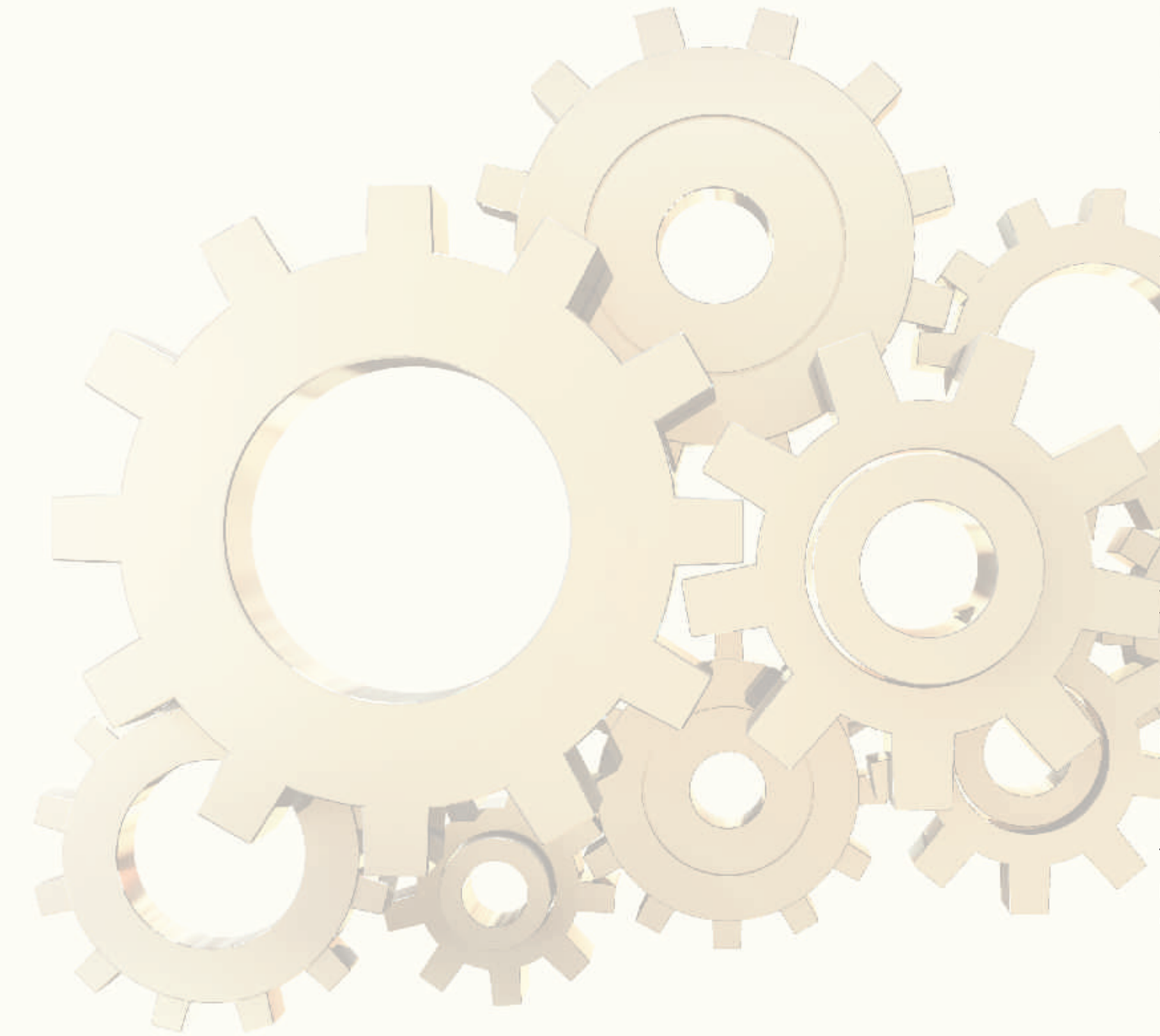


AERB exercises regulatory control over Nuclear Facilities through a well established consenting process right from Siting, Construction, Commissioning, Operation, and Decommissioning, Regulatory inspections to verify conformance with conditions of consents & statutory norms. Operating facilities undergo continuous safety review through periodic reports and regulatory inspections supplemented by exhaustive five yearly reviews that take into account existing regulatory requirements, technological advances, experience feedback and ageing management aspects.

Safety Review and issue of consents

At each stage a comprehensive review in a multi-tier structure of safety committees is carried out before issue of consent based on safety requirements specified in AERB Safety Documents , operating experience feedback and engineering judgement. Finding from reviews conducted in safety committees are further considered in Advisory Committees which include members from academic institutions such as Indian Institute of Technology and government agencies such as the Ministry of Environment and Forests, Central Electricity Authority, Central Boilers Board, among others. Thus many specialists and experts nation-wide from a variety of safety related disciplines contribute their experience in the regulatory decisions of AERB.

Regulatory Inspection and Enforcement

AERB staff carry out periodic regulatory inspections as well as special unannounced inspection at NPPs to review safety status and verify compliance with the regulations. During regulatory inspections, if major non-compliances or serious lapses of safety regulation are observed, appropriate enforcement actions are taken. Depending on the seriousness, these actions could range from curtailment of operation, shutdown of plant till rectification of deficiencies to suspension or even withdrawal of license.

Licensing of Personnel

The competence requirement and the depth of knowledge and skills for operating personnel at key position are verified through a series of performance and knowledge checks and based on detailed evaluation formal qualification license is issued for a period of three years.

Enforcement of Industrial Safety

AERB enforces Industrial safety regulations in all Nuclear Facilities which includes grant of license under Factories Act 1948 & Atomic Energy Factories Rules 1996, regulatory inspections, certification of competent persons and approval of certifying surgeons.

Nuclear Power Projects

There are four nuclear power projects with seven reactors in construction/ commissioning phase under review by AERB.

- Four units of 700MWe Pressurized Heavy Water Reactors (PHWRs)
- Two units of 1000MWe Russian Design Pressurized Water Reactors (VVERs)
- 500MWe Prototype Fast Breeder Reactor (PFBR)
- In addition, two projects with ten units (four VVERs of Russian design and six European Pressurized Reactors (EPRs) are in siting review stage)

AERB carries out safety review of all the nuclear power projects very rigorously to check the compliance of the proposed design against laid down safety standards, right through the stages of siting, construction, commissioning till the operation of the nuclear power project.

Post Fukushima accident, the safety of the projects were re-assessed to determine the safety margins available against extreme external events. For details, please see the special feature on 'Actions taken post Fukushima nuclear accident'.

Nuclear Power Projects Status

Rajasthan Atomic Power Project: Units 7&8

RAPP-7&8

Two units of indigenous 700 MWe Pressurized Heavy Water Reactor are under construction at Rawatbhatta, Rajasthan.

The consent for first pour of concrete (ie start of civil construction) was granted on July 16, 2011 following which construction activities commenced.

Next stage of construction, i.e Erection of Major Equipment is under review.

Kakrapar Atomic Power Project: Units 3&4

KAPP-3&4

Two units of indigenous 700 MWe Pressurized Heavy Water Reactor are under construction at Kakrapara, Gujarat.

Permission for construction activity beyond 91.7m elevation (beyond about one third height of reactor building) was granted on Nov. 22, 2011.

Next stage of construction, i.e Erection of Major Equipment is under review.

Prototype Fast Breeder Reactor

PFBR

Indigenously designed sodium cooled 500 MWe Prototype Fast Breeder Reactor are under construction at Kalpakkam.

Permission to integrate roof slab with main vessel, which constitutes one of the final step in equipment erection, was granted on June 16, 2011.

Main vessel has been integrated with roof slab after the erection of core catcher, core support structure, grid plate, inner vessel, etc. in the main vessel. Laying of Sodium pipe lines and erection of steam generators is in progress.

KudanKulam Nuclear Power Project: Units 1-6

KKNPP-1&2

Two units of Russian design Light Water Reactors of 1000 MWe are being set up at Kudankulam, Tamilnadu. KKNPP-1 is in advanced stage of commissioning while KKNPP-2 is under advanced stage of construction.

Clearance for important commissioning activity of hot-run i.e integrated running of reactor coolant system before fuel loading of KK-NPP unit 1 was granted on June 30, 2011.

Hot run successfully completed and preparation is underway for Fuel loading. Following the unrest at KudanKulam, preservation of the equipment was ensured.

Four more units are planned at KudanKulam site. Siting clearance for Units 3 to 6 was granted by AERB in February 2009.

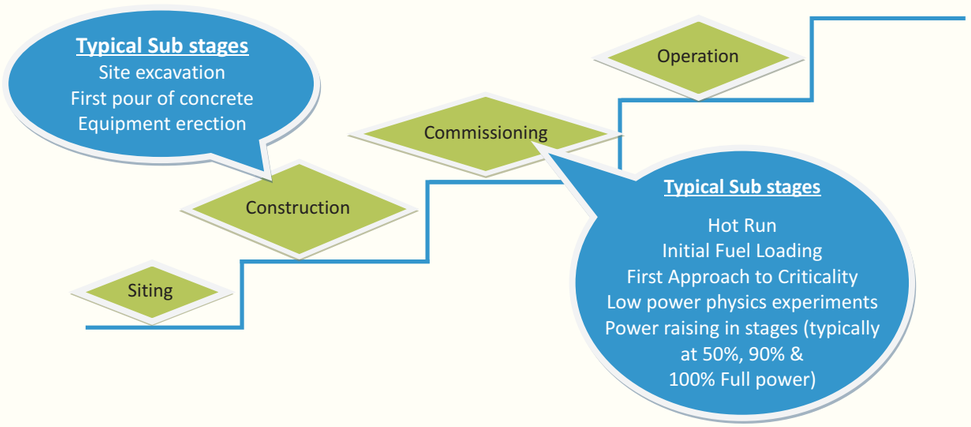
Jaitapur Nuclear Power Project: Units 1-6

Proposed EPR

Six units of European Pressurised Reactor (EPR), each of 1650 MWe Pressurised Water Reactor are proposed at Jaitapur Site on the western coast of Maharashtra.

The site evaluation of Jaitapur site is under way at AERB.

Stages of Nuclear Power Project



Safety Review Highlights

License for continuous operation of Kaiga Generating Station-4 and Rajasthan Atomic Power Project 5 &6 at rated power

After successful commissioning of the 220 MWe PHWRs at Kaiga-4 and RAPP-5&6, license for their regular operation was granted.

Kudankulam Unit-1 commissioning

As part of pre-commissioning activities of KK-NPP-1, the commissioning of various individual systems required for hot run and conduct of various transient tests with dummy fuel assembly loaded in the core with Reactor Coolant System (RCS) in hot and pressurized condition was completed. After satisfactory review, AERB granted the clearance for hot-run for KK-NPP-1 on June 30, 2011.

From October 13, 2011 to March 18, 2012, commissioning activities were suspended due to agitation by local public at KK NPP plant site. During the suspension of commissioning activities over six months, site undertook various preservation maintenance measures at KK-NPP-1&2 to keep the required water chemistry and the required environment for the various components/ equipment. The action plan for preservation was reviewed by AERB to ensure that the healthiness of the equipment was maintained. The report mentioning details of observed parameters during preservation and preventive maintenance was reviewed by AERB and found satisfactory.

Commissioning tests results of KK-NPP-1 were progressively submitted to check confirmation of respective design intents. After successful completion of hot run, various measurements and tests, KK-NPP submitted the application for opening the top head of Reactor Pressure Vessel for removal of dummy fuel assemblies from KK-NPP-1. The same was under review by AERB.

Incident of heavy rain during concrete pouring at RAPP 7&8

An incident of heavy rain occurred during concrete pouring of the nuclear building raft at RAPP-7&8. AERB undertook a special inspection and reviewed the status. The site was advised to carry out assessment of the pour concrete to ensure its soundness and provide a complete scheme of pour continuity vis-a-vis construction joint before resuming further construction in the raft. The site was also asked to review and ensure that adequate rain protection measures are in place before taking up further concreting. AERB reviewed the reports on the above aspects and permitted resumption of the activity with certain stipulations.

Experiments on passive decay heat removal system for 700MWe PHWR

Experiments were conducted by NPCIL with the scaled down facility at IIT-Bombay for validating the passive decay heat removal system which is proposed in the design of 700MWe PHWRs. Some more experiments to demonstrate decay heat removal capability are planned in the experimental setup at Tarapur R&D centre of NPCIL. AERB has asked NPCIL to submit report on feasibility of long term core cooling through this passive decay heat removal system for extended SBO duration

Operating Nuclear Power Plants

There are 20 operating nuclear power plants in the country

The first NPP in the country, TAPS units 1&2, based on boiling water reactors (BWR), supplied by General Electric, USA, became operational in the year 1969. These units have completed about 40 years of operation. During the years 2000 to 2006, these plants underwent safety assessments for continued long term operation.

The mainstay of India's nuclear power programme has been the Pressurized Heavy Water reactor (PHWR). Two 200 MW units (RAPS 1&2) were established in the 1970s, at Rawatbhata in Rajasthan, with the technical cooperation of AECL (Canada). Subsequently, in 1980s, two 220 MW PHWRs (MAPS-1&2) were constructed at Kalpakkam in Tamilnadu, with indigenous efforts. Among these, presently RAPS unit-2 and MAPS units 1&2 are operational and have undergone safety upgrades.

Based on the experience gained from constructing and operating RAPS and MAPS reactors, India developed a standardised design of 220 MW PHWRs. This design incorporated state of the art features viz. integral calandria & end shields, two independent fast acting shut down systems, high pressure emergency core cooling system, water filled calandria vault and provision of double containment with vapour suppression pool. Four reactors of this standardised design were built, two each at Narora in Uttar Pradesh (NAPS 1&2) and Kakrapar in Gujarat (KAPS 1&2). These plants became operational through the 1990s.

Subsequently eight more units of standardised 220 MW PHWRs were built, four each at Kaiga in Karnataka (KGS units 1-4) and Rawatbhata in Rajasthan (RAPS units 3-6). These units though retaining the basic standardised 220 MW PHWR design incorporated a few modifications such as locating the steam generators fully inside the primary containment, complete pre-stressed concrete construction for the primary containment and a more compact site layout. The first four of these reactors (KGS units 1&2 and RAPS units 3&4) became operational in the year 2000. Unit-3&4 of KGS became operational in 2007 and 2011 and RAPS 5&6 became operational in 2010.

In 1990s, India undertook the design and development of 540 MW PHWR. Two reactors based on this design were made set-up at Tarapur (TAPS units 3&4). These units became operational in 2005-2006.

Research Reactors regulated by AERB

The Indira Gandhi Centre for Atomic Research (IGCAR) is engaged in the design, development, construction and operation of liquid sodium cooled fast breeder reactors which hallmarks India' s second stage Nuclear Power Program . A Fast Breeder Test Reactor (FBTR) 40 MWth at Kalpakkam has been in operation since 1985.

India has taken a number of steps towards development of necessary technology for utilization of thorium as envisaged in third stage of India' s Nuclear Power Program. A research reactor KAMINI, 30 kWth which uses uranium-233 derived from irradiated thorium as fuel, has been in operation since 1997.

Operational Status of Nuclear Power Plants

TAPS 1&2, 160 MWe twin unit located at Tarapur, Maharashtra

Operationalised in 1969, first nuclear power plant in India

TAPS 1&2 are the only BWR units in India

TAPS 1&2
Tarapur Atomic Power Station

The license for operation of TAPS-1&2 was extended upto December 31, 2012

11 operators licensed at various levels

TAPS 3&4, 540 MWe twin units located at Tarapur, Maharashtra

Operationalised in 2005-2006, these units are pressurized heavy water reactors

TAPS 3&4
Tarapur Atomic Power Station

The license for operation of TAPS-3&4 was extended upto August 31, 2012

37 operators licensed at various levels

MAPS 1&2, 220 MWe twin units located at Kalapakkam, Tamil Nadu

Operationalised in 1984-1986, these units are pressurized heavy water reactors

MAPS 1&2
Madras Atomic Power Station

The license for operation of MAPS-1&2 was extended upto March 31, 2013

10 operators licensed at various levels

NAPS 1&2, 220 MWe twin units located at Narora, Uttar Pradesh

Operationalised in 1991-1992, these units are pressurized heavy water reactors

NAPS 1&2
Narora Atomic Power Station

NAPS 1&2 operated safely during 2011

26 operators licensed at various levels

KGS 1&2, 220 MWe twin units located at Kaiga, Karnataka

Operationalised in 2000, these units are pressurized heavy water reactors

KGS 1&2
Kaiga Generating Station

KGS 1&2 operated safely during 2011

16 operators licensed at various levels

KAPS 1&2, 220 MWe twin units located at Kakrapara, Gujarat

Operationalised in 1993-1995, these units are pressurized heavy water reactors

KAPS 1&2
Kakrapar Atomic Power Station

KAPS 1&2 operated safely during 2011

21 operators licensed at various levels

KGS 3&4, 220 MWe twin units located at Kaiga, Karnataka

Operationalised in 2007-2011, these units are pressurized heavy water reactors

KGS 3&4
Kaiga Generating Station

KGS 3&4 operated safely during 2011

KGS-4 obtained Clearance for continuous operation till April 2013

17 operators licensed at various levels

RAPS 1&2, 100 & 200 MWe, the first pressurized heavy water reactors in India, located at Rawatbhatta, Rajasthan

Operationalised in 1973 & 1981

RAPS 1&2
Rajasthan Atomic Power Station

RAPS-1 remained in the state of passivation with continuous radiological surveillance. There is no fuel in RAPS-1.

RAPS-2 operated safely during 2011

15 operators licensed at various levels

RAPS 3&4, 220 MWe twin units located at Rawatbhatta, Rajasthan

Operationalised in 2000, these units are pressurized heavy water reactors

RAPS 3&4
Rajasthan Atomic Power Station

RAPS 3&4 operated safely during 2011

29 operators licensed at various levels

RAPS 5&6, 220 MWe twin units located at Rawatbhatta, Rajasthan

Operationalised in 2010, these units are pressurized heavy water reactors

RAPS 5&6
Rajasthan Atomic Power Station

RAPS 5&6 operated safely during 2011

21 operators licensed at various levels

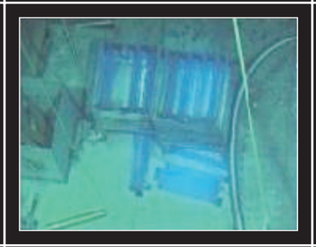
FBTR is India's first and only fast breeder test reactor. This test reactor has been operational since 1985.

The current output is 18 Mwth

FBTR operated safely during 2011

FBTR, IGCAR
Fast Breeder Test Reactor

Permission for 18th irradiation campaign at FBTR, IGCAR was given by AREB



Facility to recover Cobalt for fabrication of Cobalt Teletherapy sources, located at Rawatbhatta, Rajasthan

The activities remained suspended due to incident of contamination spread inside the facility last year

RAPPCOF
Rajasthan Cobalt Facility

Permission for fabrication of one batch of Cobalt Teletherapy sources at RAPPCOF given by AERB

Safety Review Highlights

The doses of regular occupational workers in all the operating nuclear power plants were within the prescribed annual dose limit of 30mSv. During a safety related unusual occurrence, four temporary workers, while carrying out painting job of spent fuel transfer duct at KAPS-1&2, accidentally got exposed to higher radiation dose rates. However, these doses were too small to cause any perceptible health impact.

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 far less than the annual limit of 1 mSv (1000 micro-Sievert) prescribed by AERB.

The International Nuclear and Radiological Event Scale (INES) of the International Atomic Energy Agency (IAEA) rates events at seven levels (1 to 7) depending on their safety significance. Events with no safety significance are rated at level 0 or below scale, events rated at levels 1, 2 and 3 are called 'incidents' while events rated at level 4 and above are termed as 'Accidents'. While most of the significant events reported this year were of INES level 0, the incident of damage to spent fuel bundle at NAPS-1 was rated at level 1 and the incident of accidental exposure to the temporary workers at KAPS-1&2 while carrying out painting job of spent fuel transfer duct was rated at level-2 on INES respectively.

Operating facilities undergo continuous safety review through periodic reports and regulatory inspections supplemented by exhaustive five yearly reviews that take into account existing regulatory requirements, technological advances, experience feedback and ageing management aspects. In view of the ongoing works, extension for license for operation of TAPS-3&4 was given upto August 31, 2012; TAPS-1&2 was given upto December 2012 and MAPS-1&2 was given upto March 2013.

Post Fukushima accident, the safety of the operating nuclear power plants were re-assessed to determine the safety margins available against extreme external events . For details, please see the special feature on 'Actions taken post Fukushima nuclear accident'.

All nuclear power plants operated safely during the year.

Fuel Cycle Facilities

Front-end Fuel Cycle Facilities in India

Uranium Mines

Jaduguda (Jharkhand)	Operating
Bhatin (Jharkhand)	Operating
Narwapahar (Jharkhand)	Operating
Turamdih (Jharkhand)	Operating
Bagjata (Jharkhand)	Operating
Banduhurang (Jharkhand)	Operating
Mohuldih (Jharkhand)	Development
Tummalapalle (Andhra Pradesh)	Development
Gogi (Karnataka)	Development

Uranium Mills

Jaduguda (Jharkhand)	Operating
Turamdih (Jharkhand)	Operating
Tummalapalle (Andhra Pradesh)	Commissioning

Thorium Mines

Chavara (Kerala)	Operating
Manavalakurichi (Tamilnadu)	Operating
Chatrapur (Odisha)	Operating

Thorium Mills

Udyogamandal (Kerala)	Operating
Thorium Plant, Chatrapur (Odisha)	Operating
MoPP, Chatrapur (Odisha)	Construction

Fuel Fabrication Plants

Nuclear Fuel Complex, Hyderabad (Andhra Pradesh)	Operating
Zirconium Complex, Pazhayakayal (Tamilnadu)	Operating
Nuclear Fuel Complex, Kota (Rajasthan)	Siting

Heavy Water Plants

Manuguru (Andhra Pradesh)	Operating
Kota (Rajasthan)	Operating
Thal (Maharshtra)	Operating
Hazira (Gujarat)	Operating
Baroda (Gujarat)	Operating
Tuticorin (Tamilnadu)	Commissioning/ Operation
Talcher (Odisha)	Commissioning/ Operation

Diversified Projects

All front-end Fuel Cycle Facilities operated safely during 2011-2012. AERB continued its safety surveillance on the front-end fuel cycle facilities and projects through periodic safety review and regulatory inspections.

Safety Review Highlights

Operating Front-end Fuel Cycle Facilities

Banduhurang mine in Jharkhand is the first open cast uranium mine operating in the country. The proposal for enhancement of its capacity was reviewed with respect to radiological safety and radioactive waste management aspects and consent issued.

Turamdih mine is an underground uranium mine operating in Jharkhand since 2004. The mine had been issued authorization for disposal of specified quantity and activity of wastes. However, with progressive mine development, the capacity of ore production has increased and so has the quantity of radioactive solid waste. After detailed review on the aspects of waste generation and impact of its storage, authorized limits for radioactive solid waste was enhanced.

Presently the dose of all uranium mine workers is estimated by ambient dosimetry which requires information of workplace monitoring and occupancy of miners. On recommendation of AERB, personal dosimeters were provided on sample basis in few mines. The results have been comapred with the ambient dosimetry results and the requirement of **personal dosimetry coverage** to all mine workers is under review.

After the cessation of monazite processing operations in 2004, none of thorium mines and minerals separation plants produced pure monazite. Instead the monazite concentration ranged from 40-50%. However, in view up the new monazite processing plant coming at Chatrapur, Odisha there is proposal for **upgradation of monazite concentration** to +96% in all the mineral separation plants incorporating latest technological advances. The proposal is under review by AERB

There are now six operating nuclear reactors at Rawatbhata Site and two more units are under construction. The **impact of release of hydrogen sulphide envisaging** an accident in Heavy Water Plant located at Rawatbhata Site was assessed and the emergency preparedness aspects are under review.

48 Operators of Heavy Water Plants and 13 Operators of Nuclear Fuel Complex were licensed/relicensed this year.

Naturally Occurring Radioactive Materials (NORM) Industries

Recently, AERB has brought under its regulatory control the private **Beach Sand Minerals (BSM) processing facilities.** These facilities mine the heavy minerals present in coastal beach sands and in the process generate radioactive monazite enriched tailings, which require proper disposal to ensure public and environmental safety. Till date, AERB has licensed 22 BSM facilities and continued its radiological surveillance through review of periodic reports and inspections. This year AERB reviewed and amended the license conditions of 3 BSM facilities viz. M/s V. V. Minerals, M/s Transworld Garnet India Pvt. Ltd and M/s Trimex Sands Pvt. Ltd and accorded approval for a new location of monazite tailings disposal for M/s Kerala Metals and Minerals Ltd., Chavara.

Rockphosphate processing fertilizer plants generate phosphogypsum which finds use in various commercial applications. Phosphogypsum contains small amount of uranium and radium and therefore, AERB has issued a safety directive directing all these fertilizer plants to submit quarterly analysis reports of rockphosphate imported and the resultant phosphogypsum generated. These analysis reports are periodically reviewed in AERB to ensure that radium content does not exceed the exemption limit of 1Bq/kg.

Operating Front-end Fuel Cycle Facilities

Phosphoric acid contains traces of uranium. Heavy Water Board has set up a Technology Demonstration Plant (TDP) for recovery of **uranium from phosphoric acid** at RCF, Chembur, Mumbai. AERB had carried out in-depth safety review right through siting, construction and commissioning stages and this year after elaborate review had issued license for operation of the plant.

The ongoing Thorium retrieval, uranium recovery and storage **(THRUST)** project at Indian Rare Earths Limited (IREL), Udyogamandal, under which stored thorium concentrates from concrete silos are retrieved and further processed to recover uranium and thorium values, is nearing completion. In view of this, instead of renewing the license for another five years, it was extended till November 30, 2012.

Proposals for processing of natural **uranium oxide muck** generated from Atomic fuels Division of BARC and crude **Sodium-Di-Uranate** produced from Technology Demonstration Plant of Heavy Water Board for production of Nuclear grade Ammonium Di-uranate in the existing facilities of IREL, Udyogamandal were reviewed and approved.

AERB had already issued construction consent for a new **monazite processing plant** at Chatrapur Odisha. Subsequently, the project proponent proposed to integrate this new facility with the already existing Thorium Plant at Chatrapur, which is engaged in production of gas mantle grade thorium nitrate. The proposal was reviewed from structural safety and radiation protection aspects and accorded approval.

Fuel fabrication Projects

Nuclear Fuel Complex has set up a new Zirconium Complex at Pazhayakayal, Tamilnadu. The Complex has two major units, one for production of zirconium oxide powder and another for zirconium sponge production. AERB has been reviewing this green field project right from its inception and this year had granted the license for its regular operation.

AERB has also issued siting and construction consent for a new facility at Nuclear Fuel Complex, Hyderabad which is being set up to process columbite tantalite ore to produce niobium thermit, which will be used for various metallurgical industries and space.

Diversified Projects

Heavy Water Board has initiated several diversified projects in those heavy water plants (HWP) where heavy water is no longer produced, such as in Talcher, Tuticorin and Baroda. This year AERB issued consents for projects such as operation of a facility for production of **tributyl phosphate,** an organic solvent at HWP-Baroda and siting and construction of a pilot plant for **versatile solvent synthesis** at HWP-Tuticorin.

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 did not agree to the proposed interim measure of conversion of HEWAC by-product to aqueous form and recommended HWP to expedite the development of technology for converting the HEWAC by-product to metal hydride form.*

After completion of THRUST project, IREL has proposed a unique process for production of **high purity individual rare earths** such as gadolinium, yttrium, cerium etc at Udyogamandal utilizing some of the existing equipment and buildings. The proposal is under review by AERB.

Back-end Nuclear Fuel Cycle Facilities/Projects

CORAL (earlier known as Lead Mini Cell)

CORAL is a compact lead shielded facility designed for reprocessing spent fuel from fast reactor setup by IGCAR at Kalpakkam. Over the years, CORAL took up progressive reprocessing of low burn-up fuel pins of 25 Giga-Watt day/Ton to 100 Giga-Watt day/Ton fuel pins of Fast Breeder Test Reactor with stage-wise safety clearances from AERB.

Demonstration Fast Reactor Fuel Reprocessing Plant (DFRP)

Permission to concrete the pipe tunnels was given by AERB on Sept. 20, 2011

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). Most of the construction/equipment installation and piping for the PPF had been completed. Civil construction and equipment erection activities of HEF are in progress.

Fast Reactor Fuel Cycle Facility (FRFCF)

FRFCF is an integrated fuel cycle plant to facilitate closure of the fast reactor fuel cycle comprising of:

- Fuel Reprocessing Plant (FRP) to process irradiated fast fuel of PFBR,
- Fuel Fabrication Plant (FFP) to fabricate Mixed Oxide (MOX) fuel,
- Reprocessed Uranium Oxide Plant (RUP) to provide depleted uranium oxide powder for MOX fuel pellet fabrication and depleted uranium oxide axial blanket pellets,
- Core Sub-Assembly Plant (CSP) to assemble fuel bundles,
- Waste Management Plant (WMP) to handle all radioactive wastes from the facility

Geo-technical investigations for the site have been completed. Formal notification of approval from MoEF is awaited.

All back-end Fuel Cycle Facilities operated safely during 2011-2012. AERB continued its safety surveillance on the back-end fuel cycle facilities and projects through periodic safety review and regulatory inspections.

Regulatory Control on R&D Units
&
Other Industrial Plants of DAE

Safety Surveillance of R&D units and Other Industrial Plants of DAE

Variable Energy Cyclotron Centre

Room Temperature cyclotron: This cyclotron accelerates light ions such as protons and deuterium. The cyclotron was under long shutdown for modernization and upgradaition and is now under trial operation. The operational status is under periodic review by AERB.

New Projects

Super Conducting cyclotron: This ambitious project aims at acceleration of heavy ions under liquid helium temperature. The ongoing commissioning activities & seismic retrofits are under review by AERB.

Medical Cyclotron: This cyclotron has three beam lines for radiopharmaceutical production and two beam lines for high technology end research applications, namely liquid metal target for accelerator driven sub critical systems (ADSS) and for materials science studies. The construction activities & safety analysis of R&D beam lines are under review.

Radioactive Ion Beam Facility: This facility proposes to accelerate radioactive ions through series of linear accelerators. The ongoing commissioning activities with stable beam are under review by AERB.

Electronics Corporation of India Limited

Thermal battery division: A major fire took place in this division in 2009 causing five fatalities. The renovation of this division as well as the Overall Fire Safety enhancements are under review by AERB.

Other manufacturing units: AERB continued its safety monitoring on other manufacturing units for defence sector, space sector and commercial sector.

10 MeV LINAC test facility: A linear accelerator of 10MeV is being setup with the aid of BARC. The ongoing equipment erection and commissioning activities are under review by AERB.

AERB issued licence for operation granted for smartcard printing & packaging facility at Tirupathi, Andhra Pradesh.

Raja Ramanna Centre for Advanced Technology

Synchrotrons

INDUS-I:

Electron beam is first accelerated in a 20MeV microtron and then in 450MeV booster synchrotron. The beam from booster synchrotron is stored in a storage ring called 'INDUS-1'. While rotating in the ring, the beam emanates low energy synchrotron radiation which is used in various nuclear physics, material sciences and biological sciences experiments. There are presently six beam lines in INDUS-1 to tap the synchrotron radiation. The operational status of the unit is under periodic review by AERB.

INDUS-2: There is an alternate arrangement to transport the beam from 450 MeV booster synchrotron to a synchrotron cum storage ring called 'INDUS-2' where the energy of the beam can be ramped to 2.5GeV at 300mA. Presently, the commissioning of the unit at at 2.5 GeV, 100mA and safety of R&D beam lines is under review.

Other accelerators

Besides the synchrotrons, there are various type of other accelerators which have been under trial runs for a long period and have been issued licenses for regular operation in recent past. These are:

750 keV DC accelerator: used for R&D studies related to irradiation of cables etc

10 MeV Linear Accelerator: used for R&D studies related to irradiation of medical products etc.

The operational status of these accelerators are under periodic review by AERB.

New Projects

Based on the R&D experience, a 10 MeV Linear Accelerator is being housed in a Agricultural Radiation Processing facility at Choithram Mandi Complex of Indore for irradiation of agricultural products at a commercial scale. The construction status of this Facility is under review by AERB.

A prototype for Free Electron Laser Linear Accelerator (FEL-LINAC) is being developed. The commissioning stages of this facility are under review. Another proposal for infra red FEL LINAC has been submitted to AERB. Siting and building construction for this facility is under review by AERB.

Industrial Safety

AERB is entrusted with the administration of the Factories Act, 1948 in all the units of Department of Atomic Energy including R&D Organizations (Other than BARC and BARC Facilities) within its purview.

License renewed under the Factories Act, 1948

Unit	Validity Period
Madras Atomic Power Station	Five years
Rajasthan Atomic Power Station-2	Five years

Regulatory Inspections on industrial and fire safety aspects

Units	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

140 regulatory inspections were carried out, which include 46 special monthly inspections at construction sites of nuclear power projects and 8 quarterly inspections of construction sites of fuel cycle facilities.

Based on the review and outcome of monthly inspections, written directives are issued from time to time to utilities for maintaining a safe workplace.

Designation of Competent Persons under Factories Act

Competent persons are designated under the Factories Act, 1948 (as amended in 1987) and Rule - 31 of the Atomic Energy (Factories) Rules, 1996 for the purpose of carrying out tests, examinations and inspections under various sections of the Factories Act, 1948, namely:

- civil construction & structural work
- operation of dangerous machines
- lifts and hoists
- lifting machinery and lifting tackles
- pressure plant
- dangerous fumes
- supervision of handling of hazardous substances
- ventilation system

38 persons were designated as Competent Persons in various units of DAE this year.

Appointment of Certifying Surgeons

Certifying Surgeons are appointed under Section-10 of the Factories Act, 1948 (as amended in 1987) and under Rule-5 of Atomic Energy (Factories) Rules, 1996 by AERB for carrying out the duties related to occupational health safety of workers prescribed in Rule-7 of Atomic Energy (Factories) Rules, 1996.

3 doctors were appointed by AERB as Certifying Surgeons this year.

Emergency Preparedness in Nuclear 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. Depending on the extent and severity of the accident, emergency situations are classified as follows:

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.

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

During 2011-2012, six site emergency exercises and seven off-site emergency exercises were conducted at six different NPP sites. AERB deputed its officers as observers during the off site emergency exercise

Site emergency exercise and Off-site emergency exercises were also carried out at hydrogen sulphide based Heavy Water Plants at Manuguru and Kota.

NDMA personnel training District officials

Mock Emergency Exercise

Training of NDRF personnel

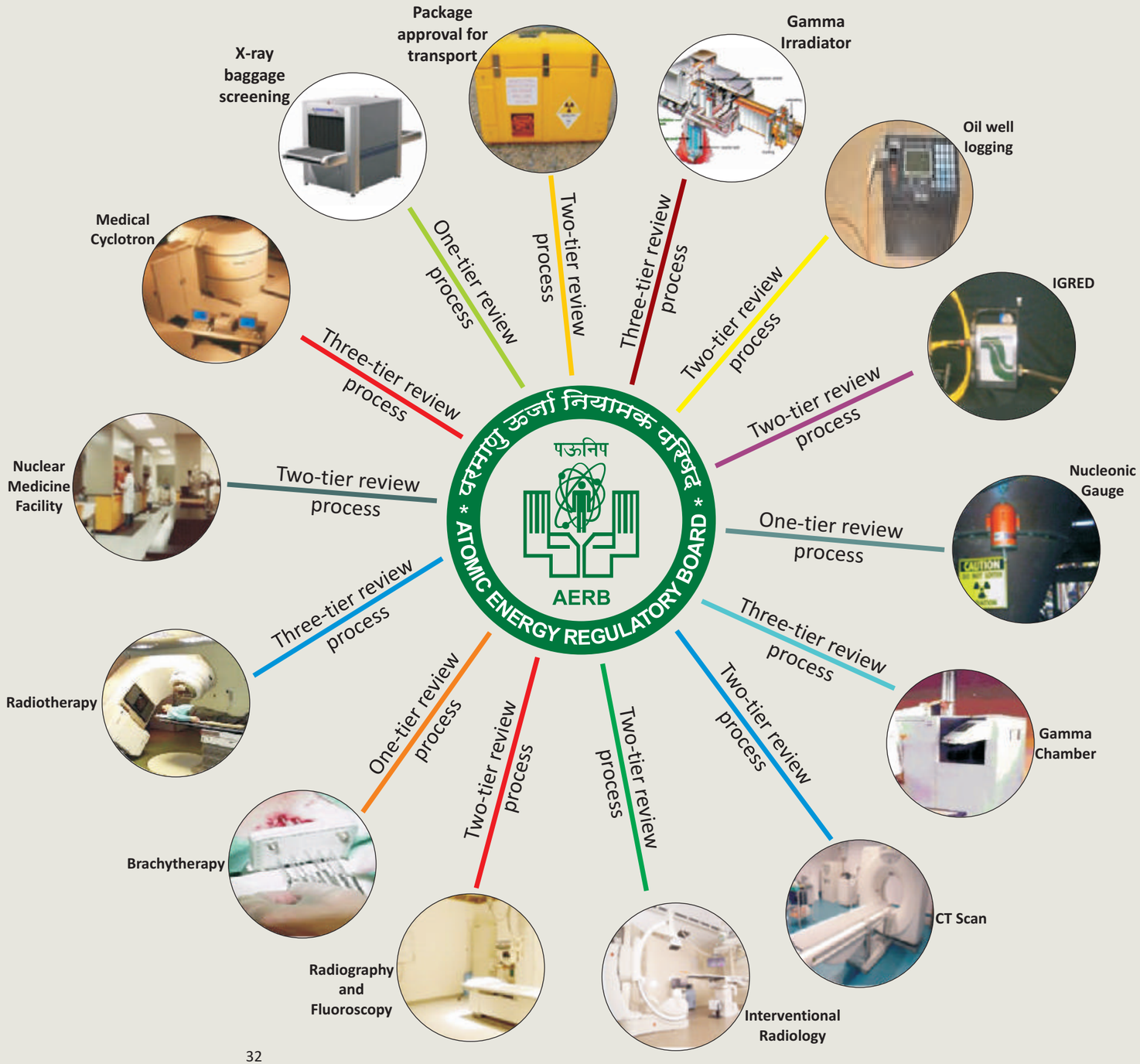
Subsequent to accident at Fukushima NPPs, National Disaster Management Authority (NDMA) participated in augmentation & standardization of the off-site emergency response procedures and sensitizing the district authorities.

Workshops for the district authorities and mock emergency exercises were conducted at all sites.

National Disaster Rapid Force (NDRF) personnel also participated in these exercises.

Regulatory Control on Radiation Facilities

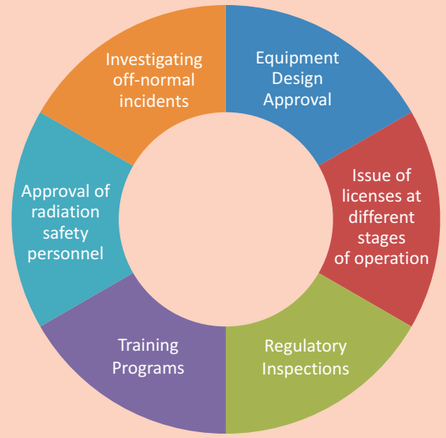
Regulation of Facilities using Radioactive Sources in Industry, Medicine, Agriculture and Research



WORLD OVER, growing economies have seen a rise in the use of Radioactive sources in the Industrial, Medical or Research applications accruing huge societal benefits.

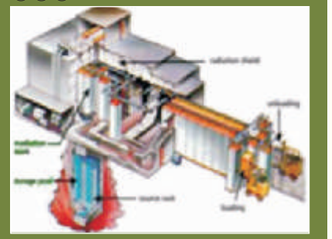
The radioactive sources are either radioactive isotopes (Such as Cobalt-60, Iridium-192, and Caesium-137) or radiation generating equipment such as X-ray or linear accelerators.

While availing the benefits, it is essential to minimize the concomitant health risks in their application, to the workers using the sources, to the patient receiving the radiation dose or to the people in its proximity. AERB strives to achieve this objective by an all- encompassing approach. Given the huge number of facilities and its ever-growing number, AERB opts for the IDENTIFY-GRADE-OPTIMISE pattern of regulation. The various elements of regulatory process in action are depicted below:

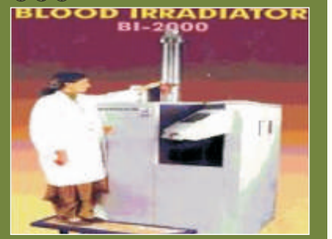


The extent of regulation depends on the radiation hazard potential of the facility.

Gamma Irradiator/ Industrial Accelerator Radiation Processing Units : 20



Gamma Chamber Units : 131



Industrial Gamma Radiography Exposure Device (IGRED)/X-ray : 2548

Nucleonic Gauges : 9404

Well Logging Sources : 754

Industrial Applications of Radiation

Certain industrial applications require the extensive use of radiation sources. The Gamma irradiator is used for preservation of food products, sterilization of health care products, Polymerization of wood, Vulcanization of rubber and uses several Giga Becquerel of radioactive material and uses Co-60, Cs-137 or Photon Electron Beam (<10 MeV). The Gamma Irradiation Chambers (or Gamma Chamber) are used either in research or as blood irradiators. The IGRED is used in the examination of welds/ pipes as a tool for Non-Destructive Examinations. The Nucleonic Gauge is very versatile, because of provision of on-line, non-contact, non-destructive measurement and is 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.

Regulatory framework: For Gamma Irradiators/ Industrial accelerator facilities/ Gamma chambers/ IGRED the consenting is at different stages as the hazard potential to worker and public is MEDIUM-HIGH. For Nucleonic Gauges there is a combined stage consenting as the hazard potential is LOW. Following are the consents issued from Jan 2011 - Mar 2012.

Regulatory consents	Type (Design) Approval	IGRED	03
		Nucleonic Gauge	78
		Gamma Chambers	05
		Sealed source design	01
	NOCs for import	IGRED	04
	Site approval	Gamma Irradiator	01
	Design and construction approval		02
	License for routine operation		10
	Authorisation for operation	Gamma Chamber	30
	Approval of Radiological Safety Officers	IGRED	293
		Gamma Irradiators	24
		Nucleonic Gauges	224
		Well logging sources	13
	Permission for procurement of radioactive source (local and imported)	Gamma Irradiators	06
		Gamma Chambers	04
		Nucleonic Gauges	317
		Well logging sources	73

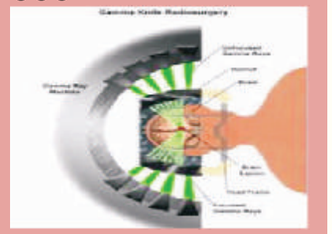
Unusual occurrences and Enforcement actions:

Incident	Type of equipment	Radio-activity on date of incident	Whether Recovered	Over-exposures to workers or public	Root cause analysis	AERB Enforcement actions
Theft of 15 Nos sources from source container from M/s Durgapur Steel plant in January 2011	Nucleonic gauges sources	Co-60 0.8 -6mCi	Three recovered from scrap shops at Durgapur	Not likely as less residual radioactivity	Improper storage of disused nucleonic gauge sources.	Suspension of operation for 3 months. AERB officers verified the enhanced security measures post-incident.
Theft of Radiography camera from M/s Hi-Tech Radiography Services, Vadodara in February 2011	IGRED (Roli-1)	13Ci Ir-192	Recovered	Not likely as equipment found in intact condition	Improper storage of equipment	
Theft of device at Paradip Refinery, Orissa in Oct 2011	IGRED (Delta-880)	84Ci Ir-192	Recovered		Negligence of radiographer of M/s IXAR towards the security of source.	
Theft of device at M/s SKB metallurgical services, Howrah	IGRED (Roli-1)	15Ci Ir-192	Recovered by local police		Improper storage of equipment	
Missing source reported by M/s Becquerel Industries Ltd from one of the sites	IGRED (Delta-880)	25Ci Ir-192	Recovered on the next day			Verification of enhanced security measures post incident
Theft of source of M/s Petrocon Engineering and Inspection Co. Navi Mumbai, kept inside a car.	IGRED (Delta-880)	28 Ci Ir-192	Not recovered	Not likely as source is placed in a tamper-proof design		Has been directed to continue search operations. Suspension of operation for 3 months. Verification of enhanced security measures.
Detachment of source. Source handled by radiographer and trainee, in an unsafe manner	IGRED (Gammarid)	35Ci Ir-192	Not applicable	Over-exposures to both Radiographer and trainee	Mal-functioning of safety mechanism of exposure device	Both of them are laid off from radiation related work. AERB has withdrawn the equipment owing to its not so satisfactory performance in earlier instances also.
Falling of IGRED from 76 m height	IGRED (Roli-3)	5.2Ci Ir-192	No damage to device	None	Accidental fall of source	Directed to submit a detailed report.
Damage to pigtail of source	IGRED (Roli-1)	4.23 Ci, Ir-192	Not applicable	None	Improper crimping of the source pigtail	Changes in design initiated by BRIT.

In the year 2011-12, 23 personnel have received doses more than 20mSv. The number of over-exposures can be attributed to the difficult conditions the radiography practice entails, and the lapses in radiation safety procedures.

Linear accelerators: 232

Gamma knife units : 08



Telcobalt units : 237

Brachytherapy equipment : 214

Brachytherapy-Others : 129

Radiotherapy

Telegamma therapy machine/ Linear Accelerator are used for treating cancers, deep seated tumors and certain non-malignant lesions. High activity Co-60 sources and high energy X-ray /electron beams are used for this purpose. In the Brachy therapy practice, discrete sources in the form of pellets, wires, needles, seeds and tubes inserted into body cavities / implanted into tissues to treat malignancy especially cervical and oral cancers.

Regulatory framework: The Licensing is carried out in different stages i.e. Siting and construction, Procurement of source, Commissioning and operation. The radiation hazard potential in this practice is MEDIUM-HIGH. The following table gives the different regulatory consents issued by AERB in the year Jan 2011- Mar 2012

Regulatory consents	Type (Design) Approval	Medical Linear Accelerators	12
		Brachytherapy	01
	NOCs issued for import to facilitate Type Approval	Medical Linear Accelerators	02
		Rotating Knife ray system	02
	Authorisation for commissioning	Teletherapy	54
	License to restart after source replacement		10
	Decommissioning		08
	Authorisation for commissioning	Brachytherapy	26
	Approval of Radiological Safety Officers		276
	Permission for procurement of radioactive source (local and imported)	Teletherapy	75
		Brachytherapy	246

Unusual occurrences and Enforcement actions :

Incident	Type of equipment	Reco-vered	Over exposures to workers or public	AERB Enforcement actions
Patient blanket getting stuck between the couch and sliding mechanism of the Automatic Positioning System leading to sliding shutter getting stuck.	Elekta Gamma Knife 4C at NIMHANS Bangalore	Yes	None	Supplier was instructed to investigate possibility of recurrence. All users of model were informed accordingly.
Fire accident at AMRI hospital, Kolkata on Dec 2011, affecting radiation therapy facility	HDR brachy-therapy source of 2.8Ci	Yes	None	Equipment was shifted to VECC, Kolkata License for operation suspended.

Nuclear Medicine

The practice of nuclear medicine uses radio pharmaceuticals for both diagnosis and treatment. Several Mega Becquerel of Radioactivity in unsealed form are administered to patients either orally or by other routes. Patients are discharged only after the activity in them is reduced to levels prescribed by AERB. Radio nuclides used Tc-99m, I-131, Thalium-201 and F-18 produced mainly positron emitters, which can be used for in molecular imaging of the organs. In Medical Cyclotrons, particles such as Protons, Deutrons etc are accelerated and made to bombard with suitable target material. A Chemical synthesis module is necessary to prepare a radiopharmaceutical. The accelerated particles may lead to activation of materials and leave residual radioactivity. Radio Immuno Assay is an in-vitro procedure in which radioactivity is not administered directly to patients. Tests are carried out by adding radioactivity in blood samples.

Regulatory framework: For Medical Cyclotrons, the consenting is at different stages as the hazard potential to Worker and Public is MEDIUM-HIGH. For Nuclear medicine labs, the Licensing is carried out in two stages as the hazard potential is MEDIUM-LOW. The RIA kits and Research labs using unsealed sources are subject to single stage consenting.

The following table gives the different regulatory consents issued by AERB in the year Jan 2011- Mar 2012 for various facilities

Regulatory consents	Site Approval of medical cyclotron facility		05
	Renewal of operation of Medical cyclotron		01
	Approval of Radiological Safety Officers	Nuclear medicine	89
		Research applications	70
	Permission for procurement of radioactive source (local and imported)	RIA facilities	64
		Nuclear Medicine-Diagnostic and therapeutic	625
		Research	253

Unusual occurrences and Enforcement actions : There was one over exposure case exceeding the dose limit of 30 mSv. The incident was investigated by designated committee and corrective actions to prevent recurrence were recommended.

Medical Cyclotron : 12

Nuclear Medicine Labs : 220

Radio-immuno Assay kits : 235

Research centers using unsealed sources : 251

Interventional Radiology

Computed Tomography

Radiography and Fluoroscopy

Mammography

Dental Radiography

Diagnostic X-ray Equipment

X-rays generated from the equipment for Imaging are used for patient diagnosis. Use of the X-ray equipment , in general, is safe to the worker, provided properly designed equipment (Type Approved by AERB) are used and minimum care such as use of lead equivalent aprons, maintaining distance from the equipment or standing behind the barrier are followed. Type Approved equipment with periodic Quality Assurance assure optimum radiation exposures to patients.

Apart from general diagnostic X-ray equipment, other facilities used for diagnosis are Computed Tomography (CT) and Interventional Radiology, which are of MEDIUM radiation hazard potential.

Regulatory framework: A single stage consenting process is followed in the case of Interventional Radiology, CT, general purpose radiography, mammography and dental procedures. The regulation of the large number of facilities pose a regulatory challenge. AERB has taken up the regulation of these facilities in a big way. (For further details please see the special feature on "Strengthening of regulatory control on radiation facilities")

Following are the consents issued from Jan 2011 - Mar 2012.

Regulatory consents	Type (Design) approval	Diagnostic X-ray equipment	67
		Interventional radiology	04
		Computed Tomography	12
	NOCs issued for import to facilitate Type Approval	Computed Tomography	16
		Interventional radiology	05
	Issue of Registrations		1245
	Issue of Licences		399
	Approval of Radiological Safety Officers		278

Unusual occurrences and Enforcement actions :

There were 10 over exposures exceeding 20mSv in the reporting period.

All cases of overexposure were investigated by the designated committees and corrective actions to prevent recurrence were recommended.

Consumer Goods

The use of small radioactive sources are used in Smoke detectors, Thorium gas mantles, Starters, Scanning etc. They are of very low hazard potential. Hence, Approval is accorded only to manufacturing facilities and/or suppliers of this equipment.

Package Approval

Transport of radioactive material is carried out only after prior approval from AERB and in approved packages. Type-A packages are used for transport of moderate activity of radioactive material such as nucleonic gauge sources, brachytherapy and nuclear medicine sources.

Type-B(U)/B(M) Packages are used for the transport of large activity of radioactive material such as teletherapy sources, gamma irradiators sources and industrial radiography sources

Disposal of 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 waste management disposal sites of BRIT, Bhabha Atomic Research Centre, Electronics Corporation of India Limited, Narora Atomic Power Station and Centralised Waste Management Facility at Kalpakkam. The sources are also sent back to the original supplier abroad, in case of imported sources.

Following are the consents issued from Jan 2011 - Mar 2012.

Regulatory consents	Type (Design) approval for X-ray baggage inspection system	05
	Approval of Radiological Safety Officer	01
	Procurement of sources for consumer goods (local and imported)	286
	Transport of radioactive sources	70
	No. of sources authorised for disposal locally	1166
	No. of sources authorised for transfer to the original supplier abroad	841
	Quantity of Depleted Uranium authorised for disposal at WMD, BARC	1103.38 Kg

No. of Unusual occurrences : Nil

X-ray baggage screening

Thorium Gas Mantle

Type A Package

Regulatory inspections carried out by AERB inspectors during 2011-12

Operating Nuclear Power Plants	47*
Nuclear Power Projects	63*
Nuclear Fuel Cycle Facilities & Projects	61*
Radiation Facilities including Transport of Radioactive Material & Consumer Products	620

*** Including special inspections and Industrial safety inspections which were carried out as listed below**

Additional Security Related Inspections

Operating Nuclear Power Plants	6
Nuclear Power Projects	3

*Special Inspections

Post Fukushima to assess capability to withstand a extreme external event	10
Health Physics Inspections during Biennial Shut down	6
Reactive inspections in response to significant events	6
Industrial Safety focused inspections of Nuclear Power Plants and Construction Projects	87

Regulatory inspections

"Regulatory Inspections (RI) is a tool of regulation carried out as a safety audit measure to ensure compliance with the AERB safety requirements and stipulations"

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)	No. of workers exceeding dose limit
20 operating NPPs	14, 312	0.44 - 1.99	10, 341	0.63 - 2.44	4

During 2011, 14312 occupational workers were monitored of which around 72% received radiation exposure, with their average dose ranging between 0.63 - 2.44 mSv.

The doses of all occupational workers were within the prescribed annual dose limit of 30mSv, except during a safety related unusual occurrence where four temporary workers, while carrying out painting job of spent fuel transfer duct at KAPS-1&2, accidentally got exposed to higher radiation dose rates. However, these doses were too small to cause any perceptible health impact.

Fuel Cycle Facilities

Radiation Doses Received by Workers in Fuel Cycle Facilities

Type of Facilities	Number of Exposed Persons	Average Dose of Exposed Persons (mSv)	Maximum Dose of Exposed Persons (mSv)	No. of workers exceeding 30mSv dose limit
Uranium mines	2234	1.26 - 5.73	10.42	Nil
Uranium mill	475	1.92	5.61	Nil
Thorium mines and mineral separation	401	0.42 - 5.75	14.11	Nil
Thorium mill	293	4.56	16.9	Nil
Fuel fabrication facilities	906	1.05	9.8	Nil

During 2011, no occupational worker in any of the fuel cycle facilities exceeded 20 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)	No. of workers exceeding 30mSv dose limit
Diagnositc X-rays	43316	0.35	18130	0.83	3
Radiation Therapy	8462	0.22	3780	0.49	0
Nuclear Medicine	1927	0.43	1143	0.72	1
Industrial Radiography & Radiation Processing	6531	0.66	2392	1.80	10
Research	4002	0.11	1096	0.40	0

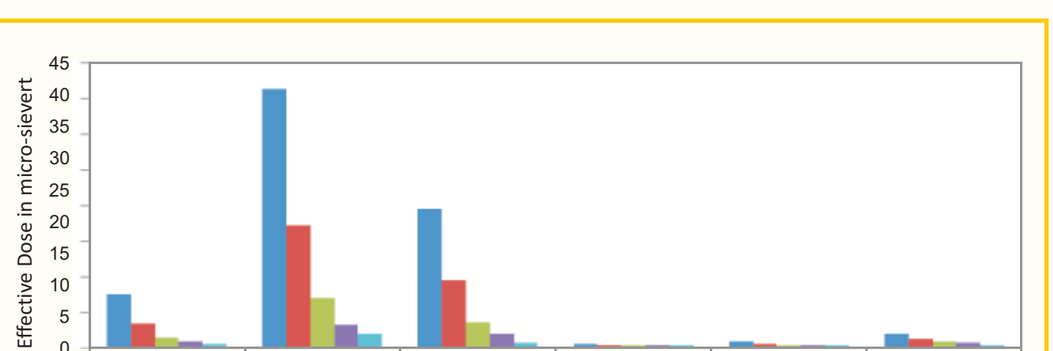
During 2011, 64,238 occupational workers were monitored in radiation facilities of which around 41% received radiation exposure, with their average dose ranging between 0.40 - 1.80 mSv. There were 14 cases exceeding the annual dose limit of 30 mSv. However, these doses were too small to cause any perceptible health impact.

Statistics: Public Exposure

AERB imposes limits on radi*oactive 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.

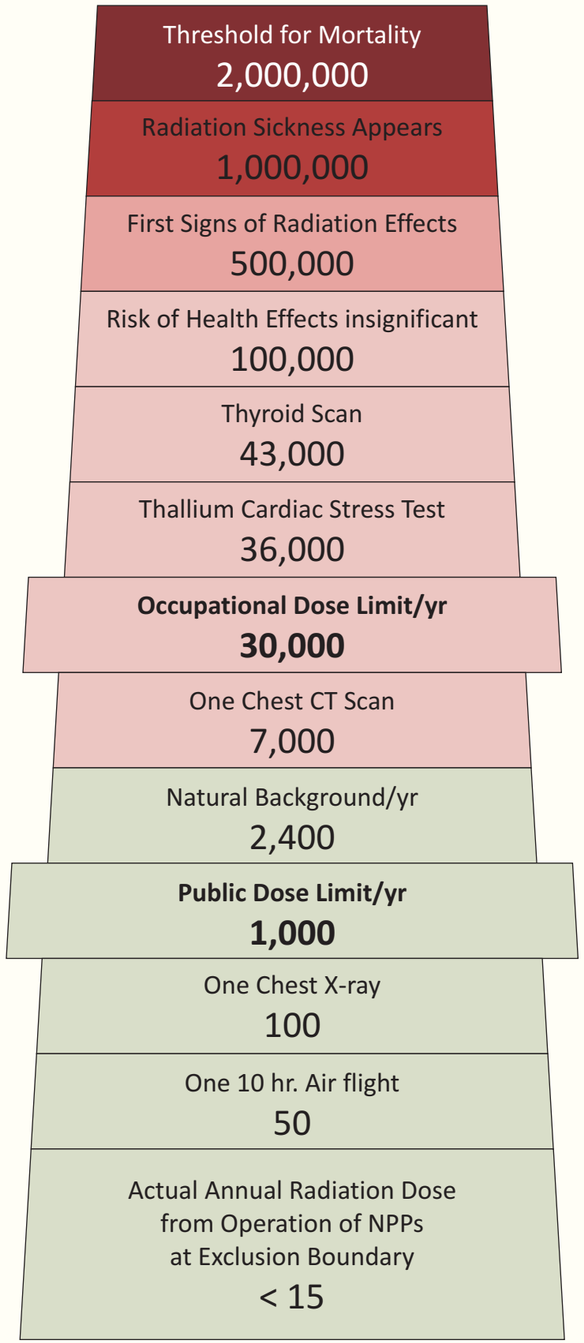
During 2011, the liquid and gaseous waste discharge from the operating NPPs continued to remain only a small fraction of the allowable discharge limits. The effective dose to public due to the radioactive discharges were estimated to be is far less than the annual limit of 1 mSv (1000 micro-Sievert) prescribed by AERB.



	Tarapur Site	Rawatbhata Site	Kalpakkam Site	Narora Site	Kakrapara Site	Kaiga Site
1.6km	7.42	36.30	19.50	0.48	0.88	1.90
1.6-5km	3.38	17.10	9.50	0.37	0.48	1.31
5-10km	1.45	7.00	3.60	0.30	0.38	0.85
10-15km	0.84	3.20	1.90	0.28	0.32	0.64
15-30km	<0.6	2.00	0.90	0.28	0.32	0.64

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 Radiation Doses



All Values in Micro-Sievert

Statistics: Industrial Safety

Reportable Injury

There were 31 reportable injuries in 2011 as compared to 54 in 2010. More or less one reportable injury per 1000 employees was being observed since 2007 till 2010 but in the year 2011, it has declined to 0.58.

Frequency Rate

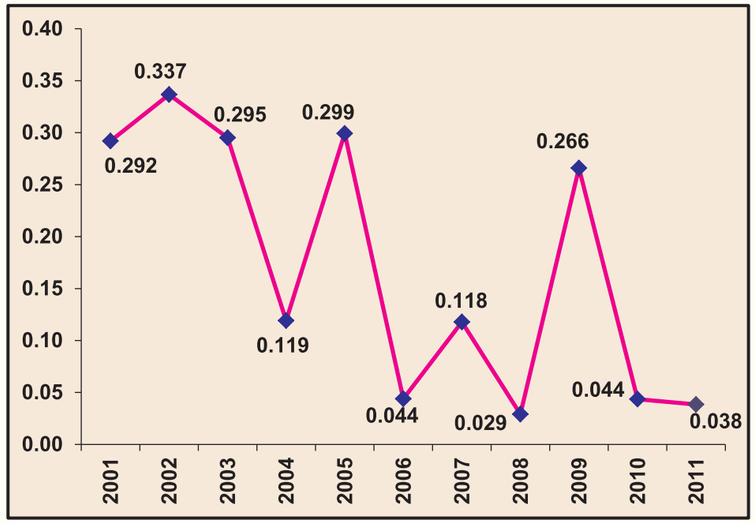
(No. of reportable injuries / million man-hrs worked)

The frequency rate has decreased to 0.23 in the year 2011 after being almost constant at 0.50 since 2007.

Severity Rate

(No. of man-days lost / million man-hrs worked)

The Severity Rate (SR) for 2011 was relatively high (166) as compared to 2010 (105) due to three fatal accidents in 2011 as against two fatalities in 2010.



Year wise injury index in DAE units

Injury Index is the product of the Frequency Rate and the Severity Rate divided by 1000.

Near Miss Accidents

In 2011, 273 Near Miss Accidents were reported from different units of DAE. 20 % of the reported near miss accidents were due to "Fall of Objects" type and 10 % were due to "Exposure to Electricity".

Occupational Health

No occupational diseases were reported from any of the DAE units during 2011-12.

Industrial Safety Performance of DAE units is in general better than other similar industries in the country

Comparison of Incidence Rates of DAE Units (2011) with Equivalent Non-DAE Industries (2005)*

Industry Type	Incidence Rate	
	Fatal	Non-Fatal
DAE: Heavy Water Plants (2011)	0.00	0.00
Manufacture of Chemicals & Chemical products (2005)	0.15	1.76
DAE: Nuclear Fuel Complex (2011)	0.24	0.96
Manufacture of Fabricated Metal Products except Machinery and Equipment (2005)	0.10	1.81
DAE: Nuclear Power Plants (2011)	0.00	0.07
Electricity, Gas, Steam and Hot water supply (2005)	0.25	3.85

(Data Source- Pocket Book of Labour Statistics 2009)

Fatal Accident

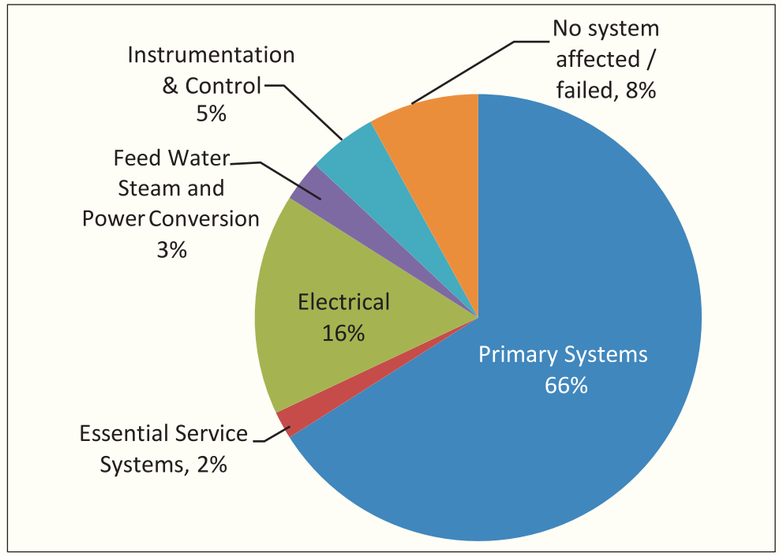
There was one fatal accident during the period April 2011-March 2012 which occurred at Nuclear Fuel Complex, Hyderabad on November 30, 2011 due to an incident of electric arc flashover. The accident was investigated by AERB and was reviewed in the Fatal Accident Assessment Committee (FAAC) in detail. The accident was also reviewed in the Apex committee of AERB - Safety Review Committee for Operating Plants (SARCOP) and by the Board of AERB. AERB communicated the lessons learnt from the accident to all DAE Units.

Based on the review of this accident, AERB issued a directive to all DAE Units to examine and identify all electric power distribution / conversion panels and systems for probable arc flash hazard and methods employed for its prevention.

Besides, AERB has prepared a comprehensive checklist to assess the electrical systems, design provisions, competency of manpower, workmanship etc of a facility and initiated special inspections of all Fuel Cycle Facilities based on the checklist.

Statistics: Significant Events

In the year 2011, 38 significant events were reported from the operating Nuclear Power Plants.



Classification of the Significant Events based on affected systems

INES Rating

The significant events in operating NPPs are also rated on the International Nuclear and Radiological Event Scale (INES). 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	2007	2008	2009	2010	2011
0	28	22	23	33	36
1	8	2	0	1	1
2	0	0	0	0	1
3	0	0	0	0	0
>3	0	0	0	0	0
Total	36	24	23	34	38

INES Rating of Significant Events in Indian NPPs

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 38 significant events in 2011, 36 significant events were rated at level 0 on INES while significant event at Narora Atomic Power Station (NAPS) - 1 and Kakrapar Atomic Power Station (KAPS) - 2 were rated at level 1 and level 2 on INES respectively.

Incident in NAPS-1 (INES Level-1)

In NAPS-1, during refueling operation a pair of spent fuel bundle got detached from its end plates resulting in separation of fuel pins from the fuel bundle. The event occurred due to a mechanical fault in fuel transfer system, used for transferring spent fuel from reactor building to spent fuel storage bay. The fuel pin of the spent fuel bundle got damaged during the fuel transfer operation, as was evident from the minor release of iodine and fission product noble gas through the stack at the time of the event. The incident was reviewed in various safety committees of AERB. Deficiencies observed in the fuel transfer system have been rectified to avoid recurrence of such an event.

Incident in KAPS-2 (INES Level-2)

In Pressurised Heavy Water Reactor (PHWR) based NPPs, refuelling is done when the reactor is on-power. The spent fuel bundles from reactor building are transferred to spent fuel storage bay through spent fuel transfer tubes (SFTT) which are inside a shielded trench called spent fuel transfer duct (SFTD). The radiation field in the SFTD area goes high for a short period during transfer of spent fuel bundles through SFTT.

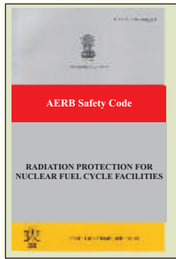
Four workers involved in housekeeping and area painting work in SFTD of KAPS-2 got exposed to high radiation field and received radiation dose of 90.72, 66.81, 58.70 and 23.23 mSv due to inadvertent discharge of a pair of spent fuel bundles to SFSB. The investigations revealed that this incident happened due to inadequate review of the procedure, inadequate appreciation of the potential hazard and non-adherence to the standard work practices. The incident was reviewed in detail by respective Safety Committee and by SARCOP, which is the Apex safety review committee of AERB. SARCOP has expressed the need for exercising access control in shielded areas and has asked NPCIL to include a provision for the same in the Technical Specifications for Operations, which has to be strictly adhered to.

Following the incident, the license of the concerned fueling handling engineer was suspended and he was sent for refresher training.

Development of Safety Documents

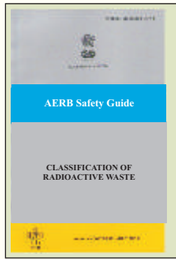
AERB develops safety documents, which include Safety Codes (SC), Safety Standards (SS), Safety Guides (SG), Safety Manuals (SM) and Technical Documents (TD) for nuclear and radiation facilities and related activities.

New Safety Documents Published



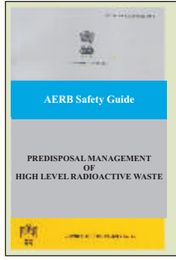
Safety Code 'Radiation Protection for Nuclear Fuel Cycle Facilities' (AERB/NF/SC/RP)

Specifies the basic requirements for radiation protection of occupational workers, members of the public and the environment from undue hazards of ionising radiation in the operation of nuclear fuel cycle facilities



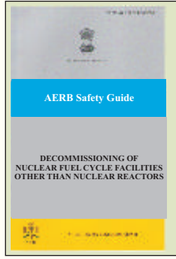
Safety Guide 'Classification of Radioactive Waste' (AERB/NRF/SG/RW-1)

Provides approaches based on which radioactive waste can be classified to meet the safety requirements prescribed in the AERB safety code on Management of Radioactive Waste.



Safety Guide 'Predisposal Management of High Level Radioactive Waste' (AERB/NF/SG/RW-3)

Provides guidance for predisposal management of high-level radioactive waste to meet various safety requirements prescribed in the AERB safety code on Management of Radioactive Waste.

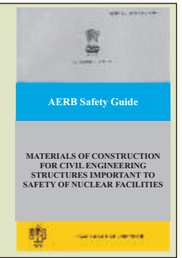


Safety Guide 'Decommissioning of Nuclear Fuel Cycle Facilities other than Nuclear Reactors' (AERB/NF/SG/RW-7)

Sets out recommendations related to safe decommissioning of nuclear fuel cycle facilities other than nuclear reactors as per the regulatory requirements prescribed in AERB safety code on Regulation of Nuclear and Radiation Facilities.

Safety Guide 'Materials of Construction for Civil Engineering Structures Important to Safety of Nuclear Facilities' (AERB/NF/SG/CSE-4)

Specifies materials to be used in construction of civil engineering structures & buildings so as to provide adequate assurance for safety of nuclear facilities in India.



Safety Manual 'Quality Assurance of Civil Engineering Structures Important to Safety of Nuclear Facilities' (AERB/NF/SM/CSE-3)

Specifies quality assurance aspects to be followed during the construction of civil structures for safety of nuclear facilities in India.

Safety Guidelines 'Control of Works' [AERB/SG/IS-1 (Rev.1)]

Provides basic framework of industrial safety organisation, safety management systems & work procedures to maintain a safe working environment.

*With these, the total number of safety documents published by AERB stands **141**.*

Safety Documents Translated and Published in Hindi

Safety Guide on 'Primary Heat Transport System for Pressurised Heavy Water Reactors' (AERB/NPP-PHWR/SG/D-8; 2003).

Safety Guide on 'Management of Radioactive Waste Arising from Operation of Pressurised Heavy Water Reactor Based Nuclear Power Plants' (AERB/NPP/SG/O-11; 2004)

Safety Manual on 'Regulatory Inspection and Enforcement in Nuclear Power Plants and Research Reactors' (AERB/NPP&RR/SM/G-1; 2007).

*Experts in AERB reviewed **9** Draft Documents and **19** Document Preparation Profiles of IAEA and offered valuable suggestions to IAEA.*

Safety Studies and Research

1. Safety Research Institute (SRI), Kalpakkam

Safety Research Institute was set up in Kalpakkam in 1999 to carry out safety research studies of regulatory interests. During 2011, safety analysis and R&D studies were carried out in diverse subject areas.

Subject Areas	Number of studies undertaken
NUCLEAR SAFETY STUDIES	
• Reactor Physics and Radiation Safety	6
• Reliability and Probabilistic Safety Assessment	3
ENGINEERING STUDIES	
• Fire Safety Studies	2
• Studies on Hydrogen Distribution in Enclosures	1
• Structural Analysis	1
• Microstructural Based Constitutive Model to Predict the Creep Behaviour of Modified 9Cr-1Mo Ferritic Steel at 873 K	1
• Numerical Simulation and Validation of Thermal Striping Phenomena	1
• Air Side Pressure Drop in AHX-B Inlet: Effect of Adjoining Structures	1
ENVIRONMENTAL SAFETY STUDIES	
• RS-GIS studies	2
• Hydrogeological and Hydrogeochemical Studies at Kalpakkam	2
• Waste Management related Studies	3

2. Safety Analysis Studies at AERB, Mumbai

In addition to the safety studies undertaken at SRI,Kalpakkam, AERB also carries out inhouse safety analysis studies which help in the normal regulatory review process. During 2011-12, ***14*** *such studies were carried out.*

Safety Studies
Behavior of High Performance Concrete Exposed to Fire
Hydrogen Sulphide Dispersion Analysis at Rawatbhata Site for Design Basis Accidents
International Round Robin Analysis on BARC Containment Test Model
Station Black Out Analysis of CANDU-6 Plant
Experimental Study on Transient Critical heat Flux in Horizontal Channels
External Coupling of 3-D Neutronics and Thermal-Hydraulics Codes
Indigenous Computer Code Development
Spatial Instability Analysis in Large PWRs
Fire Modelling of a Main Control Room in a Typical PHWR Plant
Development of Condensation Model for Hydrogen Distribution Studies
Development of Code to Implement Failure Surface for Core Disassembly in Severe Accident Conditions
Fuel bundle Deformation under Stratified Flow Conditions
Estimation of Core Radionuclide Inventory
Estimation of Conditional Probability of Stagnation Channel Break in PHWR

Safety Studies and Research

3. Safety Studies Funded by AERB

*In addition to these safety studies, AERB also has a programme to fund research & development studies of regulatory interests in academic institutions. AERB reviewed **10** new research projects studies and agreed to fund **6** of them. In addition **8** ongoing projects were renewed.*

Project Title	Organisation
Experimental and Numerical Investigations of Heat Transfer in Tube, Single Rod Bundle Geometries Using Supercritical Fluid Freon-22	IIT-Bombay, Mumbai
Development & testing of corrosion inhibitors for firewater system materials	Anna University, Chennai
Non-contact strain measurement of Zircaloy using digital image correlation (DIC) under high temperature ambience	IIT-Hyderabad, Hyderabad
Seismic fragility of the primary containment considering structural integrity and leakage through the damaged containment	IIT-Bombay, Mumbai
Thermo-mechanical failure in PT-CT tubes used in Indian PHWR	IIT-Bombay, Mumbai
Leukocyte DNA damage as a biomarker for radiation exposure to patients undergoing MDCT examinations	UCMS & GTB Hospital, Delhi

4. Safety Studies with International Collaboration

Performance of Containment vessel under Severe Accident Condition

A study on "Performance of Containment vessel under Severe Accident Condition" has been taken up by AERB under the framework of 'USNRC-AERB Nuclear Safety Cooperation Program". The activities are divided into two phases. Phase-1 deals with the examination of certain local effects which was completed last year. The second part of the study which involves examination of methods to estimate leakage rate and enumeration of methods for predicting leakage of pre-stressed concrete containment vessels including application of these methods to characterize the performance has been completed this year.

Seismic Margin Assessment benchmark study

AERB is a participant of the IAEA extra budgetary programme (IAEA-EBP) on seismic safety of existing NPPs, wherein a bench mark study based on the observations during the July 2007 earthquake that affected the Kashiwazaki-Kariwa Nuclear Power Station is undertaken. This study focuses on quantifying available margins, understanding the behavior of structures, soil and equipment during earthquake and identification of main parameters influencing the response.

AERB completed the analysis and performance evaluation of the reactor building and benchmarking exercise for residual heat removal system piping. The results/values estimated by AERB were in very good comparison with the mean values of the results from different participants.

Integral PWR Design Natural Circulation Flow Stability and Thermo-Hydraulic Coupling of Containment and Primary System During Accidents

The purpose of this IAEA International Collaborative Standard Problem Exercise is to simulate flow instability phenomena under natural circulation conditions and coupled containment/reactor vessel behavior in integral-type reactors, where, experimental data can be used to assess computer codes for reactor system design and analysis. This will also improve understanding of important phenomena expected to occur in a natural circulation integral type small reactors. AERB has carried out blind calculations of two transient scenarios, namely Loss of feed water transients and operational conditions at different power levels.

International Seismic Safety Centre Of IAEA

AERB has joined the international seismic safety center of IAEA in the following working areas:

- Seismic safety evaluation
- Tsunami hazard
- Engineering aspects of protection of nuclear installations against sabotage
- Site Evaluation and External Events Safety Assessment

AERB conducted numerical simulations of the tsunami caused by Great East Japan Earthquake of March 11, 2011.

International Cooperation

Ongoing Interaction Continued with International Agencies/Fora

International Atomic Energy Agency	Nuclear Energy Agency	CANDU Reactors Forum	VVER Reactors Forum

Ongoing Interaction Continued with Regulatory Bodies of other countries

ASN, French Nuclear Authority, France	Rostechnadzor, Nuclear Regulatory Body of Russia	United States Nuclear Regulatory Commission ,USA

Meetings and Visits

Following the Fukushima accident, there were a number of meetings and events internationally organized by IAEA and Nuclear Energy Agency (NEA) of OECD, in which AERB participated actively.

High level delegations from USNRC, NEA and ASN visited AERB for exchange of technical information including actions taken following Fukushima accident.

Meeting between AERB and OECD (NEA) delegation in progress at AERB November 4, 2011

Meeting between AERB and USNRC delegation in progress at AERB November 15, 2011

Convention on Nuclear Safety of IAEA

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.

Multinational Design Evaluation Programme (MDEP) of NEA

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).

AERB's Self Assessment for International Regulatory Review Service (IRRS) of IAEA

AERB has planned to get its regulatory process peer reviewed by the Integrated Regulatory Review Service (IRRS) mission of IAEA in the near future. As a first step, AERB decided to assess its readiness. For this purpose, AERB constituted a committee with several supporting working groups to carry out an exhaustive and meticulous review of the existing system vis-à-vis the IAEA regulatory safety standards. The elaborate activity is nearly complete.

Safety Promotional Activities

Safety Awards

AERB has annual safety award schemes to promote industrial safety, fire safety and greenery at various DAE units.

Awards	Winners for 2011
Industrial Safety Award	Rajasthan Atomic Power Project 7&8 Madras Atomic Power Station 1&2.
Fire Safety Award	Kaiga Generating Station 3 &4 Kakrapar Atomic Power Project 3&4
Green Site Award	Nuclear Fuel Complex, Hyderabad Narora Atomic Power Station Site

*A compilation of **Injury Statistics and Fire Statistics** of all DAE units with root cause analysis and comparison with other national and international statistics being released during industrial and fire safety award*

DAE Safety and Occupational Health Professionals Meet

Monograph on "Environment Protection" being released during the 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 Indian Rare Earths Ltd, OSCOM and was held at Bhubaneswar, Odisha from November 24 - 26, 2011 . The themes for the meet were "Emerging Trend in Environment Protection" for Industrial Safety and "Life Style Diseases" for Occupational Health & Safety.

Awareness Programmes

AERB organizes awareness programmes as a measure to promote and encourage safety related activities. **Fourteen** awareness programmes were conducted at various sites during 2011-2012 dealing with topical issues on radiation safety aspects such as industrial radiography, steel contamination, scrap metal recycling, handling of packages containing radioactive material, use of radiation in security monitoring devices, nucleonic gauges, diagnostic radiology, research applications etc.

Steps taken for strengthening In-house 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 211 to 286 during the last two years, 2009-2011.

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. Similar to the ongoing Orientation Course for Regulatory Processes being conducted at headquarters, Mumbai, AERB for the first time conducted this course at Safety Research Institute, Kalpakkam during June-August, 2011. The course was attended by scientists/engineers newly inducted in SRI-AERB and nominated scientific staff from units located in Kalpakkam. The course covered important topics related to nuclear and radiation safety.

AERB encourages its employees to pursue higher studies.

*This year, **5 PhDs** and **2 M. Tech** Degrees were awarded to AERB employees.*

Publications/ Paper Presentation:

- Journals: 17
- International Conferences: 16
- National Conferences: 27

Workshops/Discussion Meets

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:

- Review of Off-site Emergency Preparedness and Response Plan of Indian NPPs based on Experience of Fukushima Nuclear Accident
- Regulatory inspections of NPPs
- Implementation and Operational Aspects of Physical Protection System (PPS) at Nuclear Power Plants / Nuclear Facilities
- Discussion meet on external events in siting of NPPs
- Discussion meet on standardization of methodology for derivation of DBGM parameters for new sites
- Workshop on Evolving Trends and Technologies in Fire Safety
- Theme Meeting on R&D Activities of AERB
- Theme Meeting on Status of LWR Analysis
- Training Programme/Workshop on Acute Trauma, Cardio Pulmonary Resuscitation and Poisoning for the benefit of Para medical staff and Certifying Surgeons of DAE units.

International Workshop on New Horizons In Nuclear Reactor Thermal Hydraulics and Safety

International Workshop on New Horizons in Nuclear Reactor Thermal Hydraulics and Safety was organized in co-operation with the Board of Research in Nuclear Sciences (BRNS) and Society for Reliability and Safety (SRESA) in Safety Research Institute (SRI), Atomic Energy Regulatory Board, Kalpakkam, on January 2-3, 2012. Recent developments and future challenges in various areas of nuclear reactor thermal hydraulics especially on severe accident, emergency preparedness, and safety were discussed. The inaugural issue of New International Journal "SRESA's International Journal of Life Cycle Reliability and Safety Engineering" was released during the workshop.

Participants of International Workshop including Invited Delegates from Abroad as well as from India

The discussion focused on several important areas such as passive system versus active system, lessons learnt from Fukushima accident and preparedness for future, ultimate heat sink with air or water, margins for design basis/external events and hydrogen issues.

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.

Representation in 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 and this year had actively contributed in reviewing the terms of reference of new projects such as proposed new BARC facility at Vishakapatnam, Andhra Pradesh and Fast Reactor Fuel Reprocessing Facility at Kalpakkam, Tamil Nadu.

In addition draft guidelines of Central Pollution Control Board for Management and Handling of Phosphogypsum generated from Phosphoric acid plants were reviewed.

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 recertified as per new ISO 9001:2008 standard in November 2009.

As per the requirements laid in the ISO procedures and Quality Manual for AERB, internal audit for various divisions of AERB were carried out. All the observations the internal audits were complied. Surveillance audit was carried out in November 2011 by BIS and no Non-Compliance was reported by BIS. However, certain suggestions were provided by BIS auditor, which have been implemented.

In order to enhance awareness level on QMS requirements and improve competence of AERB personnel training programme on Internal Audit was conducted by National Institute of Training for Standardization, Bureau of Indian Standards. In addition to this, an awareness programme on QMS aspects was also held.

Public Information

AERB views transparency and openness as an essential element of regulatory process. 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.

Newsletters

Annual Report

Website

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

Ninety Three *parliament questions responded*

Eighty Six *queries under Right To Information Act replied*

Initiatives on Public Awareness

AERB for the first time took initiative to participate in science and technology fairs.

Chennai Science Festival January 27-30, 2012.

Awake Programme and Exhibition (Awake) at Satyabhama University, Chennai : February 21, 2012.

Nuclear energy Educational Meet (NEEM) at Velammal College of Engineering Technology, Madurai: March 2-3, 2012.

Displayed exhibits on the safety and regulatory aspects of Nuclear & Radiation Facilities.

AERB safety documents displayed for the public to get a glimpse of the technical aspects of regulation.

The exhibits aimed at giving a correct perspective on doses received.

The response to the AERB's exhibits at these science fairs was extremely encouraging with visitors of various age groups and students visiting the stall and getting informed about AERB and its role.

Special Feature:

Strengthening of Regulatory Control on Radiation Facilities

In April 2010, a radiological incident occurred in a metal scrap market at Mayapuri area of Delhi. Following this incident, AERB launched a vigorous campaign to strengthen the regulatory coverage and control of radiation facilities and applications in the public domain for medical, industrial and R&D uses. Owing to the large number and varying degree of radiological hazard potential, AERB has been following a graded approach with respect to regulatory control of these facilities.

Recent initiatives in this direction include intensive campaigns for :

Updating the inventory of radiation sources, to ensure that all the existing sources in the country, including legacy sources, are under regulatory coverage

Introducing an internet based system for filing of applications and issue of consents, for effectively managing the regulation of radiation sources and facilities

Increased inspection coverage for radiation facilities (620 against 383 last year)

Insistence on compliance with requirement of periodic safety reports.

Improving awareness on regulatory requirements through print media, awareness and training programmes, and AERB website.

Facilitate speedy disposal of disused sources through a coordination committee

AERB is also establishing Regional Regulatory Centres (RRC) to cater to the requirements of regulatory inspections at the Northern, Eastern and Southern zones in India. The centres at eastern and southern zones have already started functioning.

Regulation of X-Ray Facilities

Presently there are well over 50000 diagnostic X-ray units/facilities in India. AERB has faced difficulties in regulatory control of these on account of the large number of units spread across the country and the accelerated growth in their number. However the radiation hazards involved in such facilities are very low, to cause any unacceptable health risks. Such units do not emit any radiation unless they are energised. No emergency situations are envisaged at such facilities from the radiological safety stand point.

AERB had been pursuing an approach of "develop - educate - regulate", with respect to enforcement of regulatory requirements, which is a gradual process, and undertaking awareness programmes for the user community.

Further, with the objective of establishing an effective regulatory set-up for the large number of X-ray units spread over the country, AERB took efforts for formation of State-level Directorates of Radiation Safety (DRS), with the help of State Governments and to entrust them with the responsibility of inspection of these facilities. Such Directorates have been established in the states of Kerala and Mizoram and AERB has signed MOUs for formation of DRS in the states of Madhya Pradesh, Punjab, Chattisgargh and Tamil Nadu. Formation of DRS in other states and union territories is being further followed up by AERB with the respective state governments.

In view of limited success with the establishment of DRS, AERB undertook fresh initiatives and approaches based on safety analysis of the hazards involved. Based on this, AERB's present approach is enhanced focus on ensuring safety built into the design of the equipment over operational safety. The regulatory control is exercised on the suppliers/manufacturers to ensure maintenance of quality assurance during manufacturing/sale of such units to give satisfactory performance during use at the place of end users. Also manufacturer / suppliers responsibility is being enhanced to ensure that the users comply with AERB requirements.

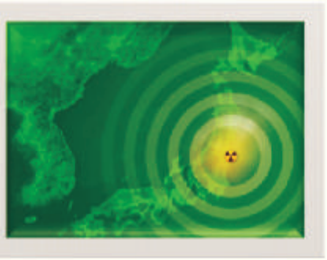
Recent additional initiatives with regard to facilitating regulation of X-ray facilities are; (a) rationalisation and simplification of the existing regulations for users in diagnostic x-ray practice, by way of amendments of AERB Safety Code, (b) enhancing regulatory control on Manufacturer / supplier, over the user and (c) development of an easy and approachable interface for the user to facilitate easy registration, using the new web based system.

Special Feature:

Actions by AERB following post Fukushima Accident in Japan

On March 11, 2011, a massive earthquake and subsequent tsunami caused extensive damage to the nuclear reactors at the Fukushima Nuclear Site in Japan resulting in release of radioactivity. This accident prompted the entire nuclear community to revisit the safety of the nuclear power plants. The accident was the first occurrence revealing that an extreme natural event, that generated stress levels far beyond nuclear power plant design-basis values, could lead to a nuclear accident of such catastrophic magnitude. It also showed how the massive destruction of a site and of the surrounding infrastructures could complicate all accident management operations.

All countries with nuclear power programme carried out a detailed verification of the existing safety margins in their plants against the extreme external hazards and reassessment of the availability of vital safety functions for a sufficient period of time. India was no exception to this and AERB which is entrusted with the responsibility to ensure nuclear and radiological safety in the country, took several steps to ensure safety of Indian nuclear plants and allay public apprehensions on possibility of occurrence of such accident in Indian scenario.



Immediate Actions

Following the accident, AERB constituted an in-house Monitoring Cell to follow the events at Fukushima and keep a close vigil on the radiation & contamination levels in Japan and India. The reports of the Cell providing details on the radiation levels in India, the status of plants at Fukushima and surrounding radiation levels, were uploaded on AERB's website on a daily basis.

Three laboratories were identified by AERB for testing of food samples imported from Japan. Coordinated with and advised the Food Safety and Standards Authority of India (FSSAI) regarding

import of Food items from Japan. AERB also advised National Disaster Management Authority (NDMA) that screening of passengers coming from Japan was not warranted, This together with regular press releases and interaction of higher management with media was useful in addressing public concerns.

Safety Reassessment of Nuclear Power Plants

AERB initiated actions for re-verification of safety of Indian nuclear power plants, from the perspective of renewed expectations of nuclear safety and protection against severe external events. As a first step, AERB asked Nuclear Power Corporation of India Ltd. (NPCIL) to carry out a comprehensive reassessment of safety against external events and emergency mitigation measures at all NPPs and projects. NPCIL conducted safety assessment of operating NPPs as well as projects to review the consequences of similar situation occurring in the Indian NPPs.

Site specific special regulatory inspections

AERB conducted special regulatory inspections of all NPPs to assess the plant capability and the preparedness to deal with the situations arising out of the natural disasters such as flood, tsunami, earthquake etc as well as the events of station black out and multiple failures. The findings of the inspections have been reviewed in AERB.

Independently AERB constituted a separate high level safety committee for external events (AERBSC-EE) to carry out a comprehensive review of capability of NPPs to deal with external events within and beyond design basis.

The Committee noted the inherent strengths of designs, operating practices and regulations followed in India, which have resulted in robust systems capable of withstanding challenges arising from external events.

However, as a matter of abundant caution, the Committee made certain recommendations to further enhance the safety features of NPPs. AERB accepted the recommendations of the

Committee and asked NPCIL to formulate the approach and action plan for their implementation. The areas requiring review /strengthening are as follows:

Reconfirmation of capability to withstand currently defined site specific external events, and assess margins beyond
Implementation of automatic reactor trip during a seismic event
Enhancing the capability to safely withstand extended station black out conditions, such as - Augmentation of emergency power by additional air cooled Diesel generators located at higher elevations - Strengthening of diesel storage provision at site
Enhancing the capability to safely withstand extended loss of heat sink through design provisions, such as - Augmentation of provisions for water sources at site - Implementation of provisions of hook up points which can be used to inject water directly into reactor core and other important systems
Review and strengthening the Severe Accident Management programme - especially those for: - Containment integrity during severe accident condition - Hydrogen management and containment venting - Monitoring of key process and plant parameters - Emergency management capability in case of adverse environment, creation of emergency response facility capable of withstanding severe external events

These recommendations are being followed by various unit level safety committees as well as by SARCOP which is the apex Safety Review Committee of AERB for a timebound implementation.

Emergency preparedness in public domain

Further strengthening the preparedness for handling off-site nuclear emergency during a simultaneous natural calamity was a necessity. National Disaster Management Authority (NDMA) has organized emergency preparedness workshops in consultation with AERB and off-site emergency mock exercise at all the operating NPP sites with the involvement of all key officials of the District Administration at all NPP sites. AERB conducted special theme meetings with all responsible organization to address any gap in off-site emergency management plans. Areas for improvement were identified.

Sharing India's review with International Community

The information on the actions taken post Fukushima was exchanged during bilateral meetings with the regulatory bodies of USA and France. During these meetings, it was noted that the actions taken in Indian NPPs are generally in-line with the actions taken in NPPs in other countries.

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.

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