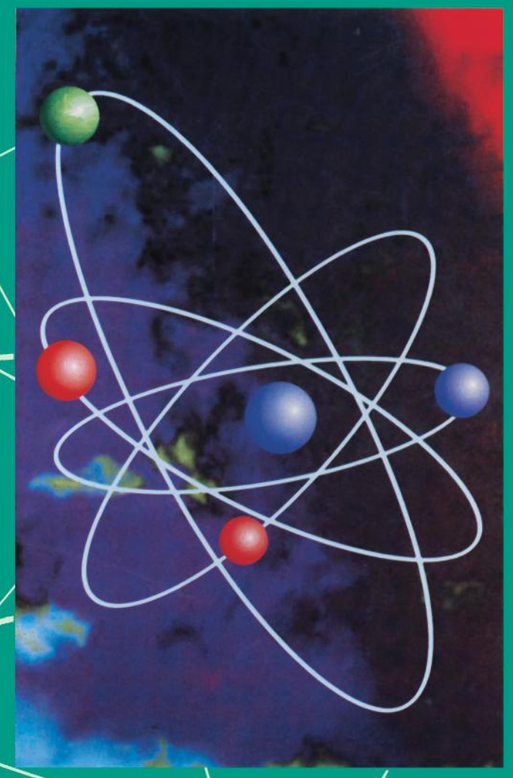
ANNUAL REPORT
2003-2004



सत्यमेव जयते

GOVERNMENT OF INDIA

ATOMIC ENERGY
REGULATORY BOARD
MUMBAI

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. Currently, the Board consists of a Chairman, four Members and a Secretary. AERB reports to the Atomic Energy Commission.

AERB is supported by the Safety Review Committee for Operating Plants (SARCOP), Safety Review Committee for Applications of Radiation (SARCAR), Advisory Committees for Project Safety Review (ACPSRs) and Advisory Committee on Nuclear Safety (ACNS). The ACPSRs recommend to AERB issuance of authorisations at different stages of projects 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 institutes, which use radiation and radioactive sources. AERB also receives advice on codes and guides and on generic issues from the Advisory Committee on Nuclear Safety (ACNS). 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 institutes, R&D organisations, industries and governmental agencies.

The AERB Safety Research Institute (SRI) at Kalpakkam organises several events/perform several activities to promote safety research. Besides carrying out research in various safety related topics, SRI holds seminars, workshops and discussion meetings of specialists.

AERB secretariat has nine divisions. The Directors/Heads of Divisions constitute the Executive Committee, which meets frequently with Chairman, AERB in the Chair and takes decisions on important policy matters related to the management of the Board secretariate. AERB enforces the following Rules issued under the Atomic Energy Act 1962:

- Radiation Protection Rules, 1971
- 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

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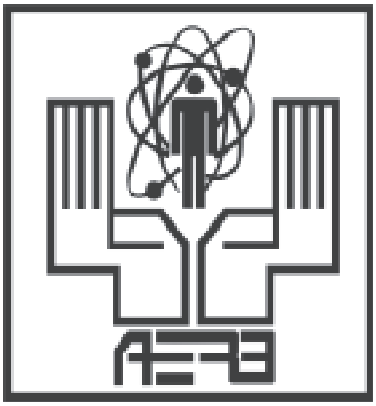

GOVERNMENT OF INDIA

ATOMIC ENERGY REGULATORY BOARD

NIYAMAK BHAVAN,
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MUMBAI-400 094.
Website : www.aerb.gov.in

THE CHARTER OF THE ATOMIC ENERGY REGULATORY BOARD

The Government of India set up the Atomic Energy Regulatory Board in 1983 by exercising the powers vested in it by the Atomic Energy Act, 1962.

The Board's responsibility is to enforce the regulatory and safety functions envisaged under the relevant Sections of the Atomic Energy Act. These functions include:

- Carrying out safety reviews of nuclear projects and radiation facilities under design, construction and operation;
- Issuing authorisations for construction, commissioning and operation of nuclear power plants and radiation installations;
- Ensuring compliance by radiation installations with the stipulated safety requirements;
- Organising and conducting regulatory inspections of DAE units and radiation installations and enforcing corrective actions;
- Assessment of radiological safety status with regard to personnel exposures and environmental radioactive releases in nuclear and radiation facilities;
- Administering the provisions of the Factories Act, 1948 in the Units of the Department of Atomic Energy;
- Reviewing the emergency preparedness plans prepared by nuclear installations; and participating in emergency preparedness drills as observers;
- Developing safety documents essential for carrying out regulatory and safety functions;
- Promoting safety research and training activities, as related to the regulatory functions of the Board;
- Keeping the general public informed of major issues of radiological safety significance.

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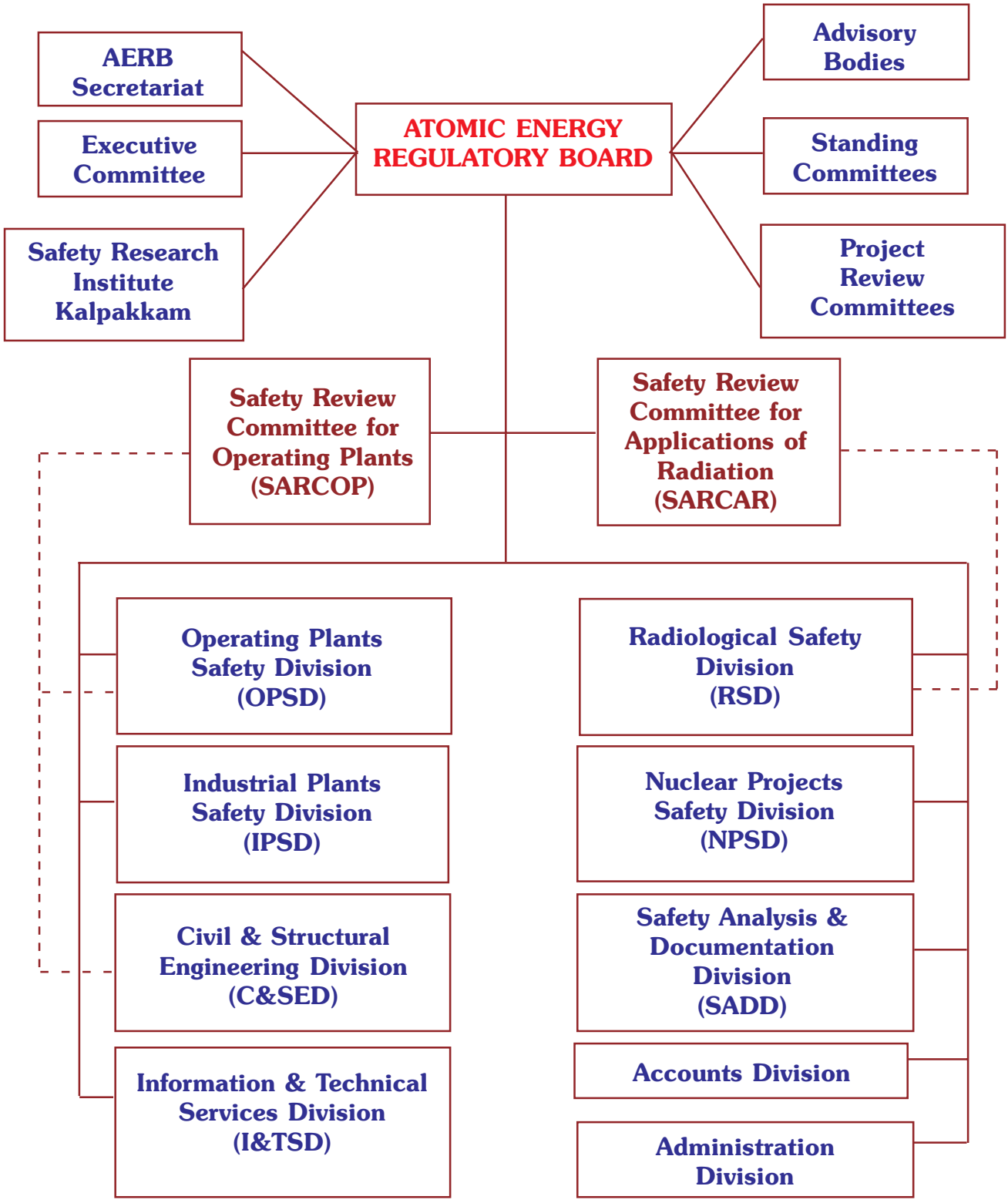
CHAPTER 1 - GENERAL

1.1 COMPOSITION OF THE BOARD

1.	Prof. S. P. Sukhatme	...	Chairman
2.	Shri. S.K. Sharma Vice Chairman, AERB Chairman, Safety Review Committee for Operating Plants (SARCOP)	...	Ex-officio Member
3.	Dr. M.V.S. Valiathan, Honorary Advisor, Manipal Academy of Higher Education, Madhav Nagar, Manipal	...	Member
4.	Dr. K.V. Raghavan, Chairman, Recruitment & Assessment Centre, Defence Research & Development Organisation, Ministry of Defence, Lucknow Road, Timarpur, Delhi-110 054.	...	Member
5.	Prof. J.B. Joshi, Professor and Director, University Institute of Chemical Technology (UICT) University of Mumbai, Mumbai	...	Member
6.	Dr. K.S. Parthasarathy Director, Information and Technical Services Division, AERB (Upto 31-01-2004)	...	Secretary
7.	Shri D.K. Dave (From 1st February 2004 onwards)	...	Secretary

1.2 ORGANISATION CHART OF AERB



1.3 SUMMARY

A wide variety of nuclear and radiation facilities in operation in India come under the regulatory purview of AERB. The nuclear facilities include 14 operating nuclear power plants and a fast breeder test reactor, a nuclear fuel fabrication facility, uranium mines and mills and facilities extracting thorium ore for the next stage of the country's 3-stage nuclear power programme. Nine nuclear power plants are presently under construction at five different project sites. There are over 3200 radiation facilities handling radiation sources for medical, industrial and research purposes, and over 30,000 diagnostic X-ray facilities in India. AERB carried out its charter of activities during the year with the support of the secretariat and specialist committees and under the guidance of the Board, which met four times during the year.

Safety Review of Nuclear Power Projects

Nine nuclear power units of diverse designs and varying capacities are at present under construction. Four of these units; Kaiga Generating Station (KGS) units 3 &4 and Rajasthan Atomic Power Project (RAPP) units 5&6 are 220 MWe Pressurised Heavy Water Reactors (PHWRs) essentially similar to the existing 220 MWe PHWRs. Tarapur Atomic Power Project (TAPP) units 3&4 are PHWRs of 540 MWe each whose design has been developed indigenously. The Kudankulam Nuclear Power Project (KK-NPP) units 1&2 are light water reactors of 1000 MWe each. These are designed and supplied by the Russian Federation. The Prototype Fast Breeder Reactor (PFBR) project at Kalpakkam is of 500 MWe capacity. The design and development has been done by the Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam. The excavation work at PFBR was started during this year by Bhartiya Nabhikiya Vidyut Nigam Ltd. All these projects are being reviewed by AERB using the established multi-tier review process.

The extent of review generally depends upon whether the project is of "Repeat Design" like KGS 3&4 and RAPP 5&6, "Evolved Design" like TAPP 3&4 or "New Design" like KK-NPP and PFBR. Based on the outcome of the review, the various clearances for different stages/sub-stages of construction of the projects were given. During the year, AERB issued clearances for Erection of Major Equipment for KGS Units 3&4 on August 8, 2003 and RAPP Unit-5 on March 15, 2004. For KK-NPP Units 1&2, clearances for construction of +5.4 m elevation slab of hermetic portion of the Reactor Building and for construction beyond +5.4 m elevation and up to +17.0 m elevation of Reactor Building were granted on April 23, 2003, and November 4, 2003 respectively. AERB issued site excavation clearance for PFBR on July 13, 2002, with a validity period of one year. This was subsequently extended up to June 30, 2004.

During the year, AERB Inspection Teams carried out a total of 11 regulatory inspections at the above-mentioned 5 projects/sites. In addition, inspections dealing specifically with civil engineering safety aspects and industrial safety were also carried out.

AERB reviewed the Preliminary Safety Analysis Report of the Kudankulam Nuclear Power Project. Among others, special emphasis was made on the report pertaining to "Design, Development of Structures, Components, Equipment and

Systems". An indepth review of the prestressing system was undertaken as unbonded strands are proposed for the first time in the containment structure of a nuclear power plant.

Safety Review of Operating Nuclear Power Plants

All the nuclear power plants and research reactors operated safely during the year. AERB reviewed a number of applications from the utilities and issued authorization/ clearances. Important among these were :

- Renewal of authorization for operation of TAPS 1&2.
- Permission for restart and operation of RAPS Unit-1 after safety upgradation.
- Permission for restart and operation of MAPS Unit-2 after En-masse Coolant Channel Replacement and safety upgradation.
- Periodic Safety Review and Renewal of Authorization for operation of NAPS units.
- Authorization for reprocessing irradiated FBTR fuel pins in the newly established Lead Mini Cell facility at IGCAR.
- Authorization for civil construction of Augmentation Of Cobalt Handling Facility (ACHF) at RAPPCOF.

Reduction of collective radiation exposure of workers in the Nuclear Power Plant (NPP) has been one of the important issues pursued by AERB. In the past decade, significant reduction / downtrend in the collective radiation exposure at the NPPs was achieved through systematic efforts by the NPPs and AERB. In order to maintain focus on this front and further bring down the collective exposures, AERB organized a Discussion Meeting in December 2003 where over 80 professionals participated. Based on the deliberations in the meeting, action plans for improvements to be implemented by various agencies and their schedules are being finalised.

A detailed safety review of the Tarapur Atomic Power Station (TAPS) units 1&2 was initiated by AERB after these units completed 30 years of operation in the year 2000. This exhaustive review was completed and the action plans for carrying out the required modifications, refurbishment and safety upgradations of these units were finalised together with time schedule for their implementation. Accordingly the Board decided to renew the authorization to operate TAPS units till June 30, 2005. The units will then be shutdown for a period of about six months for implementing the identified safety upgradations and modifications.

A number of safety related upgradations were carried out in Unit-1 of Rajasthan Atomic Power Station (RAPS). After extensive review of the safety upgradations and results of inspection of various systems, structures and components of the plant, AERB granted permission for restart of the unit in January 2004. The unit is currently operational up to a power level of 100 MWe.

Following the AERB directive, Madras Atomic Power Station (MAPS) unit 1 was shutdown on August 20, 2003 for en-masse replacement of coolant channels. During

this outage, a number of safety related upgradations will also be incorporated in this unit, similar to those implemented earlier in MAPS unit 2. MAPS unit 2 had remained shutdown from January 9, 2002 to July 23, 2003, for en-masse replacement of coolant channels. A number of safety related upgradation jobs were also carried out in MAPS Unit-2 in this shut down. After extensive review of all aspects relating to coolant channel replacement, safety upgradations, quality assurance aspects and compliance with all the regulatory requirements/stipulations, AERB permitted restart of MAPS unit-2.

AERB has been concerned about the safety status of Narora Atomic Power Station (NAPS). The main concerns have been (a) higher occupational radiation exposures at the station, (b) past incidents of violation of radiation safety procedures resulting in a significant number of contract workers receiving radiation exposures in excess of regulatory limits, (c) poor condition of access roads to the plant, which could delay the process of evacuation in case of an emergency and (d) inadequate fencing of the 'exclusion zone' around the plant. In view of this, AERB decided to put NAPS under a 'Special Watch' from August 2003. As per this program, AERB took up more frequent regulatory inspections of the plant to monitor progress on these identified issues. AERB directed NPCIL and NAPS to take appropriate actions both at the managerial as well as the technical level to address the concerns expressed by AERB. Three inspections of NAPS were conducted in September, October and November 2003. These inspections indicate that NAPS has made significant improvements in the area of radiation protection and collective dose reduction. NAPS is also interacting with Uttar Pradesh state authorities for taking required actions to improve the condition of access roads. Exclusion fencing has also been improved.

Both units of Kakrapar Atomic Power Station (KAPS) operated normally up to a power level of 220 MWe. KAPS unit 1 had an annual shut down from September 1, 2003 to October 7, 2003. Both units of Kaiga Generating Station and RAPS units 3&4 were operational upto a power level of 220 MWe. Fast Breeder Test Reactor (FBTR) was operational up to a power level of 15 MWth. The reactor has remained shutdown since December 23, 2003 for replacement of certain equipment and overhauling of turbine generator. The peak burn-up for FBTR fuel reached a level of 123330 MWd/t (Megawatt-day per tonne) without any fuel failures. KAMINI reactor was operated to carry out Radiation Physics experiments and neutron radiography of irradiated fuel.

During the calendar year 2003, a total of 19 inspections were undertaken in the operating NPPs and research reactors. Of these, 15 were routine inspections and 4 were special inspections.

A team of civil engineers from AERB inspected the ash pond at Heavy Water Plant, Manuguru where a portion of bund was breached and ash slurry was discharged from the pond. The detailed investigations on ash pond bund breach are recommended.

Safety Surveillance of Radiation Facilities

On the basis of safety analysis of the performance standards of devices incorporating radioactive materials and radiation generating equipment, AERB issued 336 pre-

marketing type approval certificates. AERB accorded approval in respect of the nomination of 245 Radiological Safety Officers at these facilities. Design approval and renewal of approval certificates were issued in respect of 5 packages. A total of over 2000 licenses were issued for a variety of radiation sources such as for operating diagnostic X-ray units and handling sources used in nuclear medicine, nucleonic gauges, industrial radiography, brachytherapy and teletherapy. Of these 1358 related to import of radioactive materials.

On the strength of data collected by AERB about diagnostic X-ray units and regulatory inspections conducted therein, AERB started issuing licences in the form of registration for operating diagnostic X-ray units in India. Announcements made through the press urging X-ray clinics/hospitals to obtain registration certificate from AERB have been effective. Many clinics approached AERB and were brought under the regulatory system.

Over 540 regulatory inspections of radiation facilities all over the country were conducted. Unsafe practices were observed during inspections in 13 institutions and necessary enforcement actions were taken. A request for assistance for the safe disposal of old radium sources was received from Kolkata. The sources were collected and brought to Mumbai for safe disposal in BARC.

Industrial Safety

Regulatory inspections on fire and industrial safety were carried out in Kaiga Atomic Power Project 3 & 4, Kudankulam Atomic Power Project and Tarapur Atomic Power Project and also in the operating nuclear power stations at Tarapur, Rawatbhata, Kalpakkam, Narora, Kakrapar and Kaiga, in the research reactors in Kalpakkam, the Heavy Water Plants, the Nuclear Fuel Complex and the Accelerator facilities in VECC, Kolkata and in CAT, Indore, Uranium Corporation of India Ltd., Indian Rare Earths ltd., Electronics Corporation of India Ltd. and Board of Radiation and Isotope Technology. Permission for resumption of work in the Wet section of the New Uranium Ore Oxide Fuel Plant at the Nuclear Fuel Complex, Secunderabad was accorded. Safety review of Heavy Water Plants and Indian Rare Earth Plants and Uranium Corporation of India Ltd., was carried out. Radon dosimeters were issued to all mine workers at the Jaduguda and Bhatin mines.

There have been nine fatalities during the year due to industrial accidents. To prevent / minimise such accidents in future, AERB appointed Fatal Accident Committee investigated the root cause of these accidents and suggested remedial measures to the site.

Safety Documents

Five safety documents were published by AERB relating to a range of topics such as In-Service Inspection of Nuclear Power Plants, Personnel Protective Equipment and the Management of Radioactive Waste arising from NPPs and 17 documents are under preparation on various topics.

CHAPTER 2
SAFETY SURVEILLANCE OF NUCLEAR FACILITIES

2.1 NUCLEAR POWER PROJECTS

2.1.1 Project Safety Review

Presently, a total of 9 nuclear power plants are under construction in India. These include: 4 units each of 220 MWe capacity and 2 units each of 540 MWe capacity Pressurized Heavy Water Reactors; 2 units each of 1000 MWe capacity Pressurized Water Reactors of Russian design and an indigenously designed liquid sodium cooled Prototype Fast Breeder Reactor of 500 MWe capacity. Utilizing the experience gained during regulatory review of earlier projects, AERB has evolved in recent years technical and administrative mechanisms to carry out systematic review of the projects and to issue related clearances at different stages/sub-stages of the projects. AERB draws upon the expertise from research centres and academic institutes and experience of the experts in the field who have retired from various organizations in the country to meet the new challenges encountered in the safety review process, especially for the projects based on either 'Evolved Design' or 'New Design'.

AERB continued the practice of multi-tier review mechanism for safety review of on-going nuclear power projects. The Project Design Safety Committee (PDSC), Civil Engineering Safety Committee (CESC) and associated specialist/working groups, carry out the first tier of review. The corresponding Advisory Committee for Project Safety Review (ACPSR), which includes specialist members from the Ministry of Environment and Forests, Boilers Board, Central Electricity Authority and educational/research institutes perform the second-tier review. The third-tier review is by the Atomic Energy Regulatory Board, which reviews the safety status of projects at major consenting stages. AERB issues clearances for various projects at different stages taking into consideration the observations and recommendations of PDSC, CESC and ACPSR. The process of safety review is supplemented by safety audit, which is carried out through regulatory inspections, for verifying compliance by the utilities with the requirements prescribed by safety committees and those prescribed in various codes, guides and standards of AERB.

In addition, many meetings of Co-ordination Groups, Specialists Groups, Task Force and Working Groups constituted by PDSC/CESC/ACPSR/AERB were held to review specific aspects of the projects. The number of project committee meetings held during the year is given in Table 1.

Table 1: Number of Project Committee Meetings

Project Committee	Number of Meetings
ACPSR-LWR	11
ACPSR-PHWR/PFBR	2
PDSC-KGS-3&4 and RAPP-5&6	12
PDSC-TAPP-3&4	50
PDSC-PFBR	6
CESC- KGS-3&4, TAPP-3&4, RAPP-5&6 & PFBR	9

Tarapur Atomic Power Project-3&4

The Tarapur Atomic Power Project units 3&4 are two Pressurised Heavy Water Reactors each of 540 MWe capacity, the design of which has been basically evolved from the 220 MWe capacity PHWRs being operated in India. During the year, the review of the project continued, based on the documents, namely: Design Basis Reports (DBRs), Preliminary Safety Analysis Reports (PSARs), design notes and responses on the observations/comments made during the review process. Reports on evaluation of ultimate load bearing capacity of containment structure of TAPP-3, were reviewed in-detail. Some of the important issues, which emanated during the review, are as follows.

- Confirmation of the adequacy of shielding provisions for all the direct penetrations emanating from the fuelling machine vaults and calandria vault.
- The shut-off rods are withdrawn under supervision of Reactor Regulating System (RRS). RRS is used for halting withdrawal of shut-off rods under conditions especially during testing. Interference of RRS with Reactor Protection System (RPS) is not normally acceptable. This aspect is under review.
- Effect on reactivity insertion rate considering failure of any of the three vent valves provided on the lines connecting the helium tank and liquid poison tanks of Shut Down System #2 (SDS#2) is under assessment.

TAPP 3&4 under Construction

- Results of various experiments being done in operating reactors KGS-1&2 and RAPS-3&4, to study the linear behaviour of Cobalt based Self Powered Neutron Detectors (SPNDs) for use in RPS would be reviewed in detail to ensure that these are in line with the design intent.

- Trip on ratio of Actual Power to Demand Power (AP/DP) as existing in 220 MWe PHWRs has been removed. Below 15 % Full Power (FP), SPNDs signals are not in the control range. In case of slow positive reactivity insertion rate, reactor trip on 'Rate Log-N' may not actuate and over-power protection would only be available at 110 % FP (SDS#1) and 130 % FP (SDS#2) on SPNDs. In view of this, requirement of a reactor trip at lower powers by SDS#1 for such situations is under review.

- Single common pressurized helium gas tank is provided to operate all the 6 poison injection circuits of SDS#2 instead of individual helium gas tank for each circuit. This design feature is under evaluation.

- Two diesel driven firewater pumps are provided vis-à-vis three such pumps in 220 MWe PHWRs. This aspect is under review.

PDSC-Members visiting TAPP 3&4 Project Site

KGS-3&4 and RAPP-5&6

Kaiga Generating Station, Units 3&4 and Rajasthan Atomic Power Project Units 5&6 are 'Repeat Design' of KGS 1&2 and RAPS 3&4 respectively with some differences. The regulatory review process was mainly focussed on design differences, feedback from operating plants of similar design and Preliminary Safety Analysis Report (PSAR) of these projects.

Review of PSAR Volume 1 (Design Description) for KGS-3&4 and RAPP-5&6 has been completed and the review of PSAR Volume 2 (Accident Analysis) is in progress. Review of certain important design basis reports and design manuals, especially for those systems, which are different from the earlier built plants has been initiated. The documents related to siting of the plants, design basis ground motion parameters, geotechnical investigations and foundation parameters, design basis reports of safety related buildings/structures, reports on analysis and design of safety related buildings/structures, and reports on construction aspects were also reviewed. Some of the major observations/recommendations are as follows:

- The designers have implemented the recommendation to improve the shielding effectiveness of the 137 cm thick North/South concrete walls of Fuelling Machine Vaults, to bring down the dose rate in adjoining accessible areas to the expected levels of 1 to 2 mR/h by using the concrete of 3.0 g/cc instead of 2.3g/cc used in earlier built plants.

- Permanent shielding arrangement would be made around the spent fuel transfer duct to prevent the increase in radiation field in the Main Air Lock barrel to more than 1 mR/h during transfer of spent fuel bundles from reactor building to the storage building.

- An analysis would be carried out to show that in the unlikely event of simultaneous failure of Calandria Tube (CT) and Pressure Tube (PT), performance of not more than one (nearest) Primary Shutdown System (PSS) rod would be affected.

- Local Control Panels (LCPs) of supplementary control room and Main Control Room (MCR) are located in the Control Building as per existing design. In case of fire in MCR, smoke might reach up to the LCPs. In such a situation, it may not be possible for the operator to access the LCPs and operate the equipment from

End shield installed in Calandria Vault of KGS 3

LCPs as per the design intent. AERB recommended relocating the supplementary LCPs away from MCR.

- The designers have planned to carry out seismic qualification of Primary Shutdown System rod on a shake table.
- All the 3 main air compressors of each unit would be provided with emergency power supply with a suitable control logic to prohibit operation of more than 2 compressors of a unit under 2 diesel generator operating condition.
- The designers are carrying out analysis and have planned experiments (Steam leak rates for main steam lines vis-à-vis crack size) towards applying Leak Before Break (LBB) criteria to high-energy pipelines.
- Feasibility of design modifications/improvements is being explored for prevention of excessive pressurization of secondary containment through the failed pressure equalization valve across the middle door of the airlock during loss of coolant accident. Also, an appropriate surveillance requirement for the pressure equalization valve would be incorporated considering its safety significance.

PDSC-members visiting RAPP 5&6 project site

- Operating experience feedback has revealed recurrent violation of Technical Specifications regarding maintenance of minimum water level in common Small Leak Handling System (SLHS) tank because of D_2O transfer to PHT. System (to make-up for shrinkage) during cool down of any one unit. The design of the system in new projects is being examined.
- It was observed that sizing of Calandria Vault (CV) vent lines is not adequate to limit the pressure within design limits for the postulated event of breakage in moderator line as mentioned in PSAR. In view of this, it was recommended that all parameters, which may lead to development of leakage in the moderator pipeline, should be ensured to be within limits during commissioning phase. Suitable measures to ensure healthiness of these moderator lines located inside the CV, during operational phase of the plants, are to be instituted. PSAR would be revised to exclude the postulation of double-ended break of moderator line.
- Based on the operating experience of PHWRs and recommendations of the safety committees, the design of decontamination facility for radioactive equipment has been upgraded to handle equipment with surface dose rate up to 5 R/h (The decontamination facility is designed for 1 R/h surface dose rate in the earlier built plants).
- Emergency preparedness plan should be prepared to ensure that the construction personnel including contractors' workers are protected in case of any emergency arising in the nearby operating NPPs or H_2S based Heavy Water Plant.

Kudankulam Project (KK NPP)

The construction and safety review of Kudankulam project consisting of two nuclear power reactors (VVERs of Russian design), each of 1000 MWe capacity, is progressing satisfactorily. KK Co-ordination Group (KK-CG) along with the Specialist Groups (SGs) carries out the first level of review of PSARs. The ACPSR-LWR carries out the second level of review of PSAR along with the combined review reports of CG & SGs.

Based on the recommendations of ACPSR-LWR, AERB granted Clearance for casting of +5.4 m Floor Slab

of hermetic portion of reactor building during April 2003 and subsequently granted clearance for construction beyond +5.4 m elevation upto +17.0 m elevation on November 4, 2003.

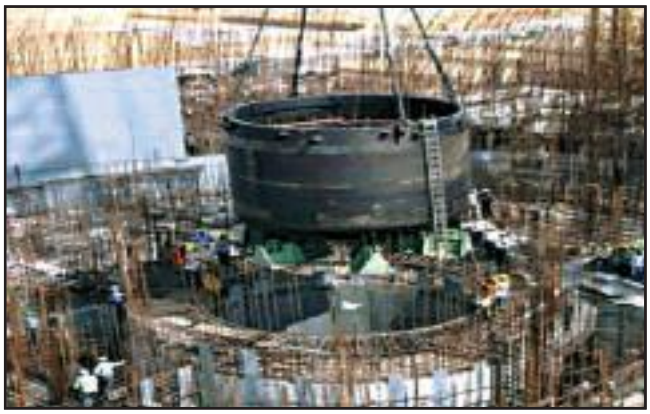
Site had requested permission for continuation of the surface mining of limestone within the property wall at about ~ 2 km radius beyond the earlier stipulated period by AERB, so that the natural resources can be gainfully utilized and trees can be planted. Based on the review, AERB has extended the permission for continuation of mining activity up to September 30, 2004.

Specific clearance for installation of core-catcher vessel was issued by AERB after a thorough review, as this is the first time that core-catcher system of such a design is incorporated in any NPP. Core-catcher vessel for unit 1 has been lowered at the bottom of reactor cavity.

ACPSR-LWR visited KK-Site in September 2003 to make an appraisal of the progress of construction activities. Brief presentations were made by Design Office, Site Authorities and by Major Contractors involved with Mega Package construction about the Project activities. Discussions were also held with resident Russian officials involved in construction activities.

An AERB Team consisting of specialists on reactor, control and instrumentation and radioactive waste management visited various Russian Design Institutes and Organizations involved with KK-NPP during April 2003. Issues such as change in fuel design, solid waste storage, resin fixation, departure from nucleate boiling ratio (DNBR) algorithm, etc were discussed.

Validation and Verification reports on some of the Computer Codes used in justification of design and also for safety evaluation of the nuclear plant systems are under review.



Core Catcher Vessel Erection at Unit-1 of KK-NPP.

To obtain further clarifications on certain issues related to mathematical modelling of structures and methodology of seismic analysis, a three day special meeting was organised at Mumbai between members of Specialist Group and Russian design analysts from CKTI, VIBROSEISM involved with seismic analysis modeling of civil structures. The issues were sorted out on the basis of additional studies carried out for substantiation of the adequacy of modelling and analysis procedures.

Construction Activities in Progress at + 5.4 m slab of RB of Unit-1 of KK-NNP.

AERB reviewed design check reports for reactor buildings, adequacy of time history for seismic ground motion used as input for seismic analysis of structures as part of follow-up of the implementation of recommendations made on the basis of inter-comparison of the KK-NPP design of civil structures by Russian and AERB safety standards and reviewed the proposed prestressing system of the containment.

Some of the salient observations/ recommendations made by Safety Committees are as follows:

- The containment liner design calls for precise construction. AERB experts reviewed the design and construction aspects in detail and mock-up test was conducted at site to establish construction methodology.
- Pre-stressing system proposed for KK-NPP uses grease coated un-bonded strands encased in HDPE sheath unlike the normal bonded strands used in Indian PHWRs. Since the un-bonded strands are proposed to be used for the first time in the construction of

containment structure of NPP, an in-depth review of the system was carried out. This review brought out various safety concerns which are to be resolved. AERB has recommended that mock-up tests are to be conducted to check certain design and installation aspects and all safety issues are to be resolved satisfactorily prior to its installation. The review of the qualification of anchorage system, cable ducts/sheaths and grout was satisfactorily completed.

- LBB criterion is applied to the main circuit of primary coolant system. Based on the review, AERB has asked for (a) information on operational experience of plants in Russian Federation to confirm that there is no significant water hammer loading, (b) demonstration of performance of the leakage monitoring systems envisaged for the adoption of LBB approach, (c) assessment of potential indirect sources of pipe rupture (e.g., failure of snubbers) and (d) confirming the adequacy of mixing of high and low temperature fluids to avoid thermal stresses on piping runs.
- Core Catcher (CC) is the first of its kind engineered safety system being incorporated in an Indian NPP to retain the core melt, in case such a low probability event occurs. Permission for installation CC vessel was granted after the detailed review.
- The proposed design for providing intermediate storage for solid waste is under review in light of the policy adopted for the existing NPPs, which have Near Surface Disposal Facility.

Prototype Fast Breeder Reactor (PFBR)

Bharatiya Nabhikiya Vidyut Nigam Ltd (BHAVINI) is building the Prototype Fast Breeder Reactor (PFBR), which has been designed by IGCAR. Project Design Safety Committee (PDSC-PFBR), Civil Engineer Safety Committee (CESC-PFBR) and the associated Specialist Groups are conducting the First-tier Review.

Chairman & Vice-Chairman visit PFBR Site

After reviewing the application, AERB had granted extension of site excavation clearance up to June 30, 2004. After this, site excavation for nuclear island was commenced and is nearing completion.

AERB reviewed documents related to design basis ground motion parameters, geological and geotechnical investigation reports, rock blasting schemes for excavation and plant layout reports. Detailed review of the design reports for civil structures of PFBR is currently in progress. During the review of PSAR and relevant Design Notes, following recommendations/observations were made.

- The physical separation aspects for various safety related instrumentation channels and electrical cables considering common cause failure such as fire are to be addressed.
- Potential missiles and their consideration in layout/ design are to be addressed.
- Justification for use of Site Assembly Shop (SAS) as an active workshop/area along with the relevant zoning and access control aspects would be reviewed. Various other provisions to be made for using SAS as maintenance building are to be indicated during the design stage itself.
- Layout aspects to facilitate decommissioning of the plant are to be addressed at the design stage.
- The layout of hydrogen charging station, turbine oil tank and main oil tank needs to be finalised taking into consideration of NAPS fire committee recommendations.
- Safety provision to avoid excessive pressurisation of the container for storage of failed fuel is under detailed review.
- The dose rates in various accessible areas of RCB including main and back-up control room under core disruptive accident condition are under assessment to ensure these areas remain habitable under accident conditions.
- Control Room (CR) ventilation design is being modified to meet the requirements of CR habitability under accident conditions. Dose to control room personnel due to inhalation route is also to be calculated and presented.

- Present scheme for liquid effluent management calls for transfer of effluent through a long length of pipeline. Design is being modified to eliminate the long pipelines and it is proposed to dilute and discharge certain categories of liquid effluents from the plant site itself.

2.1.2 Clearances Issued to Nuclear Power Projects

The clearances issued to the projects are summarized here.

1. Clearance for Casting of +5.4 m Elevation Floor Slab for the Reactor Buildings of KK NPP (April 2003).
2. Clearance for Construction from +5.4 m elevation for the Reactor Buildings and Erection of Core Catcher Vessel of KK NPP (November, 2003).
3. Permission for Continuation of Surface Mining Activity for continuation of surface mining activity at Kudankulam by M/s India Cements Limited (ICL) up to September 30, 2004 (November 2003).
4. Clearance for Erection of Major Equipment for KGS Units – 3&4 (August 2003).
5. Clearance for Equipment Erection for the Rajasthan Atomic Power Project Unit 5 (March, 2004).
6. Extension of Excavation Clearance for PFBR up to June 30, 2004 (August 2003).

Lifting of Suspension on Design Safety Review of RAPP- 5&6

The suspension which was in effect since March 2003 for violation of procedure with respect to start of first pour of concrete was lifted on July 7, 2003.

2.1.3 Regulatory Inspections

Regulatory Inspections (RI) of the nuclear power projects were carried out as a safety audit measure to ensure compliance with the AERB stipulations specified in the relevant clearances/consents and compliance with the design requirements (Table 2). During the inspections, aspects mainly related to organization and project management, equipment erection and preservation, access control, radiation zoning, status of compliance to AERB recommendations, QA, commissioning, industrial safety etc., are covered depending upon the status of the project. In addition, AERB conducted eleven site inspections at various stages of construction of TAPP 3&4, KGS 3&4, RAPP 5&6, PFBR and KK-NPP to review exclusively the civil engineering and construction aspects.

Table 2: Regulatory Inspections of Nuclear Power Projects

Site	No. of Inspections
Tarapur Atomic Power Project- Units 3&4	3
Kudankulam Nuclear Power Project- Units 1&2	2
Kaiga Generating Station – Units 3&4	3
Rajasthan Atomic Power Project – Unit 5&6.	2
Prototype Fast Breeder Reactor	1

Some of the important observations and recommendations made by inspection team are given below for each project.

TAPP - 3&4

- Equipment history documents need to be transferred from NPCIL-HQ in compliance with site Norm T-3&4-N-13.
- The process of acquisition of land and fencing at exclusive boundary needs to be completed prior to first approach to criticality in TAPP-4.
- Some of SPNDs, which were received in the early 90s and stored in 'Trombay-Stores' have shown deterioration in a decade long storage itself. Functional checks needs to be carried out to ascertain their present healthiness prior to installation in the core.
- Adequacy of shielding for Delayed Neutron (DN) monitoring room needs to be reassessed considering the location of penetration for ventilation ducts.
- Control signal-grounding (clean grounding) scheme needs to be finalised and implemented.

KK - NPP

- The types of non-compliance reports to be reported to AERB, need to be brought out clearly in the Site QA Manual.
- For fabrication of containment steel liner, the welding methods specified are as per Russian Normative Technical Documents. But, welding qualification is carried out as per ASME Section IX requirements. Permission for the change needs to

be obtained from Russian designers.

- Core catcher vessel was transported from Russian Federation with large quantities of grease coated over its surfaces for preservation during transportation. The vessel is to be inspected for any abnormal finding after degreasing. Procedures for measures of post-installation preservation for vessel are to be made and adhered to.

- Storage and preservation measures for the components of containment pre-stressing system need augmentation.

KGS- 3&4

- It was observed at Kaiga-3 that the gap between the Calandria Vault (CV) liner plates for the certain weld joints were varying between 14 and 28 mm, as against the expected maximum value of 8 mm. The gap was filled up using strip-inserts having variable width from 5 to 8 mm. The deviations from design had occurred because of lapse on the part of Shop Floor crew of the contractor. This deviation was found acceptable after review. Necessary precautions have been taken so that such problems are not encountered in Kaiga-4.

RAPP - 5&6

- The locations of Induced Draft Cooling Towers were altered during the design stage as per the recommendations of the safety committee, as they were falling in the Low Trajectory Turbine Missile Zone (LTTMZ) of RAPP-3&4.

- It was observed from detailed drawings of site layout that a small corner of each Diesel Generator Building (DGB), measuring 1.8 m horizontal & 3.9 m vertical plan distances, falls under LTTMZ strike zone of other Unit (i.e., DGB-5 corner falls under LTTMZ of RAPP-6 Turbine and vice-versa) by an angle of less than a degree from the stipulated requirement of 25^0; just outside 24.1098^0 to be precise. Since the energy of the LTTM will be sufficiently reduced due to the presence of 4 numbers of walls between the turbine building and the DGB, the deviation was accepted. However, aspects of availability of DG sets and analysis for the remaining part of the civil structure in case the DGB corner is damaged by LTTM, is under review.

- The details of sampling provision for collection of highly active containment air sample under accident condition were examined for RAPS -3. The sampling system proposed for RAPP-5&6 is similar to RAPS-3&4 and suggestions were made for improvement.

PFBR

- Site QA organization was noted to be under formation. It was recommended that Site QA organization needs to be established early and the Site Construction QA Manual to be submitted prior to First Pour of Concrete (FPC). This Manual should address the role and responsibilities of contractors and BHAVINI and also the interface with the designers.

- The staff in the Industrial Safety Section needs to be augmented considering the future construction activity in line with the AERB directives in this regard.

- The basic scheme for discharge of liquid effluents from plant is to be finalised taking into consideration the regulatory requirements.

- The PFBR complex layout plan does not indicate the location for the 7 days emergency water reservoir for make-up purposes and the scheme for transfer of water from reservoir to the reactor systems.

- The Kalpakkam Emergency Preparedness Manual is to be suitably modified taking into consideration of upcoming PFBR project.

2.1.4 Industrial Safety

Regulatory inspections on fire and industrial safety aspects were carried out in Kaiga Atomic Power Project 3&4, Kudankulam Atomic Power Project and Tarapur Atomic Power Project 3-4. In each case, a detailed inspection report was sent to the concerned unit with the major shortcomings highlighted. The major recommendations made are the following.

a) Appointment of Head, Industrial Safety.

b) Improvement in frequency of sectional level Safety Committee Meetings.

c) Testing of lifting tools and tackles.

d) Availability of job Hazard Analysis Reports.

e) Standing fire order.

f) Laying down of fire hydrant line.

2.2. NUCLEAR POWER PLANTS AND RESEARCH REACTORS

Safety review and monitoring of operating Nuclear Power Plants (NPP) and Research Reactors (RR) is carried out. The Safety Review Committee for Operating Plants (SARCOP), the apex committee for overseeing safety of operating plants, held 24 meetings during the calendar year 2003. SARCOP also visited the Nuclear Fuel Complex, Hyderabad in August 2003, for on site assessment of the safety status of the complex. The Unit safety committees established under SARCOP met number of times to review safety related issues. The information on number of meetings conducted by various unit safety committees during 2003 is given in Table 3.

Table 3: Meetings of Safety Committees

Name of Safety Committee	Number of Meetings
SARCOP	24
TAPS Safety Committee	7
RAPS-MAPS Safety Committee	20
NAPS-KAPS Safety Committee	15
KGS-RAPS 3&4 Safety Committee	10
IGCAR Safety Committee	7
CESCOP	10
SCRP	8
SCCI	6
Expert Committee on Coolant Channel Replacement	9

2.2.1 Authorizations and Restrictions

During the year, SARCOP/AERB reviewed a number of applications from the utilities and issued authorization/clearances. Important among these are:

a) Renewal of authorization for operation of TAPS 1&2

b) Permission for restart and operation of RAPS Unit-1 after safety upgradation

c) Permission for restart and operation of MAPS Unit-2 after En-masse Coolant Channel Replacement and safety upgradation.

d) Periodic Safety Review and Renewal of Authorization for operation of NAPS units.

e) Authorization for reprocessing irradiated FBTR fuel pins in Lead Mini Cell facility at IGCAR.

f) Authorization for civil construction of Augmentation of Cobalt Handling Facility (ACHF) at RAPPCOF.

Based on safety reviews, SARCOP stipulated restriction on operation of plants as follows:

a) Stipulation for shutdown of MAPS Unit-1 for En-Masse Coolant Channel Replacement (EMCCR) and safety upgradations based on coolant channel health assessment.

b) Putting NAPS units under special watch of AERB due to deficiencies in safety culture.

Safety status of individual NPPs and research reactors is briefly described below:

2.2.2 Discussion Meeting on Collective Dose in NPPs

Reducing collective dose consumption in the NPPs has been one of the important issues pursued by AERB. In the past decade, significant reduction / downtrend in the collective dose consumption at the NPPs was achieved through systematic efforts by the NPPs and AERB. In order to maintain focus on this front, AERB organized a discussion meeting on December 23, 2003. Over 80 professionals from NPCIL Headquarters & NPPs, Health Physics Division, BARC and AERB attended the meeting. Various issues related to collective dose including measures to be implemented during design, construction, commissioning and operation stages of the NPPs were discussed. Based on the deliberations in the meeting, action plans for implementation of necessary improvements by various agencies and their schedules are being finalised.

2.2.3 Tarapur Atomic Power Station (TAPS)

TAPS Units were operational up to a power level of 160 MWe. TAPS unit – 1 was shutdown for refuelling and in-service inspection from March 23, 2003 to April 12, 2003. This was the shortest refuelling outage (20 days) achieved in the history of TAPS. TAPS Unit-2 remained shutdown for 26 days for refuelling and in-service inspection from November 10, 2003 to December 6, 2003.

Continued Long Term Operation of TAPS units

TAPS units 1&2, the boiling water reactor based nuclear power plants were commissioned in the year 1969. In May 2000, AERB directed NPCIL to carry out a comprehensive assessment of safety for long-term operation

of TAPS units. The areas of review identified were the following.

a) Design basis and safety analysis.

b) Probabilistic safety analysis.

c) Operational performance and ageing management.

d) Seismic re-evaluation.

Expert task groups specially appointed by NPCIL and AERB, between the years 2000 and 2003, carried out these reviews. The reviews were based on the guidelines/ approach outlined in AERB safety guide on renewal of authorisation for operation for NPPs (AERB/SG/O-12), the USNRC standard review plan for review of safety analysis reports for NPPs (NUREG-800), NPCIL headquarters instruction on 'Ageing Management of NPP components, systems and structures important to safety' and IAEA INSAG-8 document on 'common basis for judging safety of NPPs built to earlier standards'. The reviews took into account the actual condition of the plant vis-à-vis present day safety requirements.

The highlights of the reviews are as follows.

Review of Design Basis and Safety Analysis

During review of design basis, each system was reviewed against the applicable design criteria. The review also covered aspects such as conformance with single failure criterion, redundancy, defence-in-depth, physical and functional separation of components and vulnerability to common cause failures. Based on these reviews, safety upgradation requirements were identified. Important among these are (a) modification in the emergency power supply system for the station inclusive of new diesel generators of higher capacity and unit-wise segregation of power supplies, (b) segregation of shared systems such as shutdown cooling system and fuel pool cooling system, (c) addition of an independent set of CRD (Control Rod Drive) pumps to strengthen the emergency feed water supply to the reactor, (d) addition of a supplementary control room and (e) upgradation of fire protection system.

The existing safety analysis of TAPS was reviewed with respect to adequacy of original analytical techniques, list of events analysed and design/configuration changes that have taken place over the years. Based on this review, the safety analysis was redone using current analytical methods/ tools for the enveloping cases of Postulated Initiating Events. The revised analysis showed that the safety criteria are met with good margins. It is worth mentioning here that these reactors were originally designed for 660 MWth, but are being operated at reduced power of 530 MWth since 1984, following tube failures in the secondary steam generators.

Probabilistic Safety Assessment (PSA)

A Level-1 PSA with internal events was done for TAPS for analysing the existing design, without considering the upgradations. The analysis indicated that the core damage frequency is around 7.0E-05/reactor-year, which compares favorably with the IAEA INSAG recommended value of 1.0E-04/reactor-year.

Seismic Re-evaluation

Seismic Re-evaluation of Structures, Systems and Equipment (SSE) of TAPS was done taking into account the latest ground motion parameters derived for the site. Re-evaluation of safety systems and safety support systems was done using seismic margin assessment method, considering ductility and damping factors as given in IAEA Safety Reports Series No.20 on 'seismic re-evaluation of existing nuclear power plants'. Other systems were qualified by 'seismic walk down' by experts as per guidelines given in IAEA Safety Report Series No. 20. While most of the SSEs were found to meet the requirements, a few modifications involving strengthening of support structures will be needed.

Ageing Management and Operational Performance

An exhaustive ageing assessment and management programme has been worked out for the SSEs of the units. The programme takes into account the present status of the SSCs, the in-service inspections done in the past and additional studies/ inspections required in future in specific areas. Replacement of some of the equipment is also planned. Special attention is given to the non-replaceable components such as reactor pressure vessels, containment and other civil structures. The status of reactor pressure vessel material in these reactors is monitored with the surveillance specimen programme. Analysis of the surveillance specimens indicated that the reactor pressure vessel material had adequate fracture toughness to assure safety of the pressure vessel. Fatigue analysis of the reactor pressure vessel indicated that it had sufficient residual life. Based on these assessments, an extensive inspection programme for containment and civil structures was drawn up and this will be implemented during the forthcoming

long shutdown of both the units.

Based on regulatory review of the above, the Atomic Energy Regulatory Board, in its meeting held on May 22, 2003, decided to renew the authorization to operate TAPS units till June 30, 2005. The units will then be shutdown for a period of about six months for implementing the identified safety upgradations and modifications. AERB will permit further operation of the units only after NPCIL implements all the identified safety upgradations.

2.2.4 Rajasthan Atomic Power Station (RAPS)

RAPS unit 1 which was shutdown on April 30, 2002 following AERB directive remained shutdown till end of January 2004. During this shutdown, extensive inspections and safety upgradations were carried out. After reviewing the safety upgradations and results of inspection of various systems, structures and components of the plant, AERB granted permission for restart of the unit in January 2004. The unit is presently operational at 100 MWe. RAPS unit 2 is operational up to a power level of 200 MWe. RAPS units 3&4 operated normally during the year, up to a power level of 220 MWe. RAPS unit 3 remained shutdown from May 11, 2003 to June 1, 2003 for annual shutdown jobs.

Restart of RAPS Unit 1

As reported in the previous annual report, AERB had earlier decided that operation of RAPS unit 1, in the then prevailing state of the unit, shall be limited to 7 effective full power years or up to April 30, 2002, whichever is earlier. AERB had also stipulated that continued operation of the unit will be permitted only after (a) implementation of safety related upgradation activities, (b) ageing assessment of important systems, structures and equipment, (c) inspection, health assessment and life management of coolant channels and (d) replacement of degraded heavy water heat exchangers.

NPCIL had chalked out an action plan for implementing the same. In line with this action plan, the following safety related upgradations were carried out in RAPS unit-1 during the outage.

- Retrofitting of high pressure injection provision in Emergency Core Cooling System.
- Segregation of power and control cables for safety related loads to minimise common cause failures.
- Provision of supplementary control room.
- Installation of a third Diesel Generator to cater to emergency loads following a postulated flooding of the site.
- Incorporation of a scheme for (a) dedicated air supply to selected valves and (b) isolation of reactor building compressed air supply in the event of loss of coolant accident or Station Black Out.
- Incorporation of upgraded fire and smoke detection system.
- Retrofitting of hot pressurisation scheme for primary heat transport system.
- Provision of injecting light water directly to boilers by mobile fire fighting pumps.
- Replacement of control console of primary heat transport system relief valves using state-of-the-art electronic instruments.
- Reconditioning of junction boxes of reactor channel temperature monitoring system.
- Modification of light water dousing system for the reactor containment.
- Reactor building containment de-pressurisation system.
- Calandria vault dew point monitoring system to enhance pressure tube leak detection capability.

These upgradations were similar to the ones carried out in RAPS unit 2 earlier during 1994 –1998 and this unit has been operating satisfactorily since then. With these upgradations, RAPS unit-1 now meets most of the current safety requirements.

RAPS carried out ageing studies for Safety Related Structures, Systems and Components (SSCs) of RAPS unit 1, for establishing residual life of at least five years. The station reviewed the operating experience. Additional inspections were done on certain key SSC to confirm their health. The reviews indicated that there is no concern for operation of this reactor for a further period of 5 years, from the ageing point of view.

NPCIL carried out extensive inspection of coolant channels of RAPS unit-1 during the outage. In addition, scrape samples were collected from a large number of channels, for assessment of hydrogen content in these

channels. Repositioning of garter spring spacers was carried out on 69 channels, to extend their service life. With these steps, the coolant channels have been qualified for further service.

During the current shutdown, RAPS has replaced both the moderator heat exchangers, bleed cooler and the shutdown cooler-2, with new heat exchangers. It may be noted that tube leaks in some of these heat exchangers in the past had resulted in release of tritium activity to the nearby Ranapratap Sagar Lake. Inspections have been done on all the remaining heavy water heat exchangers for assuring their health.

After extensive review of the safety upgradations and results of inspection of various systems, structures and components of the plant, AERB granted permission for restart of the unit in January 2004. The unit is currently operational up to a power level of 100 MWe.

2.2.5 Madras Atomic Power Station (MAPS)

MAPS unit 1 was operational at 175 MWe, till August 10, 2003. The unit was shutdown on August 10, 2003, for en-masse coolant channel replacement and safety related upgradation activities. MAPS unit 2, was restarted in July 2003 after completion of en-masse coolant channel replacement and safety related upgradation activities, during the shutdown of the unit from January 9, 2002 to July 13, 2003.The unit is currently operational up to a power level of 220 MWe.

En-Masse Coolant Channel Replacement of Unit-1

As reported in the Annual Report for 2002-03, AERB had earlier permitted MAPS unit 1 operation up to 10.5 EFPY, subject to an interim reassessment at 10 EFPY. A coolant channel removed from the reactor at 9.5 EFPY was subjected to Post Irradiation Examination (PIE), for checking its hydrogen content and fracture toughness. SARCOP and AERB reviewed the health of coolant channels in MAPS unit 1 in July 2003, based on the results of PIE. After review of all the issues concerning health of coolant channels, and the uncertainties involved in life assessment beyond 10 EFPY of operation, AERB directed NPCIL to shutdown MAPS unit 1 after completing 10.1 EFPY and take up en-masse replacement of coolant channels.

Following the AERB directive, MAPS unit 1 was shutdown on August 10, 2003 for en-masse replacement of coolant channels. During this outage, a number of safety related upgradations will also be incorporated in this unit, similar to MAPS unit 2. Presently preparatory activities such as decontamination of the primary heat transport system, de-fueling of the reactor and establishment of infrastructure facilities for replacement of coolant channels are in progress.

Restart of Unit-2 after En-Masse Replacement of Coolant Channels and Safety Upgradation

As reported in the previous annual report, in this campaign, the old Zircaloy-2 coolant channels with two loose fit garter spring spacers were replaced with coolant channels made of Zirconium-2.5% Niobium alloy and four tight-fit garter springs. The new coolant channels are expected to have a much longer life span as compared to the earlier Zircaloy channels, owing to lower hydrogen pick up during operation and reduced possibility of movement of garter springs from their desired locations.

A number of safety related upgradation jobs were also carried out in MAPS unit 2 as given in detail in the Annual Report for 2002-03. Some of the important safety related modifications carried out include, Retrofitting of high pressure Emergency Core Cooling System, incorporation of Supplementary Control Room, upgradation of fire detection and fire protection system and segregation of control and power supply cables of safety related systems.

Taking advantage of this long shutdown, all the old steam generators were replaced. In addition, newly designed moderator inlet spargers were installed to restore original moderator flow configuration.

The safety analysis of MAPS unit 2 was also revised, taking into account the modifications/ upgradations carried out since initial commissioning of the unit. This was done using the latest computational tools and methodologies. The revised safety analysis was reviewed and accepted by SARCOP.

After extensive review of all aspects relating to coolant channel replacement, safety upgradations, quality assurance aspects and compliance with all the regulatory requirements/stipulations, AERB permitted restart of MAPS unit 2.

MAPS unit 2 was made critical on July 13, 2003. After completing the stipulated commissioning tests, the unit was synchronized to grid on July 23, 2003. Initially AERB had restricted the reactor power to 75 % to assess

performance of the newly installed moderator spargers. After assessing the performance and the margins available, AERB permitted operation of the unit at 100 % power, in August 2003. Presently the unit is operational up to a maximum power level of 220 MWe.

2.2.6 Narora Atomic Power Station (NAPS)

Both units of NAPS operated normally up to a power level of 220 MWe. NAPS unit 2 was under annual shut down from April 19, 2003 to May 8, 2003.

Steam Generator Tube Leak in Unit 2

The Steam Generator (SG) No. 4 of NAPS unit 2 developed tube leaks in March 2003. Initial attempts made for identifying the leaky tube did not succeed. Hence, AERB permitted operation of NAPS unit 2, to allow the leak to grow to detectable size. Subsequently the unit was shutdown on July 6, 2003, when the leak rate from primary to secondary side reached about 7.5 kg/h, with tritium activity in feed water reaching about 50kBq/ml.

The leaky tube was identified after examination of the affected SG. The leaky tube located in front of the feed water inlet nozzle, was cut and removed for detailed examination to establish the cause of failure. Visual examination in the vicinity of the failed tube revealed presence of foreign material, which was removed. The foreign material was a piece of welding electrode. Preliminary examination of the failed tube showed that the damage profile matched well with the foreign material. It was concluded that fretting damage caused by the foreign material is the reason for SG tube failure.

Spillage of Heavy Water during In-service Inspection of Coolant Channel in NAPS Unit-2

On April 25, 2003, when NAPS unit 2 was under annual shutdown and in-service inspection of coolant channel K-08 using BARCIS inspection tool was in progress, a heavy water leak occurred from the coolant channel. About six tons of heavy water escaped from primary heat transport system due to the incident. Following the incident a plant emergency was declared at 1140 h. The leak was brought under control by various steps taken by the operators and the plant emergency was terminated at 1225 h. The leakage of heavy water from the channel was stopped completely by 2100 h. During the incident, five persons received internal exposures due to uptake of tritium. However radiation exposure to any of the workers did not exceed the regulatory limit of 30 mSv. The cause of the incident was attributed to human error.

Earlier in March 1999, while inspecting a coolant channel in MAPS unit 1 using BARCIS, an incident of heavy water leak from the channel had taken place. Following that incident, all the aspects relating to BARCIS were reviewed and a number of improvements covering design of BARCIS, its qualification, operating procedures, training and emergency operating procedures were carried out. The present incident took place in spite of these modifications. In view of this, SARCOP constituted an expert committee to examine whether the BARCIS equipment can be made more tolerant to human error.

SARCOP decided that inspection of coolant channels by BARCIS should remain suspended in all the units of NPCIL, till the review by the expert committee is completed and the necessary corrective actions, modifications are implemented.

The expert committee after their reviews suggested a number of improvements concerning training of personnel, supervision, documentation and procedures. SARCOP directed that inspection of coolant channels using BARCIS should be taken up only after implementing the same.

Periodic Safety Review for Renewal of Authorisation for operation of NAPS

As per the existing requirements of AERB, the authorization for operation of NPP needs to be renewed once in three years, based on review of Application for Renewal of Authorisation (ARA). Apart from this, a very comprehensive review known as Periodic Safety Review (PSR) has to be conducted every 9 years. The scope and requirements of PSR and the criteria for renewal of authorisation for continued operation of the NPP are specified in the AERB Safety Guide on 'Renewal of Authorisation for operation of NPPs'. PSR establishes requirements for safety assessment, which take into account improvements in safety standards and operating practices, cumulative effects of plant ageing, modifications, feed back of operating experience and development in science and technology.

As per the requirement of PSR, the utility is required to carry out a comprehensive review covering the safety factors identified in the guide. The purpose of the review by the utility is to identify strengths and shortcomings of

the NPPs against the requirements of current standards. Modifications or upgrades required to compensate for safety significant shortcomings are also proposed. The report on the PSR is subjected to regulatory review for satisfactory resolution of the shortcomings, before the renewal of authorisation for operation of the NPP is considered.

Earlier, the authorisation for operation for NAPS was renewed based on review of ARA, up to June 2003 and the station was asked to carry out PSR for renewal of authorisation beyond June 2003. Accordingly NPCIL and NAPS completed the PSR of NAPS. The PSR was subjected to a thorough regulatory review by SARCOP and AERB and the authorisation for operation of NAPS was renewed up to June 2006. Some of the important steps taken pursuant to this PSR are as follows.

- Instituting a systematic programme for ageing management of systems, structures and equipment.
- Instituting a systematic programme for equipment qualification.
- Revision / updating of safety analysis.
- Chalking out a programme for life management of coolant channels and preparedness for taking up en-masse coolant channel replacement.
- Chalking out an action plan for reducing collective dose consumption.

Special Watch on NAPS

AERB has been concerned about the safety status of NAPS, for some time now. The main concerns have been (a) higher occupational radiation exposures at the station, (b) past incidents of violation of radiation safety procedures resulting in a significant number of contract workers receiving radiation exposures in excess of regulatory limits (refer annual report of AERB for 2002-03), (c) poor condition of access roads to the plant, which could delay the process of evacuation in case of an emergency and (d) inadequate fencing of the 'exclusion zone' around the plant. Though these matters were taken up by AERB with the plant management in the past, improvements/ progress in resolving these issues was not satisfactory. In view of this, the Board in its 79th meeting held on July 31, 2003, decided to put NAPS under a 'Special Watch' from August 2003. As per this program, AERB took up more frequent regulatory inspections of the plant to monitor progress on these identified issues. AERB directed NPCIL and NAPS to take appropriate actions both at managerial as well as the technical level to address the concerns expressed by AERB.

Under this special watch, AERB conducted three inspections of NAPS in September, October and November 2003. These inspections indicate that NAPS has made significant improvements in the area of radiation protection and collective dose reduction and enhancement of security of the plant. NAPS is also interacting with Uttar Pradesh state authorities for taking required actions to improve the condition of access roads to NAPS. Exclusion fencing has also been improved.

2.2.7 Kakrapar Atomic Power Station (KAPS)

Both units of KAPS operated normally up to a power level of 220 MWe. KAPS unit 1 had an annual shut down from September 1, 2003 to October 7, 2003.

Steam Generator Tube Leaks

The steam generator (SG) No. 4 of KAPS unit 1 developed tube leak in October 2002 and January 2003. Also there was an incident of tube leak in SG No. 1 of KAPS unit 2 during February 2003. Units were operated with leaky tubes to allow the defect to grow to a size, where identification of the leaky tube was possible. Subsequently the leaky tubes were plugged.

During the annual shutdown of KAPS unit 1 in September 2003, KAPS had cut and removed two defective tubes from SG No. 4, for failure analysis. Visual examination in the vicinity of the tube revealed presence of foreign material (part of a spiral-wound gasket material), which was then removed. Preliminary examination of the removed tubes showed cut marks on them, matching with the recovered foreign material. Thus it was concluded that the damage caused by the foreign material was the reason for tube failures in SG No. 4. In addition, in-service inspection was also done on 25 % tubes of SG No. 1 of KAPS unit 1.

In view of the failures caused by foreign materials in steam generators, SARCOP advised NPCIL to improve quality assurance during construction, commissioning and maintenance of critical systems and equipment so that foreign material do not find their way into these and cause damage.

2.2.8 Kaiga Generating Station (KGS)

Both the units of Kaiga Generating Station were

operational up to a power level of 220 MWe.

2.2.9 Indira Gandhi Centre for Atomic Research (IGCAR)

Fast Breeder Test Reactor (FBTR)

FBTR was operational up to a power level of 15 MWth. The reactor has remained shutdown since December 23, 2003 for replacement of certain equipment and overhauling of turbine generator.

Burn-up Limit for FBTR Fuel

The fuel used in FBTR consists of a mixture of plutonium carbide and uranium carbide. Since the experience on the performance of this fuel is limited, the burn-up limits on this fuel are being increased in steps after careful review of the fuel performance (The fuel 'burn-up' in nuclear reactor refers to the energy extracted from the fuel before it is discharged from the reactor). Post Irradiation Examination (PIE) of the irradiated fuel sub-assemblies is carried out to study the in-reactor behavior of the fuel and to ascertain the permissible safe life of this fuel. Presently the peak burn-up for FBTR has reached a record level of 1,23,300 MWd/t without any fuel failures.

Kamini

Kamini reactor was operated to carry out various irradiation and neutron radiography experiments.

Authorization for Reprocessing of Irradiated FBTR Fuel Pins in Lead Mini Cell (LMC) Facility

Fast reactor fuel reprocessing, being a complex technology is being implemented in stages. These include testing of equipment and systems in the engineering laboratory and then integrating them in a hot cell for radioactive runs.

FBTR fuel reprocessing is planned in the LMC, which is a pilot plant set up in Reprocessing Development Lab of IGCAR. The objective of LMC is mainly to validate the process and equipments developed so far. These equipment based on operational feedback will be incorporated in the proposed Fast Reactor Fuel Reprocessing Plant (FRFRP).

As reported in the Annual Report for 2002-03, AERB had earlier authorized the first two campaigns of reprocessing of low burn-up FBTR fuel pins in LMC. Since then, IGCAR has completed these campaigns successfully and requested for authorisation for taking up further reprocessing campaigns. After review of the safety aspects and the performance during the first two reprocessing campaigns, AERB had authorized IGCAR for taking up two more campaigns of reprocessing at LMC.

Chairman & Vice-Chairman viewing the Lead Mini Cell in IGCAR, Kapakkam with Shri S.K. Chande

2.2.10 Regulatory Inspections of Operating Nuclear Power Plants and Research Reactors

Regulatory inspection of operating nuclear power plants and research reactors is carried out periodically to,

- confirm that the plant operation is as per the approved Technical Specifications and AERB/ SARCOP directives,
- confirm compliance with the maintenance, in-service inspection and quality assurance programmes,
- confirm proper maintenance of records/ documentation,
- check for any radiological and industrial safety status existing at the Nuclear Power Plants/Research Reactors, and
- check that observations/ deficiencies brought out in the previous regulatory inspections have been rectified.

The regulatory inspections are conducted following the guidelines specified in AERB Safety Guide AERB/SG/ G-4 on Regulatory Inspection and Enforcement in Nuclear and Radiation Facilities. A manual on Regulatory Inspections covering various procedures, checklists and other requirements has also been prepared by AERB. The draft manual is presently under review by the Advisory Committee for preparation of Code and Guides on Governmental Organization for Regulation of Nuclear and

Radiation Facilities (ACCGORN). Presently regulatory inspections are carried out once in 6 months, for nuclear power plants and once in a year for research reactors. Due care is taken in planning to ensure that the inspections cover all the following aspects, at least once in a year.

- Adherence to requirements and procedures for reactor start-up, shutdown and normal operation.
- Reactor physics, fuel management.
- Compliance with surveillance requirements.
- Reliability of safety and safety related systems.
- Maintenance activities, in-service inspections and quality assurance.
- Radioactive waste management.
- Maintenance of emergency preparedness.
- Health and environmental aspects.
- Training of personnel .
- Industrial and fire safety.

During the calendar year 2003, a total of 19 inspections were undertaken in the operating NPPs and research reactors, of which 15 were routine inspections as per the regulatory inspection programme. The remaining four were special inspections. Two special inspections were carried out at NAPS after the station was put under 'special watch' (Refer Section 2.2.5.4). Special inspections were also carried out at MAPS and RAPS, prior to restart of MAPS unit 2 and RAPS unit 1, respectively. As brought out earlier, AERB permitted (a) restart of MAPS unit 2 after en-masse coolant channel replacement and safety upgradations and (b) restart of RAPS unit 1 after safety upgradations and coolant channel life management.

The observations made during the inspections are categorized into 5 different groups depending upon their significance, as given below.

Category I : Deviations from Technical Specifications and other regulatory requirements/ stipulations.

Category II : Deficiencies and degradations in Systems/Structures/Components of Safety and Safety Related Systems.

Category III : Shortcomings identified in the design of Safety, Safety related and Safety Support Systems, based on operating experience including generic deficiencies.

Category IV : Procedural inadequacies.

Category V : Observations on housekeeping and departure from good practices.

Category wise distribution of observations made during the inspections of various plants in 2003 is given in Table 4 below.

All the deficiencies brought out during the Regulatory Inspections have been addressed. The major items especially in categories I & II have been resolved. The remaining deficiencies are in various stages of review/ resolution.

Some of the important observations made during

Table 4: Categorization of Deficiencies observed during Inspection

UNIT	Number of Inspections		Cat -I	Cat -II	Cat -III	Cat -IV	Cat -V
	Planned	Special					
TAPS-1&2	2	0	NIL	1	1	30	16
RAPS-1&2	2	1	2	3	5	47	9
MAPS	2	1	2	NIL	1	40	23
NAPS	2	2	NIL	3	13	25	5
KAPS	2	0	1	10	6	34	21
KGS-1&2	2	0	3	4	1	46	9
RAPS-3&4	2	0	4	3	6	35	15
FBTR	1	0	1	NIL	1	11	11
Total	15	4	13	24	34	268	109

the regulatory inspections and the follow up actions taken are summarized below.

1. The regulation mode of Automatic Liquid Poison Addition System (ALPAS) was being inhibited in RAPS units 3&4 during refuelling. Inhibition of ALPAS regulation mode during reactor operation amounts to deviation from technical specifications for operation. Taking serious note of the deviation, SARCOP asked the stations to adhere to the requirements of technical specifications and correct the deficiencies in the system.

2. For making up the inventory in Primary Heat Transport (PHT) system in the event of a small leak, a small leak handling system is provided in the PHWRs. This is a shared system in 220 MWe twin unit stations in India. The technical specifications for operation stipulate the minimum heavy water inventory to be maintained in this system during operation. At KGS, it was found that with one unit in operation and the other unit shut down, the inventory maintained in small leak handling system did not meet the requirement. After a review of the matter, SARCOP directed NPCIL and KGS to maintain sufficient inventory of heavy water in the system to meet the demand under various conditions, without deviating from the limits stipulated in technical specifications.

3. During the annual shutdown of NAPS-2, in-service inspection of coolant channels was carried out using BARCIS equipment. To facilitate laying of temporary cables for BARCIS, all the doors of the main airlock of the reactor containment building were kept open. Keeping the air lock doors open while opening the reactor pressure boundary for inspection was in violation of the requirements of maintaining containment integrity. After review, SARCOP stipulated that while carrying out such activities, the containment integrity shall not be impaired and the cables should be routed only through proper containment penetrations.

4. At KAPS-1, pressure difference between volume V1 (high enthalpy zone) and volume V2 (low enthalpy zone) was found to be inadequate. Also the primary containment exhaust flow was lesser than the design value. The deficiencies were later rectified by the plant.

2.2.11 Licensing of Operating Staff for Operating Plants

The number of operating personnel who were licensed from various power plants during the year is tabulated in Table 5.

2.2.12 Significant Events

It is obligatory for all operating NPPs to report promptly to the Regulatory Board, events happening in the plant which have or may have impact on operational safety.

Under the reporting system established by AERB,

Table 5: Licensing of Operating Personnel

Plants	No. of Candidates cleared for the Positions						Licensing Committee Meetings
	Management	SCE	ASCE	ASCE(F)	CE	CE(F)	
TAPS	-	3	-		1	-	1
RAPS 1-2	3	2	-	2	6	2	1
MAPS	-	4	5	2	8	2	2
NAPS	2	6	4	2	6	1	2
KAPS	-	7	2	3	4	3	3
KGS	1	3	5	2	8	2	2
RAPS 3-4	-	2	4		1	1	1
FBTR	-				1	4	1
Total	6	27	20	11	35	15	13

Abbreviations used: SCE: Shift Charge Engineer; ASCE: Asst. Shift Charge Engineer; CE: Control Engineer; CE (F): Control Engineer Fuel Handling

the events reportable to the regulatory body are divided into two categories termed as:

a) Events and
b) Significant Events

This categorization depends on the safety significance and importance to operational safety experience feedback. Based on the reporting criteria, NPP submits Event Reports (ER) and Significant Event Reports (SER) after the occurrence of an event. The system wise classification of SER in NPP during the year is shown in Fig. 1.

The SERs received from the operating NPPs are also rated on the International Nuclear Event Scale (INES). The INES system of the International Atomic Energy Agency rates events at seven levels (1 to 7) depending on their safety significance. The accident at Chernobyl nuclear power plant in the USSR (now in Ukraine) was rated at level 7 on INES. The incident involved core melt down with the consequences of large-scale off-site radioactivity release having widespread environmental and human health effects. Events rated at level 4 and above are termed as accidents. Events rated at level 2 and 3 are called incidents. An event at level 1 is an anomaly. Events at level 0 are called deviations. The IAEA-INES scale is shown in Fig. 2.

The number of SERs for each year from 1999-2000 and their ratings on INES are given in Table 6. In the year 2003 (since 1st April), a total of 31 significant events were reported from the operating NPPs. The NPP wise classifications of SERs for the year 2003 on INES scale is given in Table 7 and Fig. 2. There was no event at level 2 or above.

Ten events were rated at level 1 on INES. Out of these, seven were rated at level 1 because of overexposure of temporary workers beyond their annual limit of 15 mSv. These seven events consisted of four cases at MAPS and one each at RAPS 1&2, NAPS & KAPS. The maximum individual exposure to a contractor worker was 20.9 mSv during the cobalt element replacement job at KAPS. In this event, a hot

Table 6: Classification of SERs in NPPs as rated on INES

INES Levels	1999-2000	2000-2001	2001-2002	2002-2003 (9 Months)	April – Dec. 2003
Out of Scale	3	2	0	0	0
0	16	42	43	25	21
1	2	10	2	11	10
2	0	0	0	1	0
3	0	0	0	0	0
> 3	0	0	0	0	0
Total	21	54	45	37**	31

Note:

* For the sake of uniformity it has been decided that from this year all data will be reported for the preceding Calendar Year.

** In the last year annual report only 29 SERs were reported. Based on the findings of the Regulatory Inspections carried out by AERB, 8 SERs were submitted later.

Table 7: Classification of SERs in Individual NPPs (April 2003- December 2003)

Plant Name	Out of Scale	International Nuclear Event Scale					
		0	1	2	3	>3	Total
TAPS		0	2	0	0	0	2
RAPS		0	1	0	0	0	1
MAPS		5	4	0	0	0	9
NAPS		4	2	0	0	0	6
KAPS		0	1	0	0	0	1
KAIGA		8	0	0	0	0	8
RAPS 3&4		4	0	0	0	0	4
Total	**0**	**21**	**10**	**0**	**0**	**0**	**31**

spot appeared near the reactivity drive mechanism area, which caused the exposure to a temporary worker. The exposures to temporary workers were lower than the limits prescribed by AERB for the departmental workers.

In an event at NAPS, heavy water leaked from primary heat transport system during In-Service Inspection (ISI) of a coolant channel. During the ISI, containment doors were open, which was in violation of the Station Technical Specifications. This event was rated at level 1 on INES. (Refer section 2.2.5.4)

At TAPS, two events were rated at level 1 on INES. In one event, refuelling grapple rope snapped while loading fuel bundle in the reactor core. However, there was no damage to the fuel bundle. In another event, primary steam line relief valve opened. The relief valve did not reseat and the reactor had to be tripped manually.

Figure 1 : System Wise Classification of SERs in NPPs (Year 2003)

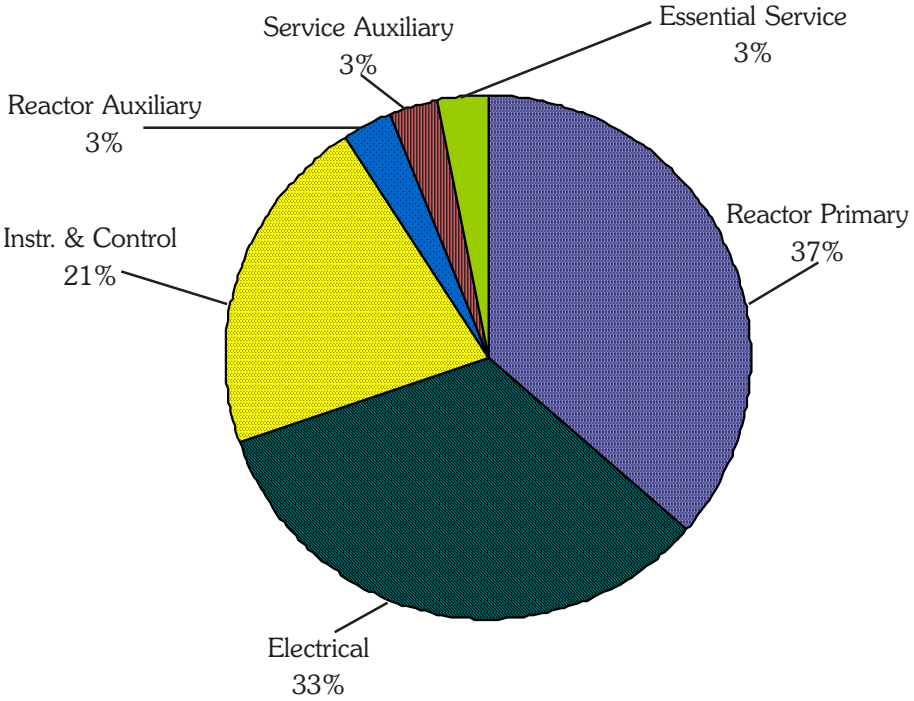


Figure 2: International Nuclear Event Scale (INES)

Level/ Descriptor	Nature of the Events	Examples
7 MAJOR ACCIDENT	• Major release: Widespread health and environmental effects	Chernobyl NPP, USSR (now in Ukraine), 1986
6 SERIOUS ACCIDENT	• Significant release: Likely to require full implementation of planned counter measures	Kyshtym Reprocessing Plant, USSR (now in Russia), 1957
5 ACCIDENT WITH OFF-SITE RISK	• Limited release: Likely to require partial implementation of planned counter measures • Severe damage to reactor core/ radiological barriers	Windscale Pile, UK, 1957 Three Mile Island, NPP, USA, 1979
4 ACCIDENT WITHOUT SIGNIFICANT OFF-SITE RISK	• Minor release: public exposure of the order of prescribed limits • Significant damage to reactor core/radiological barriers/ fatal exposure of a worker	Windscale Reprocessing Plant, UK, 1973 Saint-Laurent NPP, France, 1980 Buenos Aires Critical Assembly, Argentina, 1983
3 SERIOUS INCIDENT	• Very small release: public exposure at a fraction of prescribed limits • Severe spread of contamination/ acute health effects to a worker • Near accident, no safety layers remaining	Vandellos NPP, Spain, 1989
2 INCIDENT	• Significant spread of contamination/ over exposure of a worker • Incidents with significant failures in safety provisions	
1 ANOMALY	• Anomaly beyond the authorized operating regime	
0 DEVIATIONS BELOW SCALE	No safety significance	
OUT OF SCALE	NO SAFETY RELEVANCE	

2.2.13 Industrial Safety

Regulatory inspections on fire and industrial safety aspects were carried out in Tarapur Atomic Power Station 1&2, Madras Atomic Power Station, Rajasthan Atomic power station 1 to 4, Kaiga Generating Station and Narora Atomic Power Station. The major recommendations included the following.

a) Re-organisation of safety section.

b) Filling of vacant posts in fire stations.

c) Improvement in frequency of Sectional Level Safety Committee meetings.

d) Periodic testing of lifting tools and tackles.

e) Completion of Annual Medical Examination of workers.

Special regulatory inspections on industrial safety aspects

was carried out in December 2003 at Rajasthan Atomic Power Station - 1. The major recommendations were:

a) Relocation of diesel tank from DG room.

b) Installation of primary fire suppression system and display of exit signs.

Similarly, regulatory inspections on fire & industrial safety aspects were carried out in KAMINI and Fast Breeder Test Reactor in Kalpakkam. Recommendations in these research reactors included the following.

a) Designation of Officer responsible for fire safety.

b) Conducting of Fire Emergency exercises.

c) Improvement in Safety Work Permit procedures.

d) Commencement of Annual Medical Examination for 2003.

e) Procurement of Jockey pump for maintaining fire water header pressure.

2.3 FUEL CYCLE FACILITIES

2.3.1 Nuclear Fuel Complex (NFC)

- NFC, Hyderabad submitted a Safety Report requesting authorisation of one time processing of 33 t of depleted uranium in Uranium Oxide Plant (UOP). The report was reviewed in the Safety Committee. It was further deliberated in SARCOP and authorisation was issued.

- Proposal for processing of depleted uranium at Enriched Uranium Oxide Plant (EUOP), as well as proposal for enhancement of capacity of stripping section at New Uranium Oxide Fuel Plant (NUOFP), was discussed and was approved for implementation.

- Operation in the wet section of NUOFP, NFC was earlier suspended by Chairman, AERB, following the incident of explosion in the evaporator on November 17, 2002. Chairman, AERB constituted an investigation committee to identify the root cause of the accident. Based on the recommendations of SARCOP, Chairman, AERB agreed to permit resumption of work in the wet section of NUOFP with effect from April 7, 2003 subject to certain stipulations as specified by the investigation committee.

- Proposal for revalidation of site authorization of New Zirconium Oxide and Sponge project at Palayakayal was discussed and was recommended.

- Chairman, AERB approved site revalidation till end of 2005 for New Zirconium Oxide and Sponge Project at Palayakayal.

- NFC had applied for life extension of the old plant building for Zirconium Sponge Plant (ZSP). The AERB team inspected the building and submitted the inspection report to Civil Engineering Safety Committee of Operating Plant (CESCOP). AERB also reviewed NFC's proposal to use ZSP building for plant operation beyond the earlier stipulated period of 31st August, 2003 up to end of 2004 and submitted its review findings to CESCOP. Based on the review findings and inspection reports, CESCOP submitted its recommendations for short-term operation of ZSP up to March 2004 with appropriate monitoring scheme to SARCOP. SARCOP granted permission to operate ZSP in the old building for a short period utilisation of the building up to 31st March 2004.

- SARCOP authorised the revised proposal for processing of depleted uranium in UOP plant (0.6% U^{235}) at the rate of 45 Mt/month (max.) on regular basis with stipulation to control air activity level in the ETAVAC transfer system by providing enclosure.

- Incident of bursting of stainless steel bunker in EUOP was discussed. SARCOP reviewed the incident and recommended that automation of the CO_2 flushing system of the bunker should be incorporated in the system.

2.3.2 Heavy Water Plants (HWP)

Meetings of the Safety Committee of Heavy Water Operating Plant (SCHWOP) and SARCOP were held to review the following documents/reports and made recommendations.

- Safety Report & Technical Specifications of 60 t/a Tributyl Phosphate production facility at HWP-Talcher was reviewed and approved with some recommendations. This was subsequently reviewed in SARCOP and regular operation of the plant was permitted with the endorsement of the Safety Committee recommendations.

- Design Basis Report & HAZOP (Hazard and Operating) study report of utility plant (ammonia absorption refrigeration system) at HWP-Tuticorin was

reviewed and appropriate recommendations were made which were incorporated and the plant was authorised for operation.

- Safety Related Unusual Occurrence Report on damaged cooling tower cells and fan cylinders assembly due to high wind velocity and localised cyclonic effect at HWP-Kota was reviewed to identify the root cause.
- Report on commissioning of HWP-Baroda Revival plant with Ammonia–Synthesis gas and water operation was reviewed and clearance was given for amide addition with some stipulations.
- The revised Technical Specifications of HWP-Tuticorin were reviewed and cleared with certain stipulations.
- HAZOP study for integrating the back end ammonia water column at HWP Hazira was reviewed.

An AERB team inspected the ash-pond at HWP, Manuguru, where a portion of the bund was breached and ash slurry was discharged from the pond. Wide cracks on the surface of the bund were observed on both sides of the breached section. The ash slurry flowing out from the ash pond found a path to flow through a natural nallah and reached the river Godavari. Down stream of the ash pond, the nallah overflowed due to the high flow of ash slurry and spread into the surrounding areas including some cultivated fields containing green chillies, cotton and tomatoes. No loss of life was reported.

The AERB team asked HWP to contact the local agencies, like the State Irrigation Department, so that flow of ash slurry from the pond to the surrounding areas could be stopped. HWP was asked to carry out a detailed inspection of both the Ash Ponds and report their findings to AERB. They were also asked to appoint a specialized agency to carry out the necessary investigation, executing the repair works and development of inspection and maintenance procedures for the bund.

- Report on initial assessment on breach of Ash Pond No.1 earthen bund at HWP – Manuguru was reviewed.
- Site emergency preparedness plan for HWP, Hazira, Manuguru and Tuticorin were reviewed in SCHWOP.

2.3.3 Indian Rare Earths Limited (IREL)

Safety Review of IREL plants were carried out through Regulatory Inspections, Review of Tri-Annual Safety, Health & Environment Reports, Quarterly and Annual Health Physics Reports for radiological aspects. IRE Safety Committee reviewed the documents and discussed the following issues.

- Revised Technical Specifications of IREL Manavalakurichi, Chavara and Udyogamandal.
- Authorisation under GSR-125 for IRE Manavalakurichi.
- Safety Evaluation Report for the production of Nuclear Grade Ammonium Di Uranate (ADU) at IRE Udyogamandal.
- Design and Safety Evaluation Report of Monazite segregation at IRE Manavalakurichi.
- Study on the flow pattern of ground water at IRE, Udyogamandal.
- Dust control measures in Mineral Separation Plants of IRE, OSCOM, Chavara and Manavalakurichi.
- Safety Report of THRUST (Thorium Retrieval, Uranium Recovery and Storage) Project at IRE Udyogamandal.
- Safety Report of the production of Nuclear Grade Ammonium-Di-Uranate (ADU) from uranium tetra fluoride at IRE, Udyogamandal.
- Production of Nuclear Grade Thorium oxide at IRE, Udyogamandal.

Senior staff members of IREL and AERB discussed many pending issues concerning safety. The topics for discussion were modifications/expansions in the units, safety and fire organisation augmentation, storage of radioactive waste, decommissioning of silos 1-3, and construction of proper storm water drain in IRE, Udyogamandal and posting of a full time health physicist at IRE Manavalakurichi.

A committee has been constituted by AERB to review the radioactive waste management aspects of THRUST Project at IRE, Udyogamandal. The Committee assessed the quantity and quality of the projected waste generation and its minimisation, readiness of the plant for handling/disposal of radioactive waste and submitted its report in March 2004.

2.3.4 Uranium Corporation of India Ltd. (UCIL)

Proposal for New Uranium Mines and Ore Processing Plants.

UCIL has proposed to set up Turamdih Mill for processing of uranium ore at a capacity of 3000 t/d located adjacent to the Turamdih mine in Jharkhand. The proposal was discussed in the Unit Safety Committee and it was decided that the authorisation will be given in two stages, viz., authorisation for commencing construction work and authorisation for commissioning/operation. AERB granted authorisation with some stipulations for construction work in October 2003.

AERB has also issued "No Objection Certificate" under the Atomic Energy (Mines, Minerals and Handling Prescribed Substances) Rules, 1984 for opening of uranium mines at Lambapur in Andhra Pradesh, Banduhurang in Jharkhand and processing plant at Nalgonda District of Andhra Pradesh subjected to satisfactory stage wise safety review as intimated.

UCIL applied to AERB for authorisation for opening of an open cast Uranium mine at Banduhurang, located 5 km south west from Tatanagar. AERB has decided in the Safety Committee meeting that there will be 'one stage' authorisation for operation of the mine after submission of documents such as EIA Report, Assessment Report on radiological effect of mining with distance and Safety Report.

UCIL applied to AERB in October 2003 for opening of one more underground mine at Bagjata, Jharkhand, which was explored and sealed by AMD in 1991. AERB safety committee visited the site and the safety review of the proposal is being carried out.

Issue of Dosimeter to Mine Workers

Radon dosimeters were issued to all the mineworkers at Jaduguda (950 persons) as well as Bhatin mines (220 persons). A time bound programme of providing Radon dosimeters to mine workers of other existing underground mines at Narwapahar and Turamdih is to be implemented by UCIL.

Improvement in Ventilation of Jaduguda Mine for reducing Airborne Activity

Air flow from the Jaduguda underground mine increased from 65 m^3/s to 120 m^3/s with the new combination of one 45 m^3/s and one 75 m^3/s capacity fan. Based on the stipulation of AERB, UCIL requested Indian Schools of Mines, Dhanbad to conduct study for the adequacy of the present ventilation system. The study report indicated satisfactory results with respect to the present ventilation.

2.3.5 Licensing of Plant Personnel

SARCOP Authorisation Committee for licensing of operating personnel for Heavy Water Plants met at HWP - Manuguru and Kota and authorised/re-authorised 51 operation personnel.

2.3.6 Regulatory Inspection

Regulatory inspections on industrial safety aspects were carried out during 2003-2004 under the Factories Act, 1948 and Atomic Energy (Factories) Rules, 1996 in the following industrial plants of DAE.

- Heavy Water Plant, Thal
- Heavy Water Plant, Hazira
- Heavy Water Plant, Tuticorin
- Heavy Water Plant, Manuguru
- Heavy Water Plant, Kota
- Nuclear Fuel Complex, Hyderabad
- Indian Rare Earths Ltd., Udyogamandal
- Indian Rare Earths Ltd., Chavara
- Indian Rare Earths Ltd., Manavalakurichi
- Uranium Corporation of India Ltd., Jaduguda
- Center for Advance Technology, Indore
- Variable Energy Cyclotron Centre, Kolkata
- Electronics Corporation of India Ltd., Hyderabad
- Board of Radiation and Isotope Technology, Mumbai

In each case, a detailed inspection report was sent to the concerned unit highlighting the observed shortcomings. Some of the major recommendations made by AERB to HWPs, NFC, IREL are as given below:

Heavy Water Plants

- Illumination level at various work places in the plant should be maintained as per Rule 11(1) of the Atomic Energy (Factories) Rules, 1996.
- Damaged fire proof cement coating on structural beams at ground level to be repaired.

- Pending authorisations for operators and engineers should be completed.
- Fire barriers at cable entry point should be provided.
- Four number ammonia monitors should be relocated.
- Ammonia cooler (12R1) foundation should be repaired.
- Soundproof cabin for compressor house operators should be provided.
- Leakage of the underground fire hydrant lines should be rectified.
- Deluge operation should be checked.

Nuclear Fuel Complex

- Sectional Level Safety Committee meetings should be held once in a month.
- All modifications / field changes should be reviewed and approval obtained from appropriate committee at plant level.
- Appropriate fire detection and protection system should be installed.
- Approved procedure for bypassing any safety interlock/ trip should be in place.

Indian Rare Earths Plants

- The burner management system in Mineral Separation Plant should be upgraded.
- Supplementary mining center should be protected from unauthorised entry and drowning.
- High level alarms for all effluent containing tanks at Thorium plant should be provided.
- Fire organization should be formed.
- Violation of Technical Specifications should be intimated.
- Procedure to authorize change of set points of various alarms and change in operational parameters should be formulated.
- Safety policy should be displayed.
- Safety and fire organisations should be strengthened.
- Fire detectors should be provided in the un-manned areas.
- Physical examination of the hoists and chain pulleys as per Atomic Energy (Factories) Rules 1996 should be carried out.

2.4 OTHER NUCLEAR FACILITIES

2.4.1 Variable Energy Cyclotron Centre (VECC)

VECC-CAT Safety Committee discussed the following issues.

- Formation of a dedicated Safety Organisation.
- Documents on Control Access System for existing cyclotron, ECR-2, Super Conducting Cyclotron.
- Safety Report for Super Conducting Cyclotron.
- Health Physics Reports.

Regulatory inspection of VECC was carried out with respect to industrial and radiological safety aspects. Some of the important recommendations were preparation of Safety Report for Super Conducting Cyclotron, formation of Safety Organisation, appointment of Safety Officer to supervise the day-to-day industrial safety aspects and appointment of Competent Persons.

2.4.2 Centre for Advanced Technology (CAT)

One dedicated Safety Officer has been appointed. CAT has submitted "Conceptual Fire Protection System" report for review and has asked permission for operation of 750 kV DC accelerator using SF6 gas for medical facilities. Based on discussions in VCSC, AERB has issued authorisation for operation of the accelerator at 750 kV and 20 mA with SF6 gas for a period of one year. Site and design authorisation for construction of a 10 MeV linear electron accelerator for radiation processing facility at CAT Indore was also discussed in VCSC. Regulatory inspection was carried out in April 2003.

2.4.3 Board of Radiation and Isotope Technology (BRIT)

Regulatory inspection was carried out on August 13, 2003 at ISOMED, Trombay. Major recommendations are the following.

- Workers representation in local safety committee.
- Provision of fire detection system.
- Appropriate radiation symbol display.
- Revision of document of plant radiation protection &

procedure based on AERB Radiation Protection Manual for Nuclear Facilities Rev.3 1996.

2.4.4 Electronics Corporation of India Ltd. (ECIL)

Regulatory Inspection of Electronics Corporation of India Ltd, Hyderabad, was conducted. The major recommendations are the following.

- Appointment of the certifying surgeon.
- An independent safety committee constituted for projects and plant modifications.
- Fire protection/suppression water system as per AERB standard for fire protection systems of nuclear facilities.
- Mutual aid scheme finalisation.
- Medical examination of radiation workers.
- Audiometry tests for workers and submission of safety work permit system.

2.5 ENFORCEMENT OF THE FACTORIES ACT, 1948

2.5.1 Licenses issued

1) License of Narora Atomic Power Station renewed for a further period of five years on July 15, 2003.
2) License of Madras Atomic Power Station amended to on July 15, 2003 in view of change of Occupier.
3) Existing license of Tarapur Atomic Power Station amended on September 1, 2003 to augment the storage capacity from 5 X 900 kg Chlorine cylinders to 10 X 900 kg Chlorine cylinders.
4) Based on the request, waiver for provision of walkway for EOT cranes located in Reactor Building (62T/10T) and Turbine Building (100T/20T) under sub-rule 6 of rule 35 of the Atomic Energy (Factories) Rules 1996 subject to stipulations was granted to Tarapur Atomic Power Station on September 26, 2003.
5) License of HWP, Hazira renewed for a further period of five years on June 27, 2003.
6) License of HWP, Thal renewed for a further period of five years on July 14,2003.
7) License of HWP, Manuguru renewed for a further period of five years on August 08, 2003.
8) License was issued to IRE OSCOM on April 25, 2003 for production of commercial grade Thorium oxide at Thorium Plant, at the enhanced rate of 100 kg/month.

2.5.2 Approvals Granted

Approval was granted to Competent Persons under various Sections of the Factories Act, 1948 in the following units.

1) Seventeen persons of Narora Atomic Power Station
2) One person of Tarapur Atomic Power Station
3) Six persons of Rajasthan Atomic Power Station 1&2
4) Four persons of Rajasthan Atomic Power Station 3&4
5) One person of Heavy Water Plant – Thal.
6) Six persons of Heavy Water Plant – Hazira.
7) Two persons of Heavy Water Plant – Tuticorin
8) Six persons of Nuclear Fuel Complex - Hyderabad

2.6 SAFETY UP-GRADATIONS

AERB had prepared a comprehensive report titled "Safety Issues in DAE Installation" in 1995. The report detailed the evaluation and up-gradation, which are required in the various nuclear installations of DAE. Earlier a total 134 safety issues were identified. Out of these, 24 safety issues pertaining to BARC installations were transferred to the BARC Safety Committee for follow up. Out of the remaining 110 safety issues, 104 issues were resolved by March 2003. The following four issues were satisfactorily resolved during this year:

- Improvements to ventilation at Jaduguda Mine for reducing Airborne Radioactivity.
- Personnel Radiation Monitoring System at Jaduguda and Bhatin Mines.
- Full Scope Simulators for Training of Operation Personnel for NPPs.
- Design deficiencies in spent fuel transportation casks for NPPs.

For the following two safety issues, action plans are in progress towards satisfactory resolution.

- Reconditioning of Silos and Palletisation of Thorium Hydroxide (Unit - IRE-Alwaye).
- Non-conformance with current Fire Safety Standards for TAPS-1&2.

A checklist for fire safety audit was finalized and sent to all unit heads for carrying out self safety audit for their respective units.

CHAPTER 3
SAFETY SURVEILLANCE OF RADIATION FACILITIES

3.1 SAFETY REVIEW OF RADIATION EQUIPMENT AND APPROVAL OF SAFETY PERSONNEL

The radiation facilities in India may be broadly classified as Medical, Industrial and Research.

Medical installations include diagnostic X-ray facilities, Telegamma facilities, Medical Linear Accelerator installations and Nuclear Medicine Centres practicing diagnosis and therapy.

Industrial installations include industrial radiography institutes, gamma radiation processing facilities, users of nucleonic gauges including well logging devices and manufacturers of consumer products.

Research installations include universities and other research institutes handling a variety of sealed and unsealed radiation sources and also X-ray facilities for research purposes.

The number of various facilities and radiation devices, where applicable, which are regulated by AERB as on December 31, 2003, is given in Table 8. The regulatory activities relating to radiation facilities are the following.

1. Issuance of Type approval for radiation devices and packages for transport of radioactive material.
2. Issuance of License / Authorisation to users of radiation sources.
3. Authorisation for decommissioning and transport of spent/disused sources for disposal.
4. Inspection of radiation installations, devices and packages containing radioactive material for compliance assurance.
5. Investigation of unusual occurrences including excessive exposures.
6. Preparation of regulatory documents (e.g., Safety Codes, Standard Specifications and Safety Guides).
1. Other activities (e.g., Human Resource Development and R & D)

Table 8: Number of Radiation Installations Regulated by AERB

S.No.	Type of Application	No. of institutes as on 1-1-2004	No. of Devices in use in 2003
1	Diagnostic X-ray	~ 30,000	~ 35,000
2	Radiotherapy	199	
	Teletherapy	199	Telecobalt 258 Telecesium 7 Accelerators 50 Gamma Knife 3
	Brachytherapy	118	HDR 51 LDR 37 Manual (Intracavitary) 76 Manual (Interstitial) 29 Opthalmic (^{90}Sr) 20 Opthalmic (^{125}I) 1 Opthalmic (^{106}Ru) 1
3	Nuclear Medicine ● RIA Centres ● Diagnostic (including 22 CA thyroid treatment centres)	427 135	Not applicable
4	Research	582	Not applicable
5	Industrial Radiography	439	1186
6	Gamma Irradiators	7	7
7	Nucleonic Gauges	1347	6700
8	Consumer Products ● Gas Mantle ● Lamp starters	 64 20	Not applicable

3.1.1 Type Approval and No Objection Certificates Issued

For the purpose of ensuring that the radiation dose received by workers and members of the public does not exceed the prescribed dose limits and further that such doses are kept As Low As Reasonably Achievable (ALARA), design safety is accorded primary importance and operational control measures are monitored. With this in view, all devices including radiation generating equipment and those incorporating radioactive sources are subjected to a type approval procedure. AERB permits only type-approved devices to be marketed in India. The criteria for type approval are stipulated in the Standards Specifications (SS) documents on a variety of devices, issued by AERB. These SS documents are periodically reviewed and revised, where necessary, in order to meet internationally accepted and current standards. The Safety Review Committee for Application of Radiation (SARCAR) examines the design safety features of each device and recommends issuance of type approval. The SARCAR held five meetings during the year. Based on the recommendations of SARCAR, AERB issued type approval certificates to the manufacturers/suppliers of devices incorporating radioactive materials and radiation generating equipment. A list of the devices type approved during the year is given in Table 9.

Table 9 : Type Approvals Granted

(A) Radiation Generating Equipment and Equipments Containing Radioactive Material

S.No.	Nature of Equipment	Number of Approvals
1	Medical diagnostic X-ray Units	244
2	Mammography Units	3
3	Bone Densitometers	2
4	Radiotherapy Simulators	3
5	Computed Tomography (CT) Units	3
6	Telegamma Therapy Units	6
7	Gamma Knife Units	1
8	Medical Linear Accelerators	6
9	Remote Controlled after-loading Brachytherapy Units	3
10	Gamma Chambers	6
11	Nucleonic Gauging Devices	50
12	Ionisation Chamber Smoke Detectors	5
13	Baggage Inspection Systems	4

(B) Radiological Safety Officers

S.No.	RSO Level	Number Approved
1	RSO Level-III (Medical)	84
2	RSO Level-III (Industrial radiography)	9
3	RSO Level-II (Industrial radiography)	13
4	RSO Level-II (Nuclear Medicine diagnosis)	54
5	RSO Level-I (Nucleonic Gauge)	66
6	RSO Level-I (Research Applications)	19

(C) Approval of Transport Packages in 2003

S.No.	Package Type	Packages Approved
1	Type B(M) package (Spent fuel cask)	1
2	Registration of Type A packages of BRIT	5

3.1.2 Approval of Radiological Safety Officers

During the year, approval certificates were issued in respect of 245 Radiological Safety Officers. The break-up is given in Table 9.

3.1.3 Approval of Packages for Transport of Radioactive Material

As per our regulations, Type A packages which are permitted to transport radioactive material of activity not exceeding the specified limits, need to be registered with AERB. However, all Type B packages are subjected to a stringent approval procedure and are required to fulfill the regulatory standards. Details of Type approval certificates issued by AERB during the year are given in Table 9.

3.2 LICENSE / AUTHORISATION AND REGULATORY INSPECTION

3.2.1 License / authorisation

AERB accorded clearance to two sites for construction of radiation processing facilities, design approvals for Electron Beam Accelerator at Radiant Cables, Hyderabad and for the radiation cell of the high capacity gamma radiation processing plant at Organic Green Foods Ltd., Kolkata.

Users of radiation sources are required to obtain a license (Regulatory Consent) from AERB. The License is issued only upon ensuring that the applicant and the institute satisfy the regulatory requirements specified in the applicable Safety Codes (SC), issued by AERB. These SC documents are periodically reviewed and revised where necessary in order to meet internationally accepted standards. In the case of radioactive material to be imported, a No Objection Certificate (NOC) for the import is issued upon confirming that the applicant satisfies all the regulatory requirements.

AERB started issuing regulatory consent as Certificate of Registration to diagnostic X-ray installations upon confirming that the applicable regulatory requirements are duly satisfied. Details of licences / NOCs issued by AERB during the year are given in Table 10.

Table 10 : Consents Issued

A. Procurement of Source

Sr .No	Type of application	No. of Devices as on 1-1-2004	Regulatory consents / NOC issued	
			Local	Import
1	**Radiotherapy**	**(318)**		
	● Telecobalt	258		25
	● Telecaesium	7		0
	● Accelerators	50		0
	● Gamma Knife	3		0
	Brachytherapy	**(215)**		
	● HDR	51		57
	● LDR	37		0
	● Manual (Intracavity)	76		2
	● Manual (Interstitial)	29		0
	● Opthalmic Sr-90	20		0
	● Opthalmic I-125	1		0
	● Opthalmic Ru-106	1		0
2.	**Nuclear Medicine**	Not Applicable		
	RIA facilities		6	58
	Diagnostic		44	98
	Therapeutic		37	73
	● Research		92	167
3.	Industrial Gamma Radiography Exposure Devices (Empty IGRED)	1186	650	6
4.	Gamma Irradiators	7	3	0
5.	Nucleonic Gauges	6700	59	188
6.	Diagnostic X-ray	~ 35,000	370 (Registered)	0
7.	Consumer Products			
	● Gas Mantle	64	23	0
	● Lamp starters	20	5	0
	● Electron capture devices	–	29	0
	● Smoke detectors	–	40	0

B. Export or Disposal of Sources

Nature of consent	Export		Disposal of sources	
	By BRIT	By user	At BRIT	At WMD, BARC
Authorization	48	25 (Disused Sources)	47	30

C. Shipments approved under special arrangement : 2

3.2.2 Regulatory Inspection

Regulatory inspections are conducted for the purpose of compliance assurance with the regulatory requirements. The basis for carrying out such inspections are the following.

- Routine and periodic.
- Receipt of intimation regarding unsafe practice.
- Reported excessive exposure.

A Committee appointed by AERB in the year 2000, recommended the frequency of periodic inspections. The recommended frequency of inspection was based on the category of the source (Gamma Irradiator, Telegamma, Industrial Radiography, Nucleonic Gauge, etc.). Particulars relating to inspections carried out during the year are given in Table 11.

3.3 RADIOLOGICAL SAFETY SURVEILLANCE

3.3.1 High Intensity Gamma Irradiation Facilities

AERB carried out inspections of the following six gamma irradiation facilities.

1. Panoramic Batch Irradiation Technology (PANBIT), Thiruvananthapuram, Kerala.
2. Radiation Vulcanization of Natural Rubber Latex (RVNRL), Kottayam, Kerala.
3. Radiation Sterilization and Hygenisation of Medical Products (RASHMI), Bangalore.
4. Shriram Applied Radiation Centre (SARC), Delhi.
5. Radiation Processing Facility, BRIT, Vashi, Navi Mumbai.

Table 11: Regulatory Inspections

S.No.	Type of application	No. of institutions as on 1-1-2004	No. of inspections carried out in 2003
1	Diagnostic X-ray	~ 35,000	129
2	Radiotherapy ● Teletherapy ● Brachytherapy	199 199 118	20
3	Nuclear Medicine ● Diagnostic (RIA) ● Diagnostic (including 22 CA thyroid treatment centres)	 427 135	23
4	Research	582	
5	Industrial Radiography	439	80
6	Gamma Irradiators	7	6
7	Nucleonic Gauges	347	13
8	Consumer Products ● Gas Mantle ● Lamp starters	 64 20	 23 5

6. Isotope in Medicine (ISOMED), BRIT, Mumbai.

AERB gave general directions to improve the status of radiological and industrial safety at these facilities. These include proper functioning of safety systems, monitoring system, record keeping of periodic maintenance schedule and updating of emergency contact numbers.

The mandatory quarterly safety status reports were received for all the four quarters in the year 2003, from all the gamma irradiation facilities. The occupational exposures in gamma irradiation facilities in the last five years did not exceed 6 mSv/y, which is well below the prescribed dose limit of 20 mSv/y. Four proposals for the replenishment of Cobalt-60 sources from gamma irradiation facilities were reviewed and clearances for the same were issued for augmenting the source strength. The source loading operations were safely and smoothly completed in three gamma irradiation facilities.

The Safety Standard entitled, "Radiological Safety for the Design and Installation of Land-Based Stationary Gamma Irradiators" was revised from the viewpoint of technological update and cumulative operational experience. The revised version of the Standard was examined by the AERB Safety Committee on Radiological Safety Documents.

AERB issued amendment in the licence for routine operation to SARC irradiation facility, New Delhi, in respect of enhancement of maximum design capacity of Co-60 irradiator source from 18.5 PBq to 30 PBq.

3.3.2 RAPP Cobalt Handling Facility

RAPP Cobalt Facility (RAPPCOF) was established in the year 1972, at RAPS site to handle and process large quantities of Cobalt-60 for various applications in the country. In order to meet the increased demand for sealed Cobalt-60 sources, the Board of Radiation and Isotopic Technology (BRIT), under which the RAPPCOF is established, had proposed to augment the processing capacity by setting up additional hot cells. BRIT submitted an application, requesting authorization for Civil Construction of Project ACHF (Augmentation of Cobalt Handling Facility) at RAPPCOF. After detailed review of the design and safety aspects of the project, AERB issued authorization for construction of project ACHF.

3.3.3 Radiation Diagnostic and Therapy Facilities

Twenty teletherapy and brachytherapy installations all over the country were inspected. On the basis of pre-commissioning safety analysis, AERB issued authorisations for the commissioning of 17 teletherapy units and 6 remote after-loading brachytherapy units during the year, and for the decommissioning of five teletherapy units. Permissions were accorded for re-starting four telecobalt and two accelerator facilities and three new radiotherapy centres. Twenty-three nuclear medicine facilities where unsealed radioactive materials are used for diagnostic and therapy purposes, were inspected. Licences were issued to 8 nuclear medicine laboratories. AERB received annual safety status reports from the licensees. These reports provided one of the inputs for continuous monitoring of radiological safety. AERB inspected 129 medical X-ray diagnostic installations for confirming compliance with the regulatory requirements. Deviations and violations of regulatory requirements, which were observed during the inspections, were taken up with the users. In some cases, AERB initiated appropriate regulatory actions such as suspension of licence of the institutes.

3.3.4 Industrial Radiography

There are 439 industrial radiography institutes in India. The total number of industrial gamma radiography exposure devices, which are in use in India, is 1186. Since radiography work may be carried out only at authorised sites, authorised users seek AERB's permission for movement of their radiographic devices from one approved site / storage to another. During the year, a large number of source movements were approved by AERB for carrying out radiography activities at various sites. Eighty industrial radiography sites and installations were inspected for confirming compliance with the regulatory requirements. Each user is required to send monthly safety status reports. These help AERB to monitor the radiological safety status continuously. These reports were reviewed for confirming compliance with the regulatory requirements.

3.3.5 Nucleonic Gauging

The application of nucleonic gauges for level monitoring, thickness gauging, density measurement and moisture detection in many industries such as steel, paper, plastic, textile, cement, power, coal and oil exploration recorded a notable increase. AERB inspected over 200 installations in 13 institutions. Each user is required to submit six-monthly safety status reports. These reports were reviewed for confirming compliance with the regulatory requirements. Where discrepancies were observed, AERB wrote to the user institutions and obtained the necessary clarifications. Besides providing inputs for radiological safety surveillance, these reports help to update the source inventory. AERB compiled a database of the radioactive materials used in nucleonic gauging.

3.3.6 Manufacture of Consumer Products

Consumer products like ionization chamber smoke detectors, fluorescent lamp starters and thorium gas mantles use very small quantities of radioactive materials and are manufactured by authorized and experienced persons in approved installations. In order to maintain a high level of safety in the manufacturing units of such products, twenty-eight inspections were conducted. It was found that the practices followed were in conformity with the regulatory requirements.

3.3.7 Transport of Radioactive Materials

Data on package design approvals issued by AERB were furnished to IAEA in the prescribed format for inclusion in the IAEA PACKTRAM database. The package design approvals for BRIT Gamma Chamber model GC-12000 and Low Dose Irradiator model LDI-2000 were issued. Also, AERB revised and renewed for package design approval for Blood Irradiator model BI-2000 and PANBIT FP-100 K respectively.

Twenty-four authorizations for transport of radioactive material were issued, while four regulatory inspections of packages were carried out during the year. Safety in transport of radioactive materials in the public domain is ensured by strict compliance with the "Surveillance Procedures for Safe Transport of Radioactive Materials, 1987" and the AERB Safety Code on "Transport of Radioactive Materials, 1986". Regulatory activities include safety assessment and package design approval for transport, renewal of package design approvals. As a measure of compliance assurance, representatives of AERB witnessed the testing of one Type B packaging by BRIT and NPCIL respectively. AERB regularly communicates with other government authorities for the safe transport of the radioactive material in and out of the country. The concerned nodal agencies are Director General of Civil Aviation, New Delhi, Port Trusts, Indian Railways, Airport Authority and Customs. AERB sent twenty-one recommendations to port authorities for prompt clearance of the radioactive consignments arrived at Indian ports. Indian customs authorities are well informed about the requirements of the NOC from AERB for export/import of radioactive material by any private/government organisations.

3.3.8 Disposal of Radioactive Materials

The users send decayed radioactive materials from medical, industrial and research institutions for safe disposal to one of the approved radioactive waste disposal facilities in India. The number of authorizations issued for disposal was as follows.

Export to original supplier:	25
For transfer at domestic supplier	47
Consignments transported for disposal	30

3.4 INVESTIGATION OF UNUSUAL OCCURRENCES

Instances of unusual occurrence come to light during inspections. Often the reported instances of excessive exposure recorded in the individual monitoring (TLD) badges worn by workers also indicate possibilities of unusual occurrences. Occasionally communications are received from the licensee or third parties about instances of unusual occurrences. All such instances are investigated if the investigation reveals that regulatory safety requirements specified in the applicable safety code have not been complied with, enforcement actions commensurate with the nature of the instance are implemented. Particulars regarding unusual occurrences are given in Table 12.

Table 12: Unusual Occurrences in 2003

Activity	No. of Institutes	Common Violations
Industrial Radiography	5	(i) Radiography carried out at unauthorised sites (ii) Unauthorised source movements (iii) Trainee radiographers operating devices (iv) carrying out radiography work without TLD.
Nuclear Medicine Centres	5	(i) Alteration in the approved plan of the layout (ii) Non-availability of approved RSO & technologist. (iii) Transfer/ sharing of radio pharmaceuticals without approval.
Radiation Therapy Installations	3	(i) Non - functional equipments for carrying of routine & special dosimetry procedures. (ii) Non-availability of accessories for handling brachytherapy sources. (iii) Non-availability of approved RSO. (iv) Improper location of zone monitor.

3.4.1Theft of Three Level Gauges Containing Radioactive Sources (Co-60) from Storage of Tata Steel Works, TISCO, Jamshedpur

Three Level Gauges (make Berthold, Germany and model LB-352) each containing Co-60 radioactive source of approx. 1.8 mCi activity were stolen from the radioisotope storage room of R & D department at Tata Steel Works,TISCO, Jamshedpur. These gauges were kept as spares. The theft was noticed on 15-08-2003 in the afternoon. The hole of about 2' x 2' was noticed on the rear wall of the store room. TISCO official immediately lodged an FIR with press release and intimated AERB on 16-08-2003. Police authorities investigated the case in depth and concluded that gauges were pilfered nearly two months ago, stolen by iron scrap thieves and reached prominent scrap dealers of Delhi, via Kolkata. The search operations were conducted by TISCO officials with police at Delhi & Kolkata scrap dealers storages but could not be recovered the gauges containing isotopes.

TISCO has been recommended to enhance the security measures for the existing gauges containing radioisotopes and continue the efforts to search the gauges. AERB inspection team visited TISCO works on September 6-9, 2003 to verify the security measures provided for the other sources and found them to be adequate and suggested to take the inventory of available radioisotopes on a weekly basis.

3.4.2 Non Compliance of Regulatory Requirements in Safdarjung Hospital, New Delhi

On regulatory inspection of Safdarjung Hospital, New Delhi, it was observed that the radiation therapy department of the hospital was not complying with the essential regulatory requirements, viz (i) availability of AERB approved Radiological Safety Officer,(ii) performing Periodic Quality Assurance tests of the Telecobalt unit,(iii) calibrating and maintaining the radiation measuring and monitoring instruments in working condition , (iv) sending the annual report on status of radiation safety to AERB and (v) retaining in the hospital the unused sources and radiation therapy units, which are potential hazard . On that basis, AERB issued a Directive, AERB/RSD/RT/DL-7/2003/7423, dated October10, 2003, to the hospital that they should not admit new patients to the radiotherapy department for radiation therapy. The Board also directed that the treatment schedule of the patients currently undergoing radiation therapy may be continued, if deemed necessary.

On intimation (12.11.2003) from the Hospital, New Delhi that they have complied with the AERB stipulations, an officer from AERB inspected (14.11.2003) the radiation therapy department of Hospital and verified the compliance. Subsequently, AERB permitted resumption of the operation of the radiation therapy department of Safdarjung hospital with certain conditions.

Some other specific cases of unusual occurrences during the period are reported in brief here.

- Two nucleonic gauges containing Am-241 were caught in a fire in an industrial establishment at Nanded. Sources were intact.
- Four Nucleonic gauges incorporating Cs-137 source of low activity were found to be missing from the installation during the regulatory inspection. The search for the sources is in progress.
- A nucleonic gauge was stolen from the storage area of the factory premises. The sources were of low activity. Yet a thorough search has been instituted.
- A gamma radiography exposure device Roli-1 was reported to be stolen from the storage facility.
- A source capsule was received by the authorized user detached from the source pigtail of an industrial gamma radiography exposure device.
- Brachytherapy source of a High Dose Rate unit was found to be contaminated at Chittaranjan National Cancer Hospital, Kolkata. The unit is dismantled and contaminated parts are packed for safe disposal.
- A resident of Kolkata reported about the presence of four numbers of radium sources of total activity 2.56 GBq (70 mCi) which were used by her father, a radiotherapist, for patient treatment. The sources were recovered and are brought to Mumbai for safe disposal in BARC.

In all the above instances, a team was deputed to the affected site to conduct an investigation.

3.5. REVIEW OF NON-COMPLIANCE WITH REGULATORY PROVISIONS

3.5.1 Industrial Radiography

During inspections carried out by AERB, it was observed that six industrial radiography institutes violated the regulatory provisions stipulated for industrial radiography. These include carrying out radiography work at unauthorised sites, movement of industrial radiography devices from one site to another without obtaining prior permission from AERB, permitting trainee radiographers to operate radiography devices without direct supervision by a trained person and carrying out radiography work without using appropriate individual monitors. All these instances were investigated and enforcement actions taken against such institutes include issuance of warning letters, suspension of radiography work and authorizations to procure radiography sources for interim period, submission of detailed report on radiation safety programme being followed in defaulting institutions and withdrawal of the certificates of radiography personnel.

3.5.2 Radiotherapy Centres

Inspections of radiotherapy centres were conducted in many parts of the country. The instances of non-compliance observed include, inadequate quality assurance procedures, non-availability of basic quality assurance devices and dose measuring instruments, non-availability of accessories for handling brachytherapy sources, improper location of gamma zone monitors, non-availability of approved Radiological Safety Officer, non-submission of annual safety status report and presence of disused decayed radiotherapy sources. Enforcement actions taken against the defaulting institutions include, issuance of warning letters, revocation of license issued to operate teletherapy units, denial of fresh licenses until the safety status conformed to the regulatory standard.

3.5.3 Nuclear Medicine Centres

There were instances of non-compliance with the regulatory requirements in nuclear medicine centres. The instances included alteration of approved lay out plan of the facility, non-availability of approved Radiological Safety Officer and Technologist, permitting workers to handle radioactive material without proper individual monitors and transferring of radiopharmaceuticals among the users without prior permission from AERB. The enforcement actions taken by AERB against the defaulting institutions included, issuance of warning letters, suspension of licence issued to handle radioactive material and denial of licence to handle additional radioactive material until the safety status of the centre conformed to the regulatory standard.

3.6 PREPARATION OF REGULATORY DOCUMENTS

Regulatory documents prepared by AERB fall under three categories, viz., Safety Codes, Safety Guides and Standard Specifications. Chairman, AERB during the year constituted the Safety Committee for Radiological Safety Documents (SCRSD) to identify the need for new regulatory documents and review and revise existing documents. During the year Task Groups were appointed

for revising old documents and preparing new documents. Work on revising the Safety Codes on Teletherapy and Brachytherapy made considerable headway.

3.7 OTHER ACTIVITIES

3.7.1 Handling of Naturally Occurring Radioactive Materials (NORM)

An industrial firm at Taloja proposes to chemically process 300 tons per month of imported Columbite and Tantalite ore concentrate for the extraction of Niobium and Tantalum metal. The ore contains naturally occurring radioactive materials. The proposal was evaluated by the "Safety Committee on Naturally Occurring Radioactive Material (SCNORM)". This is the first private industry proposing to chemically process NORM.

Two industries are involved in using Columbite and Tantalite concentrates for making ferro alloys by thermic process. Slag produced in the process contains NORM, which is used in land filling in the factory area only.

3.7.2. Accreditation of laboratories

AERB devised an accreditation programme for institutions certifying the radioactivity content in commodities. Accreditation certificate was issued to the Low Level Measurement Laboratory of the Environmental Assessment Division, Bhabha Atomic Research Centre, Mumbai. Many applications have been received for accreditation.

3.7.3 Training activities

Members of AERB served as faculty for courses in BARC training school, the Diploma in Radiological Physics conducted by RP&AD, BARC and other courses.

Various medical institutes in the country are conducting training programmes for radiography and radiotherapy technicians. AERB, in consultation with experts from RPAD, BARC and on the strength of the advice provided by SARCAR, evolved a comprehensive course content for the radiological safety components of these programmes.

Training programmes were conducted for X-ray service engineers, nuclear medicine technologists, for medical physicist cum RSO in radiation therapy facilities, technicians for radiotherapy and radiography facilities and for qualifying as RSOs of gamma radiation processing facilities. With this effort, the volume of specialized trained manpower would increase. This will contribute to further improved radiological safety status in radiation facilities. In order to meet with the increase in demand for nuclear medicine technologists, AERB has accredited two more centres, namely, (1) Christian Medical College, Vellore and (2) Manipal Academy of Higher Education, Manipal, in addition to the existing training centre (Radiation Medicine Centre, Mumbai).

CHAPTER 4
ENVIRONMENTAL AND OCCUPATIONAL SAFETY

4.1 ENVIRONMENTAL SAFETY

The Environmental Survey Laboratories (ESL) of the Health, Safety and Environment Group, BARC carry out environmental surveillance of all operating plants under DAE. The radiological impact on the surrounding environment due to operation of these plants is assessed by ESL at sites on a continuous basis. The radioactivity released to the environment during the year 2003 from the operating units was only a small fraction of the prescribed safe Technical Specification limits. Fig.3a-3e show the liquid and gaseous discharges from the plants. Data for previous years is also included for comparison. Fig.4a and 4b show the committed dose to the members of public due to release of radioactive effluents from the plants. Radiation dose to members of public near the operating NPPs is estimated based on measurements of radionuclide concentration in terms of diet, i.e., vegetables, cereals, milk, meat, fish, etc. and intake of air and water. It is noteworthy that in all plants the effective dose at 1.6 km (which is the exclusion zone for all plants except Kaiga, in which case it is 2.3 km) is much less than the AERB dose limit of 1 mSv.

4.2 OCCUPATIONAL EXPOSURES

AERB stipulates for the occupational worker, a dose limit of 30 mSv per year and 100 mSv for a 5 year block (the just-concluded block is 1999-2003). Of all radiation workers who were engaged at various NPPs only one worker exceeded 100 mSv in the above 5-year block. There was no worker who exceeded the annual limit of 30 mSv in the year 2003 (Refer Tables 13a & 13b). The details of the worker exceeding 100 mSv were reported in the last Annual Report 2002-2003.

The number of workers who received radiation doses greater than 30 mSv (Annual Limit) and 20 mSv during the year 2003 in NPPs is given in Table 13(a). The percentage of workers who received doses above the limits is given in Table 13(b). Data from earlier years is also given for comparison.

Given the large number of radiation facilities and the large number of workers occupationally exposed to radiation, the individual dose received by workers has been well below the regulatory limits. Investigation of the various reported instances of excessive exposures revealed that there were only 47 instances of possible exposure above the stipulated limit of 10 mSv during the monitoring period. The total number of workers outside DAE who are subject to individual monitoring is nearly 28,000. The occupational exposure received by persons working in medical, industrial and research institutes in India during the year 2003 is given in Table 13(c).

Whenever the dose recorded in the individual monitoring badge exceeds 10 mSv in a monitoring period, as against the annual dose limit of 20 mSv, the incident is termed an instance of excessive exposure. There were a total of 58 instances of exposure in excess of the limit of 10 mSv in a monitoring period during 2003. The break-up is given below:

- Diagnostic X-ray installations : 11
- Nuclear medicine : 2
- Industrial radiography : 45

Investigations were made by AERB in respect of each of these cases. There were some instances where the workers did indeed receive the recorded dose. In the other instances, when the accuracy of the explanation provided by the worker could not be confirmed or rejected, the recorded dose was deemed genuine and assigned to the worker.

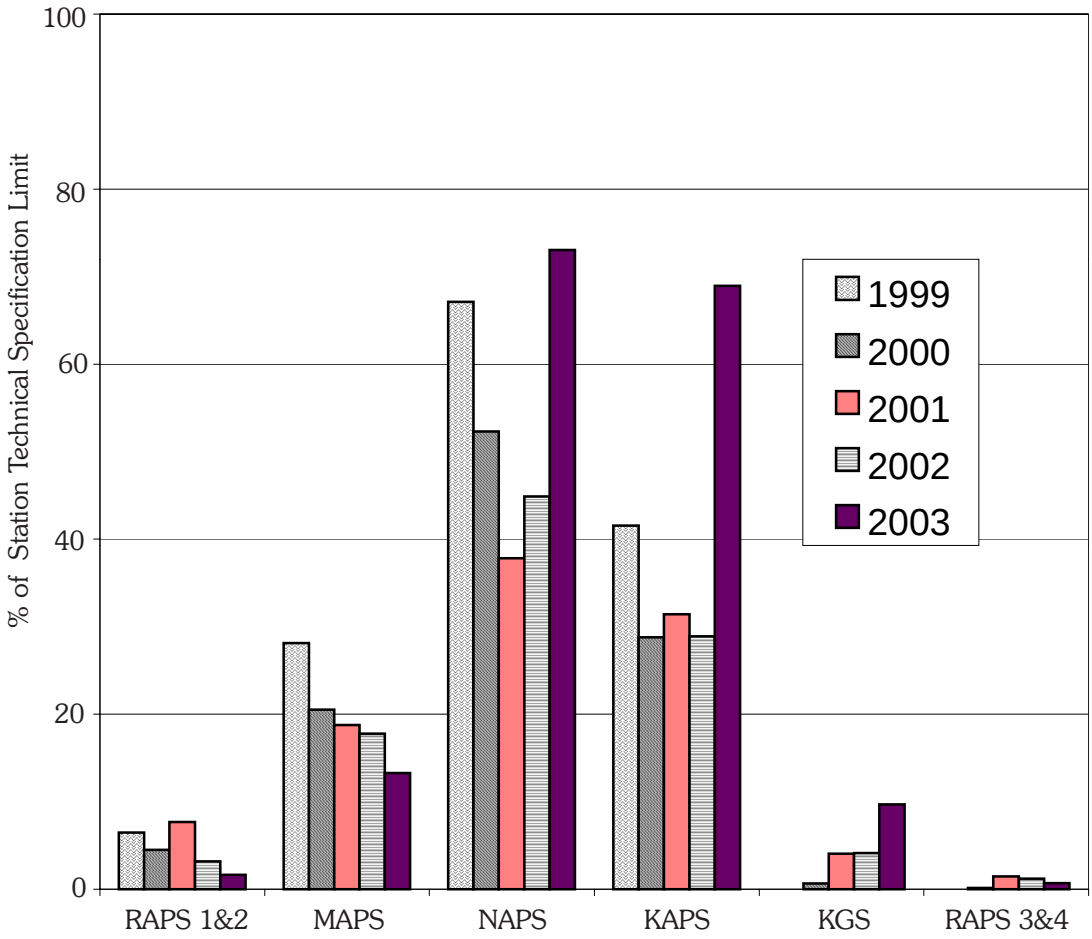
4.3 OCCUPATIONAL HEALTH SAFETY

4.3.1 Advisory Committee on Occupational Health

The major activities of Advisory Committee on Occupational Health (ACOH) was better assessment procedure of the medical records by modifying the format for reporting the Occupational Health Status as well as the format for Industrial Hygiene Surveillance. The committee has been strengthened with members who are experts in Occupational Health from outside DAE.

The health status of DAE units was discussed in the Safety Professionals Meet held in Hyderabad. Suspected Noise Induced Hearing Loss cases were detected in UCIL-Jaduguda, HWP-Tuticorin and HWP-Baroda.

Figure 3a : Liquid Waste Discharges From NPPs (Tritium)



Note:

1) TAPS is a Boiling Water Reactor. Hence, there is no generation/dishcharge of Tritium.

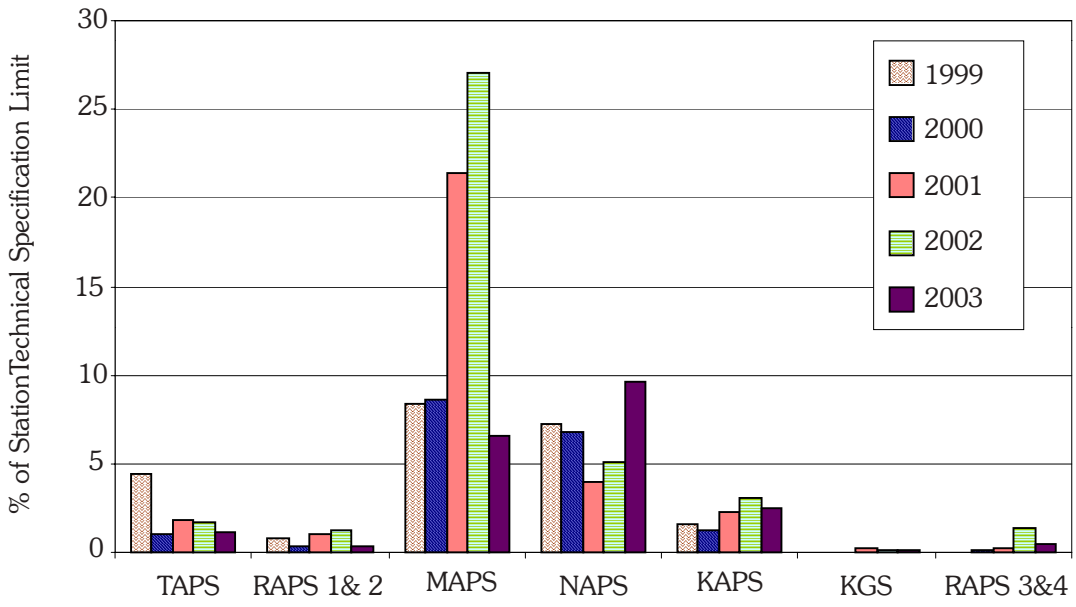
2) The data of MAPS pertains to transfer of liquid waste to Centralised Waste Management Facility, Kalpakkam for processing & discharge to the environment.

3) During 2002, RAPS-1 operated for 81 days and during 2003 RAPS-1 was shut down throughout the year.

4) During 2002, MAPS-2 remained shut down throughout the year and during 2003 it remained shut down for the first six months owing to EMCCR activities.

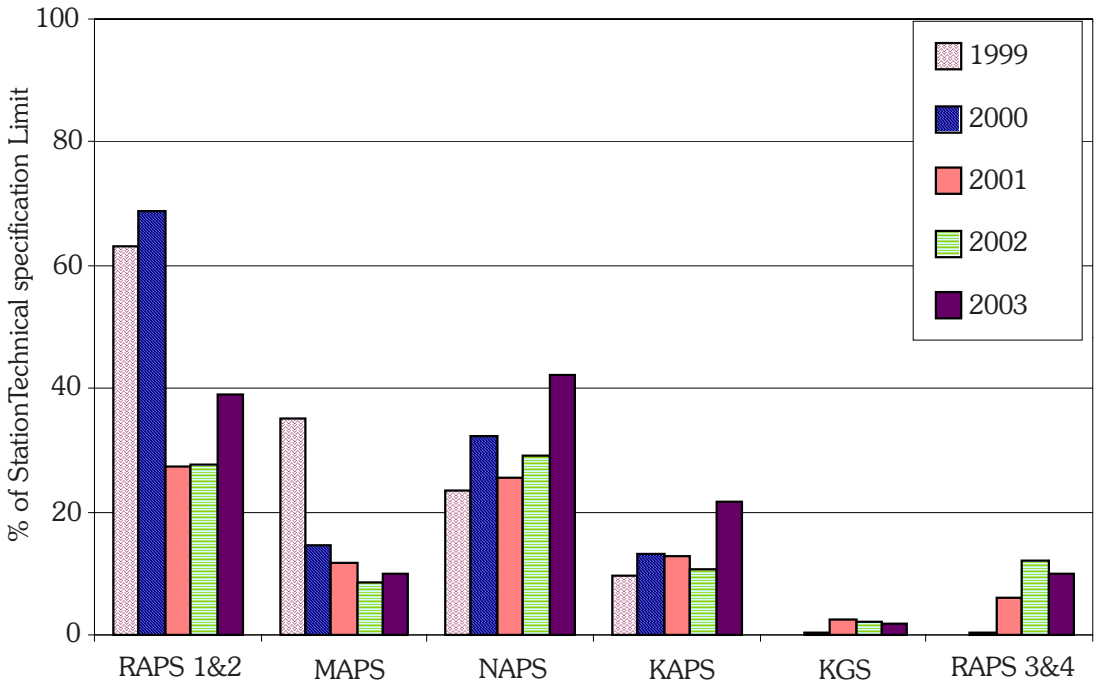
5) During 2003, MAPS Unit-1 remained shutdown for 4½ months.

Figure 3b: Liquid Waste Discharges from NPPs (Gross Beta)



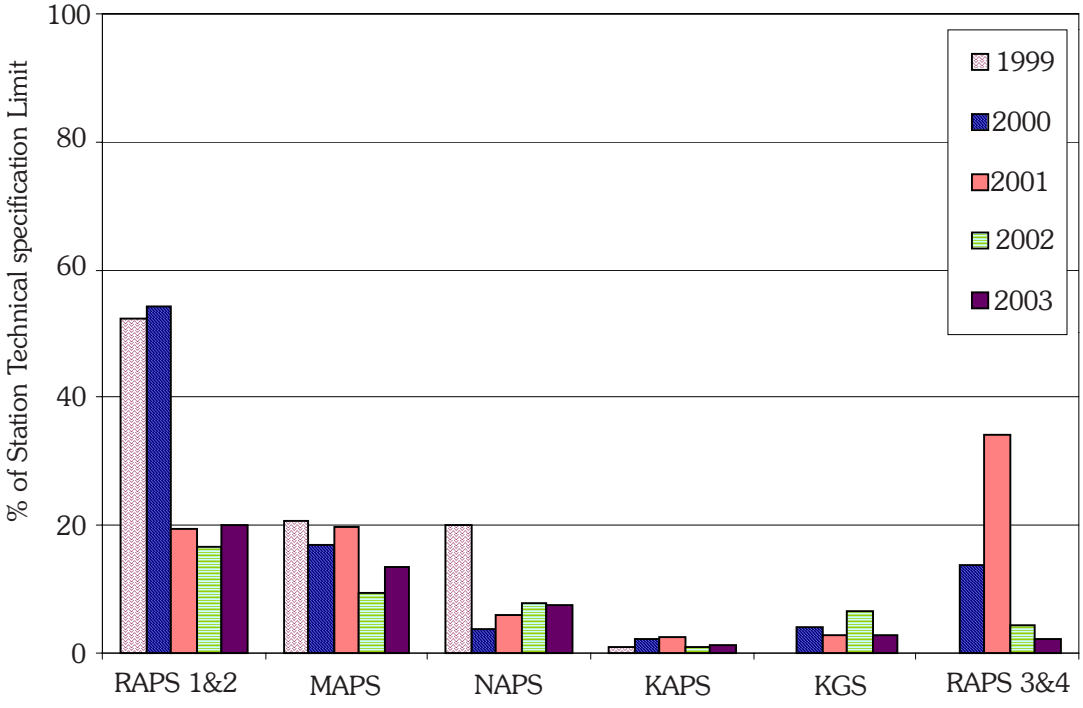
Note: The data of MAPS pertains to transfer of liquid waste to Centralised Waste Management Facility, Kalpakkam, after which it is processed and then discharged to environment.

Figure 3c : Gaseous Waste Discharges From NPPs (Tritium)



Note: TAPS is a Boiling Water Reactor. Hence, there is no generation/discharge of Tritium.

Figure 3d : Gaseous Waste Discharges From NPPs (Argon-41)



Note:TAPS is a Boiling Water Reactor. Hence, there is no generation/discharge of Ar-41.

Figure 3e : Gaseous Waste Discharges from NPPs
Fission Product Noble Gases

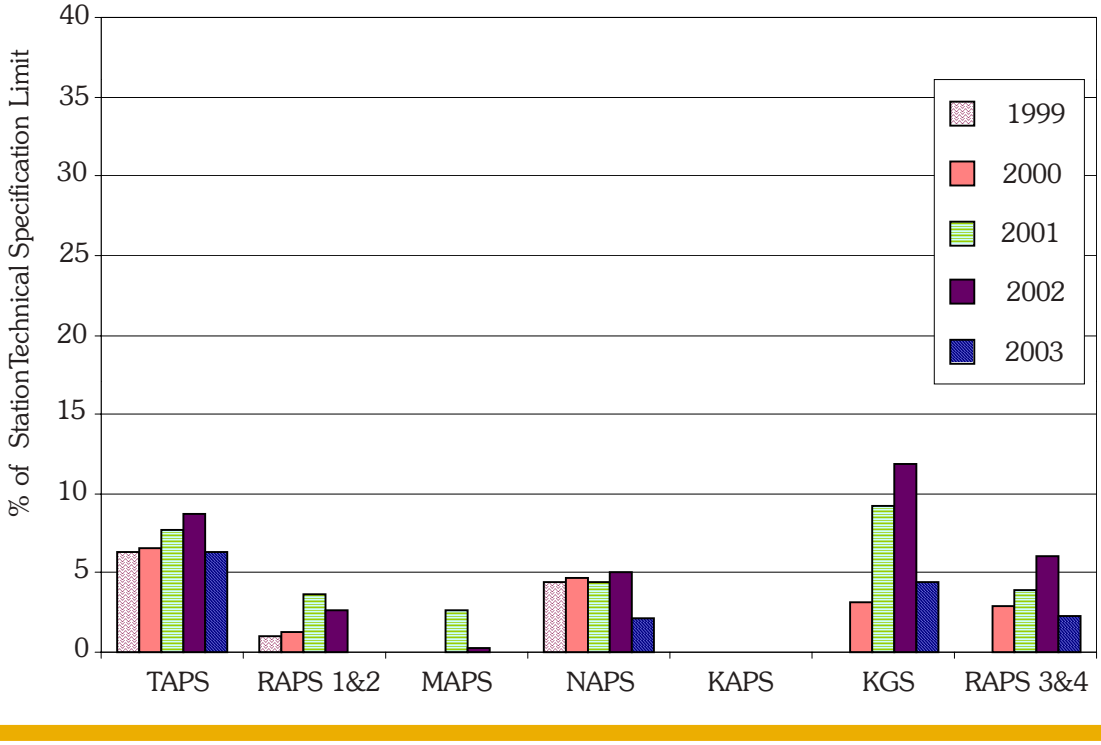


Table 13a. No. of Workers in NPPs exposed to > 20 mSv (Investigation limit) & > 30 mSv (Annual limit)

Year	1999		2000		2001		2002		2003	
	20-30mSv	>30 mSv	20-30mSv	>30 mSv	20-30mSv	>30 mSv	20-30mSv	>30 mSv	20-30mSv	>30 mSv
TAPS	0	0	0	0	0	0	2	0	0	0
RAPS1&2	29	1	1	0	37	1	0	0	0	0
MAPS	10	4	1	0	0	0	2	1	0	0
NAPS	41	0	10	1	16	1	10	1	1	0
KAPS	0	0	0	0	1	0	1	0	3	0
KGS			0	0	0	0	0	0	0	0
RAPS3&4			0	0	0	0	0	0	0	0

Table 13b: Percentage of total number of workers in NPPs exposed to between 20-30 mSv and > 30 mSv

Year	Total number of radiation workers	Those with annual dose			
		20-30 mSv		>30 mSv	
		Number	%	Number	%
1999	10233	80	0.80	5	0.05
2000	10276	12	0.12	1	0.01
2001	13059	54	0.47	2	0.02
2002	14019	15	0.11	2	0.01
2003	13568	4	0.03	0	0.00

Table 13c: Radiation Dose received by Workers in Medical, Industrial and Research Institutes

Category of Radiation Worker	Average Dose for Monitored Persons (mSv)	Average Dose for Exposed Persons (mSv)	Number of Workers Receiving Annual Individual Dose Excluding Zero Dose, D (mSv)					
			0 < D ≤20	20 < D ≤ 30	30 < D ≤ 35	35< D ≤ 40	40 < D ≤50	D > 50 Diagnostic
Diagonstic X-rays	0.52	1.29	4941	6	2	1	2	8
Radiation Therapy	0.39	0.95	1828	1	-	-	-	2
Nuclear Medicine	0.51	1.01	459	-	-	-	-	-
Industrial Radiography & Radiation Processing	0.73	2.02	950	6	1	-	2	3
Research	0.09	0.66	335	-	-	-	-	-

Fig 4a: Public Dose at 1.6 km Distance from NPPs-
AERB Prescribed Annual Dose Limit is 1000 micro-Sv

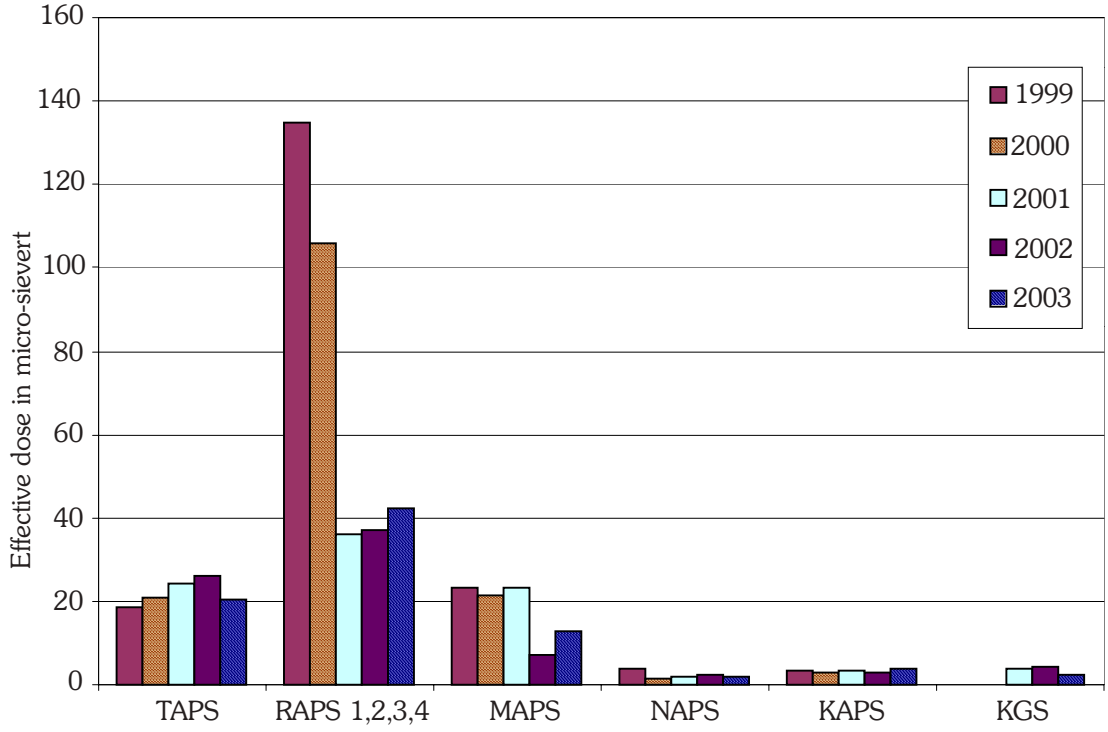
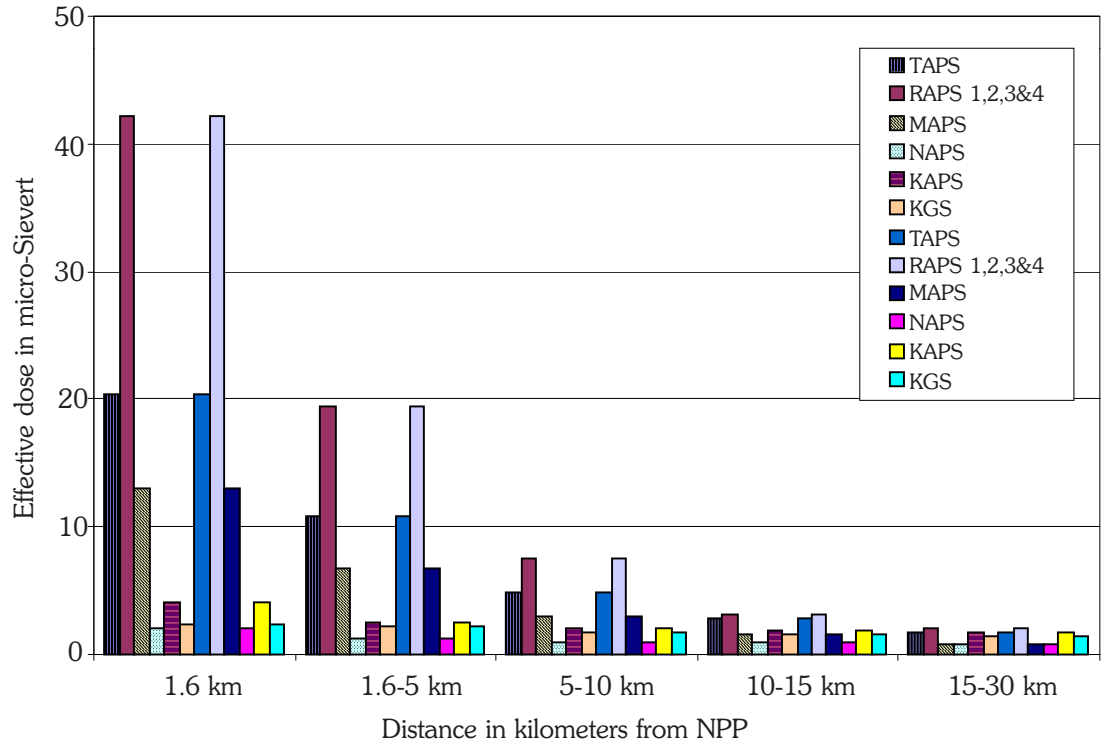


Fig 4b: Total Effective Dose in Different Zones during the Year 2003
(Dose Limit = 1000 micro-Sv)



CHAPTER 5
EMERGENCY PREPAREDNESS

Nuclear power plants are provided with adequate safety features to minimize the probability of any accident. The safety features such as containment help in mitigating the consequences of any accident. However, in the extremely rare event of a nuclear accident, it may be necessary to take mitigating measures in the public domain such as evacuation of persons in the vicinity of the plant. This requires a high degree of preparedness. Site-specific emergency preparedness plans are drawn up and maintained by all stations. To test these plans periodic emergency preparedness exercises are carried out and involve the station authorities, district administration and the members of public.

The exercises help in evaluating the readiness of plant and district agencies involved and also increase the awareness amongst public. Independent observers are posted by BARC/AERB to witness these exercises and bring out deficiencies.

During the year 2003, the offsite emergency exercises were carried out as given in Table 14.

The response of the plant personnel, officials and public involved in the exercise and general level of awareness of the public was good.

Presently, a total of 9 nuclear power plants are under construction. 7 of these 9 units, (except the two units at Kudankulam) are being constructed at the existing sites, wherein nuclear power plants and/or H_2S based heavy water plant or other nuclear facilities are already operational. Generally, a few thousand construction-personnel are involved during construction phase of the power project, normally lasting 5-8 years. A large number of contractors' personnel and their family members reside in the "Labour Colony" located within the Emergency Planning Zone, during the construction phase.

Considering this, AERB has stipulated that Emergency Preparedness Plan should be prepared to ensure that the construction personnel including contractors' workers, and the personnel residing in the labour colony are protected in case of any Emergency arising in the nearby operating NPPs, H_2S based Heavy Water Plant or any other nuclear facility.

Table 14. Off-Site Emergency Exercises

PLANT	PEE* (once in a quarter)	SEE* (once in a year)	OSEE* (once in 2 years)
TAPS	3	1	1
RAPS 1&2	3	1	0
MAPS + IGCAR	4	2	1
NAPS	3	1	1
KAPS	4	1	0
KGS	4	0	0
RAPS3&4	4	0	0

PEE : Plant Emergency preparedness Exercise
SEE : Site Emergency preparedness Exercise
OSEE : Off-Site Emergency preparedness Exercise

CHAPTER 6
DEVELOPMENT OF REGULATORY DOCUMENTS

One of the important functions of AERB is to develop safety documents, which include safety codes, standards, guides and manuals for nuclear, radiation and industrial facilities and other related activities. The various working groups and Divisions of AERB and advisory committees such as Advisory Committees on codes and guides for design, operation, quality assurance, siting etc. are involved in the preparation of these documents. Safety Analysis and Documentation Division has been coordinating in the preparation process and publication of these documents.

6.1 DOCUMENTS PUBLISHED

Hydrogen Release and Mitigation Measures under Accident Conditions in Pressurised Heavy Water Reactor (AERB/NPP-PHWR/SM/D-2)

This safety manual deals with estimation of hydrogen generation due to metal-water reaction and radiolysis during accident conditions in pressurised heavy water reactors. It also provides information on hydrogen mitigation measures in containment.

In-Service Inspection of Nuclear Power Plants (AERB/NPP/SG/O-2)

This safety guide outlines the provisions relevant to In-service Inspection of safety and safety-related systems and pressure retaining components including their supports. It covers the classification of areas subject to inspection, responsibilities, provision for access, inspection techniques and procedures, personnel qualifications, frequency of inspections, documentation, records, evaluation of inspection results, disposition of non-conformances and repair requirements.

Management of Radioactive Waste Arising from Operation of Pressurised Heavy Water Reactor Based Nuclear Power Plants (AERB/NPP-PHWR/SG/O-11)

Guidance on management of radioactive waste generated from operation of PHWRs and other special activities carried out during the life time of the plant such as coolant channel replacement, chemical decontamination of reactor system and waste generated on account of LOCA have been covered in the safety guide.

Proof and Leakage Rate Testing of Reactor Containment (AERB/NPP/SG/O-15)

This safety guide provides guidelines for proof testing and leakage rate testing of reactor containments with primary containment as pre-stressed concrete (PCC) and secondary containment as reinforced concrete (RCC). It covers both pre-operational and in-service tests. Guidance on leakage rate calculation methodologies and criteria for test acceptance are also provided.

Guidelines for Personal Protective Equipment (AERB/SG/IS-3)

This publication provides guidelines to the management of sites to maintain effective performing for protection against potential hazards using appropriate types of personal protective equipment for situations where the hazard could not be eliminated or controlled by engineering methods.

6.2 DOCUMENTS UNDER PREPARATION

Safety guide AERB/NPP/SG/G-1 on "Consenting process for Nuclear Power Plants and Research Reactors: Documents Submission, Regulatory Review and Assessment of Consent Application":

Reviewed and cleared by ACCGORN for submission to Chairman, AERB for publication.

Safety guide AERB/NF/SG/G-2 on "Consenting Process for Nuclear Fuel Cycle and Related Industrial Facilities: Documents Submission, Regulatory Review and Assessment of Consent Applications"

Under final review by ACCGORN.

Safety guide AERB/RF/SG/G-3 on "Consenting Process for Radiation Facilities: Documents Submission, Regulatory Review and Assessment of Consent Applications"

Under review by ACCGORN.

Safety manual AERB/NPP/SM/RI-1 on 'Regulatory Inspection of Nuclear Power Plants'

Under review by ACCGORN.

Safety guide AERB/NPP/SG/O-13 on "Operational Safety Experience Feedback for Nuclear Power Plants"

Reviewed by ACCGASO and under review by ACNS.

Safety guide AERB/NPP/SG/O-14 on "Life Management of Nuclear Power Plants"

Under review by ACNS.

Safety manual AERB/NF/SM/O-1 on 'Probabilistic Safety Assessment Guidelines'

Under review by ACCGASO.

Safety guide AERB/NPP/SG/QA-6 on 'Assessment of Implementation of the Quality Assurance programme in Nuclear Power Plants':

Under review by ACNS.

Safety guide AERB/NPP/SG/QA-7 on 'Establishing and Implementing a Quality Assurance programme for Nuclear Power Plants'

Reviewed by ACCGQA and under review by ACNS.

Safety guide AERB/NPP/SG/QA-8 on 'Document Control and Records for Quality Assurance in Nuclear Power Plants'

Under review by ACCGQA.

Safety guide AERB/NPP/SG/QA-9 on 'Non-conformance control and Corrective actions for NPPs'

Under review by ACCGQA.

Safety guide AERB/SG/D-12 on 'Radiation Protection Aspects in Design of Pressurised Heavy Water Reactor Based Nuclear Power Plants'

Under review by ACNS.

Safety guide AERB/SG/D-10 on 'Safety Critical Systems for Pressurised Heavy Water Reactor Based Nuclear Power Plants'

Under review by ACNS.

Safety guide AERB/NPP/SG/S-5 on 'Methodologies for Radiation Dose Computation from Radioactivity Concentrations in Environment'

Under review by ACNS.

Safety Guide on Management of Radioactive Waste from Mining and Milling of Uranium, Thorium and Processing of NORM

Under review

Safety Guide on Accelerators

Under preparation

AERB/S/IRSD/-1 on Fire Safety Standard for Nuclear Installations

Under revision

CHAPTER 7
SAFETY ANALYSIS AND CODE DEVELOPMENT : WORKSHOPS, CONFERENCES AND SCIENTIFIC PUBLICATIONS

7.1 SAFETY ANALYSIS

As a defence-in-depth principle to safety assessment for a nuclear facility, safety analysis is carried out by two approaches: deterministic analysis also known as Accident Analysis and Probabilistic Safety Assessment (PSA). The PSA complements/ supplements deterministic analysis, engineering judgement and experience. PSA is performed in three levels.

Level 1 PSA quantifies probability (frequency) of damage, called core damage frequency (CDF) to a nuclear power plant (NPP), Research Reactor (RR), postulates occurrences of various initiating events and develops accident sequences based on success/failure probability of mitigating systems. A Level 1 PSA provides insights into the weak links in the design and ways of preventing core damage.

Level 2 PSA, taking inputs from Level 1 PSA, quantifies the frequency of radioactivity release outside the containment under accident conditions. Level 2 PSA provides insights into the relative importance of accident sequences leading to core damage in terms of the severity of the radioactive releases, containment failure modes, basis for off-site emergency planning strategy, etc.

A Level 3 PSA, together with the results of Level 2 analysis, assesses off-site consequences and estimates risk to the public and provides insights into the relative importance of accident prevention and mitigatory measures expressed in terms of the adverse consequences for the health of both plant workers and the public, and the contamination of land, air, water and foodstuffs.

7.1.1 Probabilistic Safety Analysis

Regulatory guidelines on PSA include submission requirements of PSA studies for various activities/ stages of consenting process for new and operating plants, use of plant specific data/ relevant generic Indian NPP/RR data/ Bayseian updates as applicable for analysis, establishing probabilistic safety goals/ targets and uses of PSA. Although PSA inputs are primarily used with risk-informed approach, a host of other parameters related to plant performance for operating plant is also considered for the consenting process that includes periodic safety reviews and license renewal. Some of these performance parameters e.g., effectiveness of training, plant safety culture etc. may not be quantifiable but are qualitatively evaluated. Risk-informed approach in our parlance implies risk-informed performance based evaluation.

The guidelines on different aspects of PSA including regulatory aspects, performance and review with assured quality and use of state-of-the-art methodology and softwares are incorporated in a safety manual (titled as 'Guidelines on PSA' in previous annual report). This draft document is now in an advanced stage of review by the Advisory Committee (ACCGASO).

The Committee on PSA for Nuclear Facilities constituted by AERB in August 2002, has been reviewing and monitoring PSA-related studies in DAE. The Level 1 PSA studies for internal events of TAPS were reviewed and recommendations given for further improvements in safety. The Level 1 PSA studies for KAPS is in an advanced stage of review. Updation of MAPS Level 1 PSA for internal events with plant specific data and incorporation of latest plant modification (e.g., high pressure emergency core cooling injection) is also in an advanced stage of review.

The report on reliability analysis on Reactor Shutdown System for PFBR has also been reviewed. Earlier, reactor decay heat removal system was reviewed and cleared.

Development of risk monitor with the help of BARC to know the current risk status in the plants is in progress. The software is undergoing various tests and validation prior to approval for installation at site for day-to-day use.

7.1.2 Deterministic Safety Analysis

The Preliminary Safety Analysis Report (PSAR) on accident analysis of Kudankulam project was reviewed. There were 13 packages covering Anticipated Operational Occurrences, Design Basis Accidents, Severe Accidents and Hypothetical Accidents. Reviews of all the packages have been completed by the Specialists Group (SG). The comments of SGs on the six packages were reviewed by the advisory committee (ACPSR-LWR) and accepted.

The revised accident analysis reports of NAPS and MAPS submitted as part of periodic safety reviews have been reviewed by an Expert Group. The reports with regard

to the NAPS have been accepted (with certain recommendations with regard to refinement in analysis coverage and documentation). The review report for MAPS is in the final stage of issuance.

Validation of the "ASTEC" code against some experimental results for vessel rupture case, ex-vessel phenomena, especially melt layer formation with results obtained from "MELCOR" code is under progress.

Detailed design and stress analysis of AHWR steam drum down comer nozzle as per ASME Section III code requirements was carried out using Finite Element Method (FEM) package 'ANSYS'. Analysis on fracture and structural integrity assessment on other components under this project is in progress.

7.2 SAFETY RESEARCH & DEVELOPMENT

The Safety Research Programme of AERB made good progress during the year. AERB approved the following projects after detailed discussions in the various meetings.

- Cell Membrane Injury and Apoptosis as A Predictor of Radio-Response: Optimization of Use of Radiation In Treatment of Uterine Cervical Carcinoma By BARC, Trombay.

- Estimation of Thick Target Neutron Yields From Charged Particle Reactions For Accelerator Safety Research: Comparison of Nuclear Reaction Model Codes By Visva-Bharati, Shantiniketan.

The Committee on Safety Research Programme reviewed the presentations made by the Principal Investigators on the progress of the following AERB projects. CSRP recommended renewal of 16 ongoing projects and grants to 14 organizations / institutes for conducting various seminars /symposia / conferences for the year.

Sr. No.	Project No./Title	Principal Investigator and Institution
1	AERB/26/01 Validation on the measurement of translocation frequency for cumulative dose estimation	Dr. Solomon F.D. Paul SRMC, Chennai.
2	AERB/26/02 Micronuclei and comet assay as a tool for radiation biodosimetry	Dr. G.C. Jagetia Kasturba Medical College, Manipal.
3	AERB/26/03 Radiation induced chromosome aberrations and their use in biodosimetry	Dr. G.S. Pant, AIIMS, New Delhi.
4	AERB/26/04 Study of telometric damage patterns in cancer patients before and after radiotherapy	Dr. Sridevi Hegde, Manipal Hospital, Banagalore.
5	AERB/AGSR/04/01 Single-phase and two-phase thermosyphon analysis	Prof. Kannan Iyer IIT Bombay.
6	AERB/AGSR/04/02 Coupled neutronics and thermal-hydraulics analysis of PHWRs	Prof. J. B. Doshi IIT Bombay.
7	AERB/SRP/15/01 Velocity and temperature distribution in a volumetrically heated fluid simulating moderator flow in calandria vessel	Prof. R. P. Vedula IIT Bombay
8	AERB/SRP/20/01 Study of crack initiation and propagation in nuclear component under low cycle fatigue	Dr. Uday Chakkingal IIT Madras.
9	AERB/SRP/SRI/01 Development of newer interventional strategies for counteracting the effects radiation fallout	Dr. D. N. Pahuja RMC, Parel.
10	AERB/SRP/22/01 Development of plastic material for nuclear track detection	Dr. V. S. Nadkarni Goa University, Goa.
11	AERB/SRP/20/02 Implementation of QA programme in mammography and breast cancer control	Dr.Shobha Jayaprakash BYL Nair Hospital Mumbai.
12	AERB/SRP/17/07 and AERB/SRP/23/03 Radiation dosimetry in graves disease treated with I-131 & Radiation dose to relations/attendants of patients treated with I-131 for hyperthyroidism	Dr. G. S. Pant AIIMS, New Delhi.

7.3 ANNUAL DAE SAFETY & OCCUPATIONAL HEALTH PROFESSIONALS MEET

The 20th DAE Occupational Health & Safety Professionals Meet was held at Nuclear Fuel Complex (NFC), Hyderabad during November 6-8, 2003. The theme of the meet was "Safety in Material Handling and Health Effects of Chemicals". Around 120 safety and occupational health professionals participated in the Meet and discussed on various safety related issues. Experts from various industries like M/s. L&T Mumbai,M/s BHEL, M/s Shivra Cranes, Chief Inspectorate of Factories, Andhra Pradesh and Former Associate Director of Medical Division, BARC delivered invited lectures.

7.4 WORKSHOPS/LECTURE PROGRAMME

- A One-Day Lecture Programme was organized on November 21, 2003 on "Design and Safety Aspects of 700 MWe PHWRs". The programme was mainly oriented towards giving glimpses of the salient design and safety features of the 700 MWe PHWR, which is an evolved design concept of 540 MWe PHWR.
- AERB together with other Civil Engineering Groups of DAE, celebrated "Concrete Day" at AERB on 22.09.2003.
- A half-day seminar on "Fly Ash Concrete" was arranged during this celebration. Ninety participants from AERB, BARC, NPC, HWB, Grasim Industries Limited, consultants and contractors of different units of DAE participated in the seminar. Prominent experts from DAE and Grasim Industries delivered lectures during the seminar, which was followed by a panel discussion.
- IAEA workshop on "Ageing Management of Nuclear Power Plants (AM-NPP)" was organised by AERB, Mumbai during 8 to 12, December 2003. Total seventy-five participants from various units, attended the workshop. Prominent experts from IAEA and DAE delivered lectures during the workshop, which was followed by panel discussion.

7.5 PARTICIPATION IN CONFERENCES/ WORKSHOPS/SEMINARS/TRAINING COURSES

1. Raut V.V. and Kulkarni H.K. attended 3-Days training on "Safety Engineering & Management" at Central Labour Institute,Mumbai between August 11-13,2003.
2. Ghosh P.K., Bhattacharya S. & Chodankar N.M attended the "20th DAE Occupational Health and Safety Professionals Meet" held on November 6-8, 2003 at Hyderabad.
3. Ghosh P.K. attended the Joint OECD/NEA-IAEA Technical Meeting on Exchange of Information on Safety Related Experiences Gained in Fuel Cycle Facilities held in November 18-21, 2003 in Paris
4. Ramprasad K. and Bhattacharya S. attended the IAEA workshop on "Ageing Management" held between December 8-12, 2003 at Niyamak Bhavan.
5. Raut V.V. and Kulkarni H.K. attended Seminar on "Occupational Health & Safety Management System-Challenges & Opportunities" organised by BIS at Mumbai on December 10,2003.
6. Ghosh P.K., Prasad J., Bhattacharya R. and Bhattacharya S. attended the Seminar of Indian Nuclear Society, on December 17-18 2003 at IGCAR Kalpakkam.
7. Raut V. V., Kulkarni H.K, Bhave S.R., Lakhaman V., Gholap V.P. attended the Work shop on "Risk Management in Chemical Industry " organised by HWB ,Mumbai at AERB Auditorium on January 29-30, 2004
8. P.Hajra, K. Srivasista and Y.K.Shah participated in IAEA workshop on "Ageing Management of Nuclear Power Plants" (AM-NPP) from December 8-12, 2003 held at AERB, Mumbai.
9. S.K. Dubey was nominated for Induction Training at NTC, RAPS from 02-12-2003 to 31-03-2004 and 15-04-2004 to 15-08-2004
10. Utkarsh. S. C attended workshop on "Severe Accident Analysis and use of MELCOR Computer code" organized by CNSI at Trnava, Slovakia
11. Prabir C. Basu attended 17th International Conference on Structural Mechanics in Reactor Technology (SMiRT 17), held at Prague, 17-22 August 2003
12. Prabir C. Basu attended IAEA International Symposium on Seismic Re-evaluation of existing Nuclear Facilities (IAEA-IS-SEENF) at Vienna, 25-29 August 2003
13. L. R. Bishnoi attended National Seminar on "Quality

Assurance in Civil Engineering Through Material Testing" organized by Indian Chapter of ACI during 28 and 29th August 2003 at Mumbai.

14. Shylamoni P. attended a refresher course on "Revision of IS:800 Structural Steel & Composite Construction" organized by Indian Concrete Institute-Maharashtra Centre during 28th and 29th August 2003 at Institution of Engineers, Haji Ali, Mumbai.

15. Shylamoni P attended National Seminar on "Reinforcement Today & Tomorrow" organised by India Chapter of ACI held at Mumbai, 13-14 June 2003.

16. Ajai S. Pisharady attended the three day advanced course on "Structural Health Monitoring, Repair and Rehabilitation of Concrete Structures" conducted by SERC, Chennai during February 3 to 5, 2004.

17. A.D. Roshan attended 2nd Indo German workshop on "Structural Safety of Structures, Risk Assessment and Disaster Mitigation" organized by Indian Institute of Technology, Madras during February 15th and 16th, 2004.

18. Prabir C. Basu, attended the AERB-USNRC safety discussion meeting held at Mumbai during February 23-25, 2004.

19. Prabir C. Basu attended 2nd RCM of IAEA-CRP on "Safety Significance of Near Field Earthquakes" during March 08-12, 2004 at Trieste, Italy.

20. Prabir C. Basu attended American Concrete Institute (ACI) Centennial Convention during March 14-19, 2004 at Washington.

21. Prabir C. Basu attended International Symposium on Advances in Concrete Through Science and Engineering (ACTSE) during March 22-24, 2004 at Centre for ACBM at Evanston, USA.

7.6 PAPERS PUBLISHED / PRESENTED / INVITED TALKS

7.6.1 Papers published

1. John Arul. A, Senthil Kumar C, Marimuthu S and Om Pal Singh, "The Power Law Character of Off-site Power Failures", Annals of Nuclear Energy, 30, 2003.

2. Gurumoorthy, C and Singh, D. N., (2004) "Experimental Methodology to Assess Contaminant Diffusion in Rock Mass", Environmental Monitoring and Assessment, Vol.91, pp277-291.

3. Gurumoorthy, C., Sasidhar, P., Arumugham, V. and Mathur, R.K., (2004) "Sub-surface Investigations on Deep Saline Ground Water of Charnockite Rock Formation, Kalpakkam, India", Environmental Monitoring and Assessment, Vol.91, pp211-222

4. Prabir C. Basu, "Behavior of Steel Plate – Concrete Interface in Tension" ING-IABSC Journal Bridge and Structural Engineer.

5. L. R. Bishnoi, Prabir C. Basu, "Siting of Nuclear Power Plants", News letter, Atomic Energy Regulatory Board, Vol. 16, No. 3, 2003, pp. 4.

6. Kanta Chhokra, M.L. Bhutani "X-ray shielding Consideration in Mammography", Journal of Medical Physics, Vol.28, No.3, 2003.

7.6.2 Papers Presented in Conferences/Workshops

1. Senthil Kumar, John A. Arul and Om Pal Singh, "Comparison of Fault Tree and Integral Models for the Estimation of Nuclear Power Plant Blackout Frequency", Eleventh International Conference on Nuclear Engineering (ICONE-11), Japan, April 19-24, 2003.

2. Senthil Kumar, John A. Arul, "Reliability Demonstration Test Planning Using Bayesian Analysis", Eleventh International Conference on Nuclear Engineering (ICONE-11), Japan, April 19-24, 2003.

3. P. Sasidhar, Review of "Report on Safety Analysis of the Püspökszilágy Radioactive Waste Treatment and Disposal Facility – An Assessment of Post-Closure Safety" Proceedings of Joint Working Group Meeting of ASAM, IAEA. June 2-6, 2003.

4. Gurumoorthy, C and Singh, D. N., (2004) "A Methodology to Evaluate the Diffusion Coefficient of Radio Nuclides through Rock Mass in a Short Experimental duration", International Conference on Waste Management '04 (WM'04), Tucson, Arizona, USA February 29 – March 4, 2004

5. Prabir C. Basu, Shylamoni P presented paper "On Characterisation of Steel Reinforcement for RCC Structures", Proceedings, National Seminar on "Reinforcement Today & Tomorrow" organized by Indian Chapter of ACI held at Mumbai during 13th and 14th June 2003.

6. Basu Prabir C., Shylamoni P., Roshan A.D., "Characterisation of Steel Reinforcement for RC Structures: An Overview and Related Issues", The Indian Concrete Journal, Special issue on Steel Reinforcement in concrete, Vol.78, January 2004, No.1, pp. 19-30

7. Roshan A.D., Sudhir K. Jain, Prabir C. Basu, "Analysis of Data From Structural Response Recorders in North and North East Indian Earthquakes", Paper#K03-3, 17th International Conference on Structural Mechanics in Reactor Technology (SMiRT 17), Prague, Czech Republic, August 2003.

8. Prabir C. Basu, A.D. Roshan, A.S. Pisharady, "Seismic Fragility of Reinforced Concrete Frame Structures", Proceedings of IAEA International Symposium on Seismic Evaluation of Existing Nuclear Facilities (IAEA-IS-SEENF), Vienna, Austria, pp. 102-113, 25-29 August 2003.

9. L. R. Bishnoi, Prabir C. Basu, "Structural Integrity Test for Containment Structures of Nuclear Power Plants", Proceedings of National Seminar on Quality Assurance in Civil Engineering Through Material Testing, India chapter of ACI, Mumbai, pp. 90-98, August 2003.

10. Ghosh P.K., "Safety Review of Projects of Front End Nuclear Fuel Cycle Facilities" Nuclear fuel Cycle Technologies: Closing the Fuel Cycle INSAC 2003, December 17-19, IGCAR, Kalpakkam.

11. Bhattacharya S. and Ghosh P.K., "Safety in Uranium Mining-Role of Atomic Energy Regulatory Board" Nuclear fuel Cycle Technologies: Closing the Fuel Cycle INSAC 2003, December 17-19, IGCAR, Kalpakkam.

12. Bhattacharya R. and Ghosh P.K. "Safety in Mining and Processing of Beach Sand Minerals–Regulatory Approach" Nuclear Fuel Cycle Technologies: Closing the Fuel Cycle INSAC 2003, December 17-19, IGCAR, Kalpakkam.

13. Gholap V.P., Kulkarni H.K, Prasad J. and Ghosh P.K., "Issues and Methods of Radiation & Industrial Hazards control in Nuclear Fuel Fabrication" Nuclear Fuel Cycle Technologies: Closing the Fuel Cycle INSAC 2003, December 17-19, IGCAR, Kalpakkam.

14. Ghosh P.K. "Risk Analysis of Industrial Plants" Aerospace Safety Trends and Challenges ASTRA 2004, January 17, 2004, VSSC, Trivandrum.

15. Ghosh P.K. "Risk Control in Chemical Industry" Workshop on "Risk Management in Chemical Industry" organised by Heavy Water board, Mumbai at AERB Auditorium on January 29-30, 2004

16. P. Hajra presented a paper on 'Safety Margins for Deterministic and Probabilistic Assessments: Regulatory Practices in India' at IAEA Headquarters, Vienna, Austria in a Technical Meeting held during 13-15 October, 2003.

17. P.Hajra and S.K Dubey participated in "Winter Academy 2003" at IIT, Guwahati held during 8-17, December 2003 and gave as expert lecture on 'Safety Analysis for Nuclear Power Plants-Approach, Methodology and Regulatory Aspects'

18. A. Ramakrishna delivered a talk on "Regulatory Aspects and Role of AERB" in the international conference on Cancer-research under the auspices of the Cachar Cancer Hospital Society ,Silchar, Assam

19. A. Ramakrishna delivered a talk on "Various applications of Atomic energy and role of Regulatory role of AERB in Nuclear Power Programme " in the MNJ institute of Oncology and RCC in Hyderabad.

20. A. Ramakrishna participated in INS-2003 Conference on Nuclear Fuel Cycle Technologies held in IGCAR, Kalpakkam in December, 2003.

21. R.S. Rao submitted a paper titled "Sub-Channel Analysis of Steam line Break for 1000 Mwe Kudankulam Nuclear Power Plant" in 17th National and 6th International Heat and Mass Transfer Conference" held in January, 2004 at IGCAR, Kalpakkam.

22. S.K. Dubey submitted a paper titled "Large Break Loss of Coolant Accident Analysis of 220 MWe Indian PHWR for MAPS with Thermal Hydraulic Code RELAP5/SCDAP/MOD 3.2" in the 17th National and 6th International Heat and Mass Transfer Conference" held in January, 2004 at IGCAR, Kalpakkam.

23. K.C.Upadhyay, Manisha Inamdar, R.K.Singh, S.P.Agarwal, Annual collective doses due to transport of disused sources, IAEA-International conference on the safety of the radioactive material, IAEA, Vienna, July 7-11, 2003.

24. S.P.Agarwal, A.N.Nandakumar, K.C.Upadhyay and A.R.Sundararajan, Safety in the Transport of Radioactive Material-Indian Scenario, IAEA-International Conference on the Safety of the Radioactive Material, IAEA, Vienna, July 7-11, 2003.

25. Khaidem R.Singh, Arunkumar, C.P.Raghavendran, S.P.Agarwal, Transport of Industrial Radiography Sources – Indian Scenario, IAEA-International Conference on the Safety of the Radioactive Material, IAEA, Vienna, July 7-11, 2003.

26. Khaidem R.Singh, S.P.Agarwal, K.C.Upadhyay, M.Inamdar, Safe Transport, Use and Disposal of Nuclear Medicine Sources in India, IAEA-International Conference on the Safety of the Radioactive Material, IAEA, Vienna, July 7-11, 2003.

27. A.U.Sonawane, V.K.Shirva, Skin Entrance Dose (SED) and Radiation Safety Audit of Diagnostic X-ray Installations in Four Hospitals, 24th Annual Conference of AMPI, Patna, Nov. 7-9, 2003.

28. G.Sivaraman, R.M.Nehru, Type Approval Procedures for Source hold Assembly-an Analysis, IARP Conference, IGCAR, Kalpakkam, March 4-6, 2003.

29. R.I. Gujrathi, Regulatory Requirements for Nuclear Facilities, seminar on Regulatory and Safety requirements for BARC facilities" held during Nov 27-28, 2003, organized by BARC.

30. Anu Dutta, I.A. Patwegar, S.K. Chaki and V. Venkat Raj 'Part Load Performance of the Steam and Feed Water System of AHWR' presented in the 'Seventeenth National and Sixth ISHMT/ ASME Heat and Mass Transfer Conference' held during January 5-7, 2004, at Indira Gandhi Centre for Atomic Research, Kalapakkam (India).

31. R.P. Gupta and Deepak De presented a paper in Hindi titled "Vipatti Prabandhan ki Drishti se Nabhikiya Pariyojanaon ki Suraksha Samiksha" in the 'Vaigyanik Sangoshthee' held during July 29 – 30, 2003 at Regional Research Laboratory, Bhubneshwar organized by Hindi Vigyan Sahitya Parishad.

32. A.N.Nandakumar, "The Role Of A Medical Physicist – The Regulatory Standpoint", presented in the workshop conducted by the Tamil Nadu Pondicherry Chapter of the Association of Medical Physicists of India, Chennai, August 2003.

33. A.N.Nandakumar, "Nabhikiya Durghatna Mein Vikiran Dose Se Bachav", presented in the 'Vaigyanik Sangoshthee' held during July 29 – 30, 2003 at Regional Research Laboratory, Bhubneshwar organized by Hindi Vigyan Sahitya Parishad.

7.6.3 Invited Talks

1. Bhattacharya R., "Factories Act, 1948"; "Role of Competent Person on Pressure Plant"; "Role of Competent Person on Hazardous Chemicals handling" at TAPS 1&2 on April 18, 2003.

2. Bhattacharya S., "Role of Competent Persons" and "Fatal Accident Case Studies" at TAPS 1&2 on August 18, 2003.

3. Ghosh P.K., Bhattacharya S., Natarajan G. and Chodankar N.M. delivered lectures on role of AERB, the Atomic Energy Act, 1962, Rules framed under the Act, Radiation Protection for Nuclear Facilities and at UCIL on September 15, 2003.

4. Bhattacharya R., "Atomic Energy (Factories) Rules, 1996 "and "Role of Competent Person under various sections of the Factories Act, 1948" at VECC on November 4, 2003.

5. Ghosh P.K. "Atomic Energy Regulatory Board" and "Atomic Energy Act, 1962" at VECC Kolkata on November 4, 2003.

6. Bhattacharya S., "Fatal Accident Trend in DAE Units" and "Occupational Health Statistics for 2002" during 20th DAE Occupational Health and Safety Professionals Meet on November 6-8, 2003 at Hyderabad.

7. Ghosh P.K. "Safety Trend in DAE Units" 20th DAE Occupational Health and Safety Professionals Meet on November 6-8, 2003 at Hyderabad.

8. Prabir C. Basu, delivered a guest lecture on "Pozzolonas for High Performance Concrete Composites" on the Concrete Day conducted by Indian Concrete Institute, Bangalore on 7th September 2003.

9. Prabir C. Basu, delivered a keynote lecture on "Durability of HPC, an Overview" at the International Conference on Recent Trends in Concrete Technology & Structures organised by Kumaraguru College of Technology, Coimbatore during 10-12 Sept. 2003.

10. Prabir C. Basu, delivered a guest lecture "Reinforced Concrete Structures of Nuclear Power Plants" in National Institute of Construction Management and Research at Pune Campus on 18th September 2003.

11. Prabir C. Basu, "Admixture Cement Compatibility" organised by Institute of Chemical Technology (Autonomous), at the seminar on Modern Materials & Techniques in Civil Engineering held at Mumbai in December 2003.

12. Prabir C. Basu, "High Volume Fly Ash Concrete" at the workshop on Next Generation Concretes organised by Association of Consulting Civil Engineers (India), Bangalore on 2nd January 2004.

7.7 AERB Colloquia

AERB conducted the following colloquia in the year 2003-2004.

1) Mr. George Philip, Senior Assessment Officer in the Department of Nuclear Safety and Security, IAEA delivered a talk on the following topics:

a) Convention of Nuclear Safety: Issues and Trends

b) Overview of Safety Services of the Division of Nuclear Installation Safety including International Regulatory Review Missions.

2) Shri H.S. Kushwaha, Dr.A .K. Ghosh and Shri Vivek Bhasin from BARC delivered talks on the following topics.

a) Probabilistic Structural Integrity Assessment

b) Generation of hazard curves, determinations of fragilities of components and convolutions of failure probabilities with fragilities of components for Seismic PSA.

7.8 OTHER ACTIVITIES

Bureau of Indian Standards (BIS) Documents

Draft revision of IS-8089 & IS-8091 has been completed and merged into a single document. The merged document was sent to Director (Chemical), Bureau of Indian Standards, New Delhi on February 4, 2004, for finalisation.

Draft Indian Standard, Poly Aluminum Chloride, ICS NO. 71.060.01, was reviewed and comments sent to Bureau of Indian Standards, New Delhi.

Members of AERB served in the Nuclear Instrumentation Sectional Committee LTD 26, reviewing publication of Indian Standards for BIS.

Cyclone Protection Manual

Contributed in the preparation of the document on Guidelines for Cyclone Protection Manual for the coast based industries of India, which was prepared by a committee constituted by National Safety Council and the document has been published in November 2003.

Review of Draft National Policy on Safety, Health & Environment at Workplace

Contributed in the review of the draft National Policy on Safety, Health and Environment at Workplace based on the feedback from the national conference held at Delhi earlier.

CHAPTER 8
SAFETY RESEARCH INSTITUTE

8.1. INTRODUCTION

Since its formal inauguration on February 20, 1999, the Safety Research Institute (SRI) at Kalpakkam has been making steady progress towards establishing its basic infrastructure. Construction and procurement of necessary furniture for the guesthouse and the office building have been completed. Prof. S.P. Sukhatme, Chairman, Atomic Energy Regulatory Board inaugurated the Safety Research Institute building on October 6, 2003 at Kalpakkam. The SRI guest house was made operational earlier on January 30, 2003.

Research activities in the following areas are being pursued.

- Nuclear Safety Studies
- Radiation Safety Studies
- Environmental Safety Studies
- Seismic Analysis

Besides research, other components of SRI activities, as planned, include

- Periodic Training Workshops and Discussion Meetings
- Archiving of Technical and Research Reports, Course Materials and Management of Databases and Safety Related Computer Codes.

SRI also provides support to the Radiological Safety Division of AERB for Regulatory Inspection activities in the southern region. The progress made in the above activities during this year is described below.

8.2. NUCLEAR PLANT SAFETY STUDIES

8.2.1 Probabilistic Safety Assessment and Reliability Engineering

Reliability study of Real Time Computer System (RTCS) for Core Temperature Monitoring System (CTMS) of Prototype Fast Breeder Reactor (PFBR) was carried out to analyze different configurations of RTCS namely, (a) hot standby system, and (b) dual system architecture with 1/2, 2/2 and 2/3 voting logic in CTMS. The reliability targets for safe and unsafe failures of RTCS to meet operational and safety requirements respectively are arrived at based on reliability allocation to various subsystems of Shut Down System. The results indicate that hot standby configuration meets the target for safe failures but falls short with respect to unsafe failures. The hot standby system reduces the spurious trips arising from RTC, compared to 1/2 configuration by switching over to the second system. However, unsafe failure probability of hot standby system is comparable to that of 2/2 system, as unsafe failures may not lead to a switch over to the second system, even if it were to work successfully. Analysis points out that 2/3 voting model satisfies both safe and unsafe reliability targets.

The reliability study of Shut Down System (SDS) of PFBR, carried out earlier, was revised to include the comments of AERB committee on PSA of Nuclear Facilities. Major considerations for revision are 1) use of recently acquired "RISK SPECTRUM" software for fault tree analysis and drawing of fault trees, 2) incorporation of sensitivity analysis results and 3) inclusion of block diagrams for safety logic. The overall frequency of shutdown function failure remains as 0.7E-6/y, which meets the reliability requirements.

Studies on the Station Black Out (SBO) frequency for PFBR/FBTR and Kalpakkam Site were revised to include the comments of the IGCAR Safety Committee. The revised results include the analysis for the updated data on loss of offsite power, failure data on transformers and feeders. Further analysis was carried out for a case when the feeder is unavailable for seven days. A study on the comparison of the fault tree model and integral model was made for the estimation of nuclear power SBO frequencies. The aim of this study is to obtain an effective value of mission time to be used in fault tree model to obtain accurate results. This value of mission time is obtained by comparing the fault tree with the complicated but accurate integral model. A paper on this study was presented at the Eleventh International Conference on Nuclear Engineering (ICONE-11) held in Tokyo, Japan (April 19-24, 2003).

8.3. RADIATION SAFETY STUDIES

8.3.1 Radiation Shielding Computations PFBR Radiation Streaming Studies

(a) Top Shield (TS): Roof Slab (RS), Large Rotating Plug (LRP), Small Rotating Plug (SRP), Control Plug (CP) forms

the Top Shield for reactor vessel. LRP and SRP installed for accessing different Sub-Assembly locations inside the reactor vessel and hence engineered annular gaps are provided between RS-LRP, LRP-SRP and SRP-CP. These annular gaps range from 1.5 cm to 2.5 cm and can allow radiation streaming from the reactor vessel above the Top Shield. The dose rates due to radiation streaming were computed for checking the adequacy of the shield design provided using three-dimensional Monte Carlo Computer Code, MCNP.

(b) Transfer Arm: Transfer Arm is used for transferring fuel, control and blanket subassemblies within the core. An annular gap of 4 cm is provided for the operation of Transfer Arm, which forms a path for radiation streaming from the reactor vessel to the area above the TS. The dose rates due to radiation streaming were computed for checking the adequacy of the shield design provided using three-dimensional Monte Carlo Computer Code, MCNP.

(c) Inclined Fuel Transfer Machine (IFTM)

IFTM is used to transfer fuel, control and blanket subassemblies from the temporary storage locations within the core to the storage bay outside the reactor vessel. Annular gaps in the primary ramp of IFTM can provide a path for radiation streaming from the reactor vessel above the TS. Also the movement of irradiated sub-assembly through the primary ramp causes increased dose rates above the Top Shield. To assess the shield requirement around the IFTM primary ramp, three-dimensional modeling and computations were carried out using MCNP.

(d) Primary Sodium Pump & Intermediate Heat Exchanger

Primary coolant sodium pump and intermediate heat exchangers have been provided with a few annular gaps for its operational requirements. These annular gaps can allow radiation streaming from the reactor vessel to top of the TS. Complementary shield design was reviewed by using the three-dimensional modeling capability of MCNP code.

Dose Rate Computations for PFBR Control Rooms during Core Disruptive Accident

Computation of gamma dose rates inside the main and backup control room due to the bottled up activity inside Reactor Containment Building (RCB) during a core disruptive accident in PFBR was recalculated to take account of changes in the wall dimensions of RCB.

Neutron Reaction Rate Computations for AHWR Streaming Experiments at APSARA

BARC is carrying out the experiment on radiation streaming through ducts of various representative shielding geometries of Advanced Heavy Water Reactor (AHWR) at the shielding corner of APSARA reactor. Monte Carlo simulation for the proposed experimental set up was carried out using MCNP code for estimating the neutron reaction rates. Out of the ten sets of experiments planned, computations have been completed at SRI for the first three sets of experiments.

Computations for 10 MeV and 10kW Electron Beam Radiation Processing Facility

A linear accelerator based electron beam radiation processing facility for sterilization of agricultural and medical products is being established at CAT, Indore. Linear electron accelerator of 10 MeV and 10 kW will be used as the radiation source in the facility. The shielding design for this facility was made in collaboration with scientists from CAT, Indore.

8.4. ENVIRONMENTAL SAFETY STUDIES

8.4.1 Environmental Impact Assessment for Nuclear Power Plants (NPPs)

A Collaborative Project on the possible use of Remote Sensing and Geographic Information System (RS-GIS) data for environmental impact assessment around NPPs between SRI and Space Application Center (SAC), Ahmedabad is in progress. The main objective of the study is to demonstrate the design and organization of a digital database and information system for carrying out Environmental Impact Assessment (EIA) for all the nuclear power plants in the country. Kalpakkam nuclear power plant site was taken up at the first instance. In continuation of this collaborative project, the ground survey was carried out in an area of 50 km radius around MAPS and detailed mapping of the information is in progress. .

8.4.2 PFBR Hydrogeological Investigations

Hydrogeological investigations form an integral and important component of the evaluation of PFBR site during the pre-construction phase. The purpose of the investigation is to obtain valuable information for modeling the possible migration of radionuclides through the terrestrial environment due to the potential leaks in spent-fuel bay as well as from a radioactive waste disposal facility. The hydrological information gathered would also help in managing

groundwater resources, if required. Keeping these in view, a project on "Aquifer Parameter Estimation, Flow Velocities and Impact Analysis around Kalpakkam Coastal Area, Tamilnadu" was entrusted to National Geophysical Research Institute (NGRI), Hyderabad. The above study covered the stretch between Edayur backwater and the main security gate at Kalpakkam and was carried out jointly by IGCAR, NGRI and SRI.

A detailed reconnoiter field survey was first carried out for the purpose of obtaining the sub-surface cross-section data using electrical resistivity technique. The results from this study indicated five different layers. The depth to bedrock and depth to water table were delineated. Based on the results, 10 locations were identified for drilling pumping and monitoring borewells. The borewells were utilized for measurement of water level (for one hydrological cycle) and also for carrying out pumping tests to estimate aquifer parameters. The regional groundwater flow and velocity maps were prepared for different seasons to understand the recharge patterns. The groundwater characteristics were also systematically evaluated and Piper and Schoeller Diagram were constructed to arrive at groundwater classification. The water quality data clearly show that at the present rate of extraction of water, there is no seawater incursion from the Bay of Bengal into the aquifer system. However, the Buckingham canal has been charging the aquifer in the vicinity and very high levels of salinity are recorded. Three types of ground waters were encountered, viz., Na-Ca-Cl-HCO_3; Mixed and Na-Cl type.

The pumping test drawdown/recovery data were utilized to estimate aquifer parameters, viz., transmissivity (2.2 to 44 m^2/day) and storage coefficient (0.001 to 0.00001). These parameters are vital for management of groundwater resources. A groundwater flow model was developed based on the water table data and aquifer parameters using SUTRAN Software. The groundwater velocities are found to vary between .034 and 34 cm/day. The model has been used as a predictive tool to assess the impact of additional withdrawal of water on the groundwater quality (or salinity). A final report of the two-year project has been submitted in November 2003, on "Hydrogeology of Kalpakkam" for inclusion in site evaluation report of PFBR.

8.5 MARINE DISPERSION STUDIES AT MAPS JETTY AREA, KALPAKKAM

Studies have been initiated to develop a marine dispersion model based on the dilution factors of key radionuclides discharged into the sea. Dilution factors will be evaluated based on discharge volume and discharge activity and the concentration levels of these radionuclides around MAPS Jetty. Past data available on waste dilution, discharge volume and duration and radioactivity levels were collected from MAPS and CWMF to evaluate the total waste discharge and waste activity. SRI and ESL, Kalpakkam will jointly carry out the monitoring studies for one year. The samples would also be analyzed simultaneously for water quality parameters, viz., pH, salinity, total suspended solids, chlorophyll content and microbiological parameters.

8.6 PROJECTS AWARDED BY SAFETY RESEARCH INSTITUTE

Projects on studies in some selected areas of work are awarded to academic institutes and national laboratories. The following is a list of such collaborative research projects together with the report on the progress made during the year.

8.6.1 Characterization of Thermal Internal Boundary Layer (TIBL) along the Eastern Coast of India

A model study has been undertaken to simulate the coastal atmospheric boundary layer by Department of Meteorology and Oceanography, Andhra University, Visakhapatnam on the east coast of India particularly on the phenomenon of land - sea breeze circulation, the topographic flow due to complex hilly terrain, their interaction, the boundary layer heights, the stability/turbulence which may influence the pollution dispersion in the region and to validate with the surface and upper air observations. The onset, strength, inland penetration and the depth of the sea breeze inflow layer, the associated internal boundary layer were studied to understand their influence on the pollution dispersion. The characteristics of dispersion under simulated boundary layer phenomena were studied using a random walk particle dispersion model.

8.6.2 Development of Tracer Release, Sampling and Analysis Technique

A study is undertaken by Leather Research Institute, Chennai in the development of Tracer Release, Sampling and Analysis.

Gas Chromatograph (GC) with Electron Capture detector for SF_6 tracer gas were commissioned. The GC has been calibrated and very low level detection of tracer gas were achieved (5 ppt of SF_6 gas). The facility is ready to receive tracer sampled tedler bags from tracer release

experiments. Tracer release protocol for the field experiment is being formulated. Data acquisition from Met Towers (installed by SERC) is continuing.

8.7 DISCUSSION MEETINGS AND TRAINING

One of the objectives of the SRI is to provide a forum for designers, operators, research groups and regulators to come together for exchange of information and expertise. As part of these efforts, SRI organized a one-day Discussion Meeting on Environmental Impact Assessment of Nuclear Facilities on October 6, 2003 at Kalpakkam. About 20 delegates from the various units in DAE and other academic institutions participated. The meet provided an opportunity to the delegates to know the various planned research activities being carried out at various institutes and in particular use of remote sensing tool for the environmental impact assessment.

Chairman inaugurates Discussion Meeting in Environmental Impact Assessment of Nuclear Facilities, IGCAR, Kalpakkam

8.8 COMPUTER CODE DEPOSITORY

SRI continues to maintain a depository of Safety Codes and makes them available for interested users. It also conducts periodic training in running these Codes. One such training in the operation of MCNP code was conducted for the benefit of many scientists from other units of DAE. A new computer code RISK SPECTRUM used for Probabilistic Safety Analyses was acquired recently by SRI and was applied to currently ongoing PSA studies.

8.9 SURVEILLANCE OF RADIATION INSTALLATIONS

With its proximity to the Industrial Radiography units in the southern region, SRI provided support to the Radiological Safety Division of AERB by carrying out Regulatory inspections at 14 radiography sites at Kalpakkam, Chennai, Chengalpet, Ranipet and Vellore. The inspections were carried out without prior intimation to the concerned institute. There were no major regulatory violations and radiological safety status was satisfactory. SRI officials assisted in the revalidation tests conducted at Chennai and Thiruchirappally for radiographers and Site-in-Charges of Industrial Radiography agencies located in Southern Region.

8.10 INFRASTRUCTURE DEVELOPMENT

10th Plan AERB Expansion Project: AERB is working for construction of the Annex building adjacent to existing Niyamak Bhavan as a part of 10th plan "AERB Expansion Project". In order to reduce design cost and time and also for maintaining aesthetic balance of the area, it was decided to construct the Annex building as a replica of Niyamak Bhavan. The construction of the building will be executed by the Directorate of Construction Services and Estate Management (DCSEM). The financial sanction for the project was obtained from DAE. AERB held number of discussions with DAE and DCSEM. Tender for dismantling work of temporary quarters situated at the proposed location of Annex building was floated by DCSEM. Tendering work for the building construction is in progress.

SRI Guest House: Prof. S.P. Sukhatme, Chairman AERB, formally inaugurated the Guest House on January 30, 2003. Guesthouse is catering well to the needs of the visitors to DAE Units at Kalpakkam from September 2003.

SRI Building: Prof. S.P. Sukhatme, Chairman AERB, formally inaugurated the SRI building on October 6, 2003. Further, on the same day Remote Sensing and Geographical Information System Laboratory was inaugurated by Shri S.K. Sharma, Vice chairman of AERB.

Chairman inaugurates SRI. Shri S.K. Sharma, Vice-Chairman, Dr. Baldev Raj Director, IGCAR, Shri S.K. Chande and Shri A.R. Sundarajan are also seen.

CHAPTER 9
PUBLIC INFORMATION / AWARENESS PROGRAMMES

The staff of AERB continued to interact with professional associations, print and electronic media to be transparent in regulatory activities of AERB. The Board issued several press releases on its activities.

9.1 PRESS RELEASES

9.1.1. AERB Clears Operation of Wet Section of Natural Uranium Oxide Fuel Plant, Hyderabad (April 22, 2003).

The Atomic Energy Regulatory Board (AERB) has permitted the management of Nuclear Fuel Complex at Hyderabad to resume operation of the Wet Section of Natural Uranium Oxide Fuel Plant (NUOFP). The Board had suspended the operation of this section of the plant on November 20, 2002 pending enquiry into the reasons of a chemical explosion. The explosion did not cause injury to or contamination on any plant personnel or radioactive releases into the environment.

A specialist investigation committee appointed by AERB confirmed that the explosion was due to what is known as "Red Oil Reaction". "Red Oil Reaction" is an uncontrolled chemical reaction involving hot organic liquid and aqueous nitrate solution. The Committee observed that the necessary conditions such as presence of nitrate, organic liquids and temperature for causing the reaction existed in the evaporator at the wet section of the plant at the time of the incident.

The Committee recommended that a hazard and operability study should be carried out for all process plants of similar operation. AERB stipulated a limit on the plant capacity. If the capacity has to be enhanced, NFC must provide sufficient backup data along with the performance report of the plant. NFC management has now modified the process to exclude the evaporation step.

AERB issued the permission to resume operation after a three member inspection team from AERB visited Nuclear Fuel Complex and verified the adequacy of measures taken by the plant management in light of the recommendations of the investigation committee.

9.1.2 Safety Up-gradation of Tarapur Atomic Power Station (May 30, 2003).

AERB in its meeting held on May 22, 2003 has decided to renew the authorisation to operate the two units of Tarapur Atomic Power Station till June 30, 2005. The station will then close down for a period of about six months for carrying out safety up-gradations and modifications. The Board will permit further operation of the reactors only after NPCIL has implemented all the safety up-gradations identified by it. AERB has also decided to conduct a mid-term review in 2004 to assess the progress in the up-gradation activities.

The Board had earlier noted that these reactors have been operating for the past 30 years. As directed by the Board, NPCIL has made detailed studies on operating experience, ageing management, design basis and safety analysis, probabilistic safety assessment and seismic re-evaluation and submitted comprehensive reports. NPCIL has also identified the modifications and up-gradations needed to enhance the safety status of the units which were designed as per earlier standards and had submitted a time-bound action plan. In arriving at the required up-gradations, NPCIL has adopted the review procedures recommended by the International Atomic Energy Agency for judging the safety of nuclear power plants built to earlier standards.

9.1.3 Visit of Indian Specialists to US Nuclear Regulatory Commission (July 3, 2003).

In continuation of the ongoing nuclear safety dialogue between Atomic Energy Regulatory Board of India and United States Nuclear Regulatory Commission (USNRC), a team of six specialists from India will visit USNRC during the second week of September 2003. Shri S.K. Sharma, Vice Chairman, AERB had lead the team. The experts will have comprehensive discussions on regulatory and safety related topics such as Licence Renewal, Periodical Safety Review, Design Modifications and Retrofits and Emergency Operating Procedures. The team had also visited a Nuclear Power Plant and Safety Research Laboratories in US.

9.1.4 Stolen Sources do not pose any Significant Hazard (August 18, 2003).

Officials of Tata Iron and Steel Company have informed the AERB about an incident in which three radioactive (cobalt-60) sources of about 1.8 mCi (67 MBq) each were stolen from their storage room.

These sources are in non-dispersible form and are designed to the safety specifications of the International Standards Organization. Each source capsule is kept in an adequately shielded device approved by AERB.

Since the sources are of low activity, they do not pose any significant radiological hazard to persons and environment.

9.1.5 AERB Delegation Visits USNRC (September 25, 2003).

As a follow-up of the ongoing interaction on nuclear safety related topics between the Atomic Energy Regulatory Board (AERB) and the United States Nuclear Regulatory Commission (USNRC), a team of six Indian specialists led by Shri S.K. Sharma, Vice Chairman, AERB visited USNRC at Washington D.C, from September 8 to 17, 2003. Senior officials of NRC and the Indian team held discussions and exchanged information on licence renewal process, ageing management, plant retrofits, design modifications, emergency operating procedures and fire safety. The team also visited the National Institute of Standards and Technology, University of Maryland and the Surry Nuclear Power Plant. Further discussion meetings are planned in 2004 in India and USA.

9.1.6 AERB Directive to Safdarjung Hospital, New Delhi (October 17, 2003).

On October 10, 2003, the AERB directed the Safdarjung Hospital, New Delhi, that they should not admit new patients to the radiotherapy department for radiation therapy. The Board also directed that the treatment schedule of the patients currently undergoing radiation therapy may be continued, if deemed necessary by the hospital. The directive was issued, as the institute had not complied with essential safety requirements.

The department did not have a Radiological Safety Officer approved by the Board. The other unsafe practices included retaining unused radioactive sources in the hospital and not sending annual report on the status of radiation safety in the department. The response received from the Head, Department of Radiotherapy was not satisfactory.

The hospital has confirmed to AERB that no new patients would be taken up for treatment in the radiotherapy department and the pending regulatory requirements would be complied with, within three months.

9.1.7 AERB Lifts the Ban on the Radiotherapy Department, Safdarjang Hospital, New Delhi (November 18, 2003).

AERB today revoked the restrictions placed on the Radiation Therapy Department of Safdarjang Hospital, New Delhi. On October 10, 2003, AERB had directed the hospital not to admit new patients for radiation therapy as the hospital had not complied with radiation safety requirements.

The hospital has now implemented the essential safety measures. AERB lifted the ban after one of its officers inspected the hospital and verified its compliance with safety provisions.

9.1.8 AERB Permits Restart of RAPS Unit-1 (January 29, 2004).

AERB issued clearance to Nuclear Power Corporation of India Limited (NPCIL) to restart Unit-1 of Rajasthan Atomic Power Station (RAPS) on January 29, 2004 after an extensive safety review. Earlier AERB had asked NPCIL to close down the unit from April 30, 2002. The reactor remained shut down since then.

During the 21 month shut down of RAPS Unit-1, NPCIL inspected various systems, structures and components of the Unit to assess their fitness for further service. The required actions were then taken by way of replacement of certain major equipment like some of the heavy water heat exchangers. Other safety related up-gradations included incorporation of high pressure emergency core cooling system, provision of supplementary control room and addition of a third emergency diesel generator. The fire and smoke detection system in the plant was also upgraded. These up-gradations were similar to those carried out on Unit-2 earlier, which has been operating satisfactorily since then. The upgraded plant now meets the current safety requirements. AERB will again review the safety status of the reactor after six months of operation for issuing further operating authorisation.

9.1.9 AERB Industrial Safety Awards (March 16, 2004).

The annual Industrial Safety Awards function was held at the AERB on March 16, 2004. Shri S.D. Soman, former Chairman, (AERB) presented the Safety Awards for 2003 to Tarapur Atomic Power Station, Heavy Water Plant Tuticorin and Indian Rare Earths Ltd., Chavara for attaining high levels of industrial safety.

On this occasion, Prof. S.P. Sukhatme, Chairman, AERB released a compilation entitled "Industrial Safety Statistics of the Department of Atomic Energy (DAE) Units for the Year 2003". The compilation contains data on the injury statistics amongst different units of DAE. This data is analysed and compared with data from units outside DAE and available international data. The comparison of safety statistics of DAE units with non-DAE industries in India shows that the safety statistics of DAE units are better than the non-DAE industries. Also comparison with the frequency rate of injuries published for nuclear operating Units worldwide shows that the value for Indian operating units is lower.

9.2 AERB NEWSLETTER

Volume 16 no. 1 to 4 AERB News Letters were published during the year.

Volume 16 no.2, the first Hindi AERB News Letter was published.

9.3 AERB WEB SITE

The AERB website www.aerb.gov.in continued to disseminate information on AERB. The information published on the site included Press Releases, Annual Report, AERB Newsletter, a list of publications, composition of the Board and its important committees. The texts of the Atomic Energy Act 1962 and the safety related rules and some of the AERB safety codes are available on the site. AERB site also includes the format of applications related to its safety research programmes and that of applications pertaining to type approval of radiation equipment, approval of radiological safety officers among others.

CHAPTER 10
INTERNATIONAL ACTIVITIES

10.1 DEPUTATIONS ABROAD

Name of officer	Period of deputation	Venue	Purpose
Prof. S.P. Sukhatme	02.06.2003 to 07.06.2003	Vienna Austria	Advisory Commission on Safety Standards
Prof S.P. Sukhatme	15.09.2003 to 19.09.2003	Vienna Austria	To attend the IAEA General Conference as part of Indian Delegation and Special Programme on Safety for Senior Regulators
Shri S.K. Sharma	07.04.2003 to 11.04.2003	● Vienna Austria ● Paris, France	● 15th meeting of IAEA Nuclear Safety Standards Committee (NUSSC) ● Discussions with French Regulatory authorities
Shri S.K. Sharma	14.08.2003 to 28.08.2003	● Argentina ● Egypt	IAEA Expert assignment on Independent International Advice and Evaluation of the Egyptian Reactor Facility
Shri S.K. Sharma	08.09.2003 to 17.09.2003	U.S.A. Washington DC	To attend a Technical Meeting with USNRC authorities
Shri S.K. Sharma	29.09.2003 to 01.10.2003	Paris France	To attend a meeting with the IRS National Co-ordinators
Shri S.K. Sharma	13.10.2003 to 17.10.2003	Vienna Austria	IAEA working group meeting on Revision of the Draft Safety Code of Conduct on the Safety of Research Reactors
Shri S.K. Sharma	13.11.2003 to 17.11.2003	Vienna Austria	IAEA meeting of International Nuclear Safety Advisory Group
Shri S.K. Sharma	17.03.2004 to 24.03.2004	Vienna Austria	1) IAEA Biennial Meeting of the International Nuclear Event Scale (INES) 2) INSAG Meeting
Shri S.K. Chande	08.09.2003 to 17.09.2003	U.S.A. Washington DC	To attend a Technical Meeting with USNRC authorities
Shri S.K. Chande	03.11.2003 to 07.11.2003	China	Annual meeting of Senior Regulators of Countries Operating CANDU type reactors
Dr. P.C. Basu	17.08.2003 to 29.08.2003	● Vienna Austria ● Czech Republic	17th International conference on Structural Mechanics in Reactor Technology and International symposium on Seismic Evaluation of existing facilities
Dr. P.C. Basu	07.03.2004 to 24.03.2004	● Italy ● Washington USA ● Evanston USA	1) 2nd RCM of IAEA-CRP on Safety Significance of Near Field Earthquakes 2) American Concrete Institute (ACI) Centennial Convention 3) International symposium on advances in Concrete Through Science and Engineering (ACTS)

Name of officer	Period of deputation	Venue	Purpose
Dr.A.N. Nandakumar	07.01.2004 to 20.01.2004	Vienna Austria	Consultancy services to IAEA regarding Action Plan on Safe Transport of Radioactive Material
Shri P. Hajra	13.10.2003 to 15.10.2003	Vienna Austria	Implications of power uprates on safety margins of Nuclear Power Plants
Shri P. Hajra	17.11.2003 to 20.11.2003	Vienna Austria	IAEA Technical Meeting on probabilistic Hazard Evaluation for External Events
Shri S.P. Agarwal	07.07.2003 to 11.07.2003	Vienna Austria	International conference on safety of transport of radioactive material
Shri S.P. Agarwal	20.10.2003 to 24.10.2003	Vienna Austria	Technical Meeting to review a draft of the technical document and comments provided by members states on establishing standards of safety
Shri S.P. Agarwal	10.11.2003 to 14.11.2003	Bonn Germany	Technical Meeting to review the regulations or the safe transport of radioactive material
Shri P.K. Ghosh	18.11.2003 to 21.11.2003	Paris, France	Technical Meeting on exchange of information on safety related experiences gained in fuel cycle facilities
Shri S. Harikumar	20.10.2003 to 22.10.2003	Czech Republic	Technical Meeting to monitor progress in the implementation of accident management programmes
Shri R.S. Rao	15.01.2004 to 14.01.2005	Stockholm Sweden	To undergo graduate studies for a period of one year at Royal Institute of Technology
Dr.P. Sasidhar	02.06.2003 to 11.06.2003	Vienna Austria	Joint working group meeting of IAEA CRP on application of safety assessment methodologies for radioactive waste disposal facilities
Dr.P. Sasidhar	09.02.2004 to 13.02.2004	Vienna Austria	2nd Research Co-ordination Meeting (RCM) of IAEA-CRP on Application of Safety Assessment Methodologies for Near Surface Radioactive Waste Disposal Facilities (ASAM)
Shri S.K. Shirva	17.11.2003 to 21.11.2003	Bangkok Thailand	Regional training course on the authorisation and inspection of radiation sources in diagnostic radiography
Shri V. Jagannath Mishra	31.03.2003 to 07.04.2003	Russia	Visit of AERB team to Russian Federation in relation to issues raised during Safety Review of KKNPP
Shri A. Ramakrishna	31.03.2003 to 01.04.2003	Russia	Visit of AERB team to Russian Federation in relation to issues raised during Safety Review of KKNPP
Shri S.K. Warrier	30.06.2003 to 03.07.2003	Vienna Austria	Technical Meeting on safety aspects of ageing management of BWR reactor pressure vessels and core internals
Shri S.A. Sukheswalla	09.09.2003 to 12.09.2003	Vienna Austria	IAEA technical meeting on the Role of Govts. and regulators infostering a strong nuclear safety culture
Shri George Thomas	07.07.2003 to 11.07.2003	Vienna Austria	Technical Meeting to undertake a review of national experience on the regulatory control of discharge

Name of officer	Period of deputation	Venue	Purpose
Shri P.R. Krishanamurthy	17.11.2003 to 21.11.2003	Vienna Austria	Technical Meeting on NPP safety performance indicators for use by the regulatory organisations
Shri P.S. Virdi	13.10.2003 to 17.10.2003	China Beiging	IAEA regional training course of Radiation Protection of Radioactive Waste Management.
Shri J. Koley	July 2003 to March 2004	Voronez Rusia	Phase B training of 1st batch of NPC-KK and AERB Engineers in VVER-1000 MWe plants
Shri K. Suneet	July 2003 to March 2004	Voronez Rusia	Phase B training of 1st batch of NPC-KK and AERB Engineers in VVER-1000 MWe plants
Shri B. Dipto	July 2003 to April 2004	Voronez Russia	Phase B training of 1st batch of NPC-KK and AERB Engineers in VVER-1000 MWe plants
Shri C. Senthilkumar	19.04.2003 to 24.04.2003	Tokyo, Japan	11th International Conference on Nuclear Engineering (ICON-11)
Shri S.C. Utkarsh	18.09.2002 to 27.11.2003	Stockholm Sweden	Training in service accident analysis of VVER-1000 reactors and use of Melcor computer code.
Shri A.U. Sonawane	24.11.2003 to 27.11.2003	Hanoi Vietnam	Development of National Strategies for improving control over radioactive sources.

10.2 COLLABORATION WITH FOREIGN ORGANISATIONS AND REGULATORY BODIES OF OTHER COUNTRIES

C&SED is participating in the IAEA Coordinated Research Project (CRP) on the "Safety Significance of Near Field Earthquakes". The CRP aims at applying the recent engineering practices to evaluate seismic vulnerability of non-nuclear facilities in the seismic safety assessment of nuclear facilities with respect to the effects of near field earthquakes.

In relation to this, the division carried out work related to the non-linear analysis of concrete shear walls and portal frames. A general-purpose software program for generation of the moment curvature relationships for RCC sections was developed during this period. A pushover analysis to calculate the ultimate capacity of the RCC frame structures utilising this software is being carried out. A research paper based on this work has been accepted for publication in the IAEA International Seminar on "Seismic Evaluation of Existing Nuclear Facilities".

10.3 IAEA WORKSHOP ON "AGEING MANAGEMENT OF NUCLEAR POWER PLANTS (AM-NPP)"

AERB organised an IAEA workshop on "Ageing Management of Nuclear Power Plants (AM-NPP)", in Mumbai during 8 to 12, December 2003 at AERB Auditorium. Delegates from AERB, BARC, NPCIL, IGCAR, NFC, HWB participated in the workshop.

Chairman inaugurating the IAEA Workshop on Ageing Management.

The workshop focused on the safety aspects of the long-term operation programmes now in many countries. The workshop covered all the major safety issues behind the long-term operation (LTO) of a nuclear power plant and the ageing management programme (AMP), clarifying safety objectives, scope and methods, and discussing possible implementation frame works at Indian NPPs. Both PWR and PHWR issues were covered in a systematic overview of the most significant degradation mechanisms to be addressed by AMP and LTO.

Indian experience on AMP was also presented by participants during the workshop. The daily round tables

supported a thorough understanding of the safety issues behind the implementation of an AMP both at plant level and at the utility level, clarifying mainly the practical issues on the basis of the experience of the experts. At the final round table with all the experts, the main implementation issues of the AMP were highlighted. It was acknowledged that additional IAEA guidance could effectively support the LTO processes now in place in India.

10.4 AERB-USNRC DISCUSSION MEETING ON NUCLEAR SAFETY

A six-member USNRC delegation led by Ashok Thadani, Director, Office of Nuclear Regulatory Research, USNRC visited India for the third AERB-USNRC Nuclear Safety Discussion Meeting that was held during February 23-25, 2004 at the World Trade Centre in Mumbai. The Indian team for the meet was led by AERB Vice Chairman, S.K. Sharma. The topics of focus during the discussions were Fire Safety, Ageing Management and License Renewal of Nuclear Power Plants. Presentations made by experts from both the sides were followed by extensive discussions. A large number of specialists from AERB, NPCIL, IGCAR and BARC took part in the discussions.

On 26th February 2004, the US NRC delegation called upon Chairman, AERB at Niyamak Bhavan. This was followed by an enlightened talk by Ashok Thadani on "Perspectives on Reactor Safety" at the Nabhikiya Urja Bhavan Auditorium which was attended by a large gathering.

The USNRC delegation visited the Madras Atomic Power Station at Kalpakkam on 27th February 2004. Here, they were briefed by the station personnel on the En-masse Coolant Channel replacement and various safety upgradations carried out earlier in unit 1 and similar works being undertaken presently in unit 2. They were given demonstration of coolant channel replacement at the mock-up facility and the on-power refuelling operation at the fuelling machine rehearsal facility. The delegation also had a field visit of MAPS, the Turbine Building, Control Room and switchgear areas.

The inter-regulatory co-operation between AERB and USNRC resumed in February 2003 when a USNRC team led by their Chairman, Dr. R.A. Meserve visited India. The safety related topics pertaining to NPPs identified for this co-operation are Fire Safety, Ageing Management and License Renewal, Emergency Operating Procedures, Risk Informed Regulation and Design Modifications. Brief discussions on these topics were initiated in the first meeting and these were expanded during the second meeting that was held in Washington D.C. in September 2003 when a six member Indian delegation led by AERB Vice Chairman, S.K. Sharma visited USNRC. The fourth meeting of the two year programme for 2003/2004 is proposed to be held in USA during August/September 2004 for AERB-USNRC discussion meeting on Nuclear Safety.

Chairman meets US Consul General, Mr. Angus Simmons at the time of USNRC delegation visits to India. USNRC Team Leader, Mr. Ashok Thadani and Mr. S.K. Chande, Director, OPSD are also seen.

CHAPTER 11
HUMAN RESOURCE DEVELOPMENT

11.1 AERB TRAINING PROGRAMME

The Training Programme for AERB Staff, which was started in October 2001 was successfully completed in November, 2003 covering a total of 58 training modules under various topics of Basic Safety, Radiological Safety, Industrial Safety and Civil & Structural Engineering Safety. The experts drawn from AERB, BARC, NPCIL and Consultants delivered the lectures to the AERB staff during the training programme. The details on the number of modules covered are given in the table below.

Sr. No	Modules	Number of Modules Completed (2003-2004)	Cumulative Number of modules
1	Basic Safety	7	23
2	Radiological Safety	0	12
3	Industrial Safety	0	12
4	Civil & Structural Engineering Safety	1	11
	Total	8	58

The feedback session on the training activity was held on 3rd February 2004. The salient points that emerged in the feedback session are the following.

1. Specific Management modules useful to improve effectiveness in the functioning of AERB staff needs to be conducted from reputed training institutes.
2. Regular colloquia should be conducted (a) on specific topics by experts and (b) on deputation assignments not only of AERB staff but also of officers from DAE units and workshops should be conducted.
3. The time interval before the commencement of the next training activity should be utilized by scheduling talks on specific topics of interest. It is expected that the topics of interest will encourage the AERB personnel to participate in the training programme. Specific training programmes are being conducted by NPC sites and NPC Head quarters; AERB can approve participation in these programmes. On the job training of new technical persons joining AERB, should be arranged.
4. Basic training modules for other and specific training modules like industrial and radiation facilities in essence to upgrade basic knowledge, should be included. Also subjects like Quantitative Risk Assessment for chemical plant, unresolved/current safety issues, feedback of regulators from different countries, operating experience feedback, ISO certifications (as applicable to Regulatory Body, such as 9000/14000/18000), should also be included.
5. The training programme should not be on all the four full Mondays in a month. The programme should be twice in a month on Monday. The schedules should be drawn and intimated well in advance (preferably for the whole calendar year).
6. Attendance should be compulsory for basic modules. However, judicious thought should be given to decide which modules are to be made compulsory for attendance.
7. There is difference of opinion about conducting examination on the training modules. A majority of the AERB personnel proposed that examinations need to be conducted and persons getting through should be appropriately recognized and felicitated which would motivate persons to attend training and take the training course seriously.
8. As regards methods of examination, majority opined that answer banks should not be provided. At the most, questions bank can only be given. Lecture materials should be provided before the lecture day.

11.2 TRAINING PROGRAMME TO NPCIL TRAINEES

Shri A. Ramakrishna, SADD delivered 6 lectures to NPC Trainees on BWR concepts and TAPS Reactor Physics in MAPS NTC, Kalpakkam during 4-6 February 2004.

CHAPTER 12
SAFETY PROMOTIONAL ACTIVITIES

12.1 PRESS NOTICES FOR USERS OF RADIATION SOURCES

Two press notices were issued regarding the regulatory requirements relating to the operation of diagnostic X-ray units and also handling of radioactive materials.

12.2 WORKSHOPS ON SAFETY AND SECURITY OF INDUSTRIAL RADIOGRAPHY SOURCES

In order to prevent occurrence of incidents and accidents and to emphasize the need for the safety and security of industrial radiography sources, a series of one day regional workshops were organized on "Safety and Security of Industrial Radiography Sources" for the entrepreneurs. Two workshops were conducted each at Mumbai, Delhi and Kolkata and one each at Chennai and Thiruchirapalli. On an average about 45 participants attended each workshop. The participants received the workshop well and all of them requested that the workshop be conducted annually.

12.3 TRAINING PROGRAMMES FOR RADIOTHERAPY TECHNICIANS

AERB organized and conducted six training courses for radiotherapy technicians in different parts of the country. In view of the acute shortage of nuclear medicine technologists in the country, AERB studied the syllabi of formal training programmes conducted by reputed organisations in the country and determined the course content for accrediting such training programmes. AERB determined the course content for the M.Sc. (Radiation Physics) programme of Jodhpur University. Persons with this qualification would be eligible to function as Medical Physicists and RSO Level III in Radiotherapy centers.

12.4 INDUSTRIAL SAFETY AWARDS

The Industrial Safety Awards Presentation function was held on March 16, 2004 in AERB auditorium. Tarapur Atomic Power Plant & Heavy Water Plant-Tuticorin won the awards amongst operating units of Nuclear Power Plants & Heavy Water Plants. Indian Rare Earths Ltd. - Chavara Plant won the award amongst other production units of DAE for the year 2003. Shri S.D. Soman, former Chairman AERB was the chief guest and presented the safety shields to the winners.

12.5 FIRE SAFETY AWARD

The Fire Safety Award is decided by taking into account the safety record on fire incidents and the fire potential at the site. The award is given on the basis of best performance in fire safety amongst all DAE units. Tarapur Atomic Power Station (TAPS) 1&2 has been selected as the winner for the year 2003.

12.6 GREEN SITE AWARD

IRE, Orissa Sands Complex (OSCOM) and Electronics Corporation of India Ltd. (ECIL) were selected as the winners of the AERB Green Site Award for the year 2003.

12.7 INDUSTRIAL SAFETY STATISTICS OF DAE UNITS

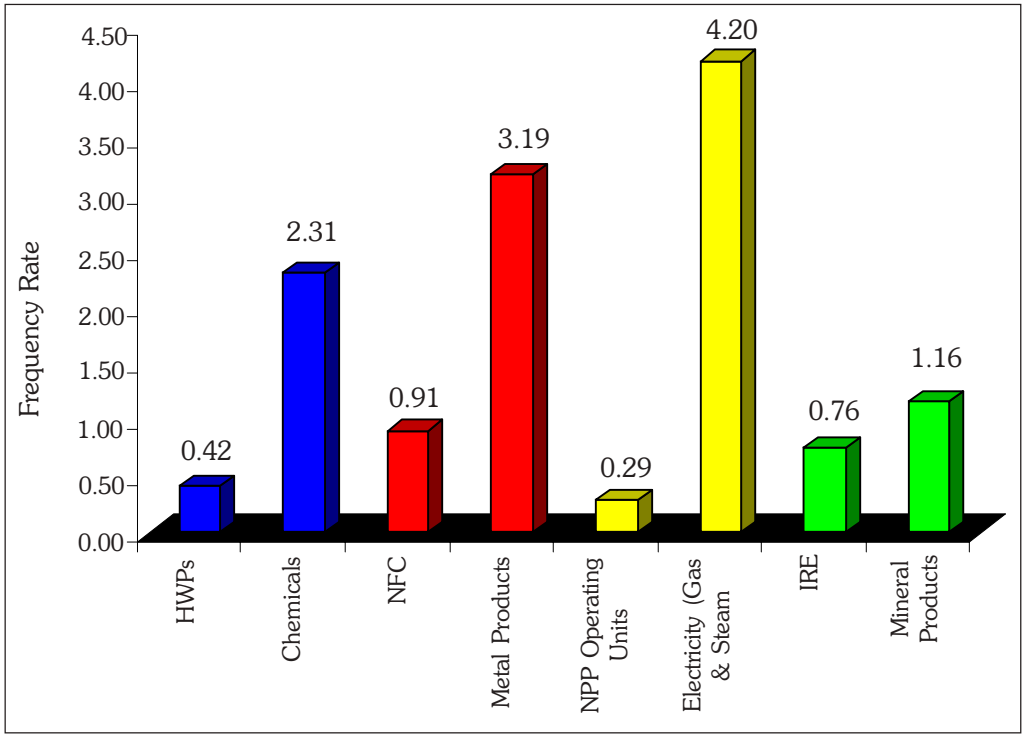
The data related to injuries sent by various DAE units were compiled and a document entitled "Industrial Safety Statistics of DAE Units for year 2003" was released on March 16, 2004 during the Industrial Safety Awards presentation function at AERB.

This document contains safety statistics of DAE

Chairman addressing the gathering at industrial Safety Award Fundtion

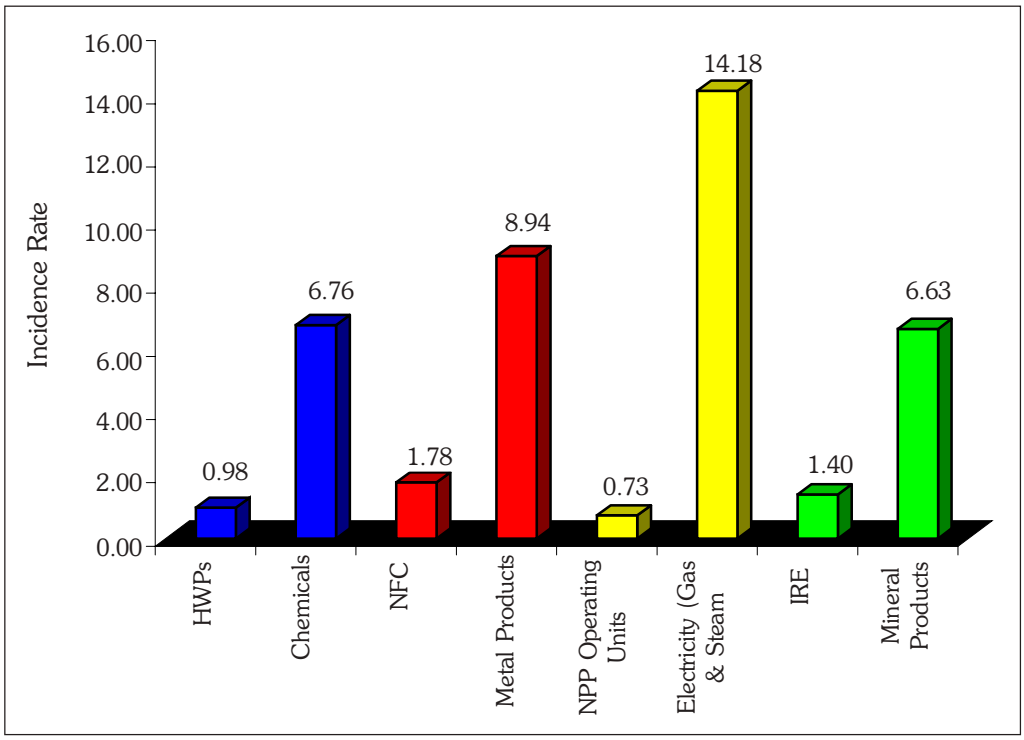
units with respect to parameters such as lost time injuries, man-days lost, frequency rate, severity rate, injury index and incidence rate. Trends of accident statistics of DAE units for these parameters from 1999 to 2003 are also included. A break-up of injuries and man-days lost is made with respect to agency involved in the injury, type of accident causing the injury, unsafe act causing injury, unsafe condition leading to injury, nature of injury and location of the part of the body injured. In addition, an analysis of injuries in 2003 was made on the basis of time of occurrence of the day. Frequency rates (number of lost time injuries per million man-hours worked) and incidence rates (number of lost time injuries per thousand persons employed) in DAE units in comparison with those in other industries in India are given Fig. 5 and Fig. 6 respectively. Unit wise break-up of injuries and man-days lost for DAE units is given in Fig. 7. Number of lost-time injuries in different years (1999-2003) is shown in Fig.8

Fig .5 Comparison of Frequency Rates of Injuries in DAE Units with Data for Other Industries in India



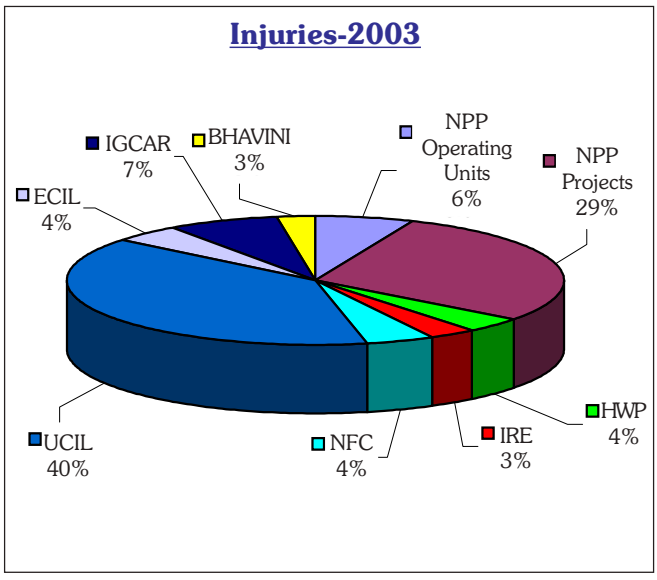
Frequency Rate : Number of lost time injuries per million man-hours worked

Fig. 6 Comparison of Incidence Rates of Injuries in DAE Units with Data for Other Industries in India



Incidence Rate : Number of lost time injuries per thousand persons employed.

Fig. 7 Unit wise break-up of Injuries and Mandays Lost



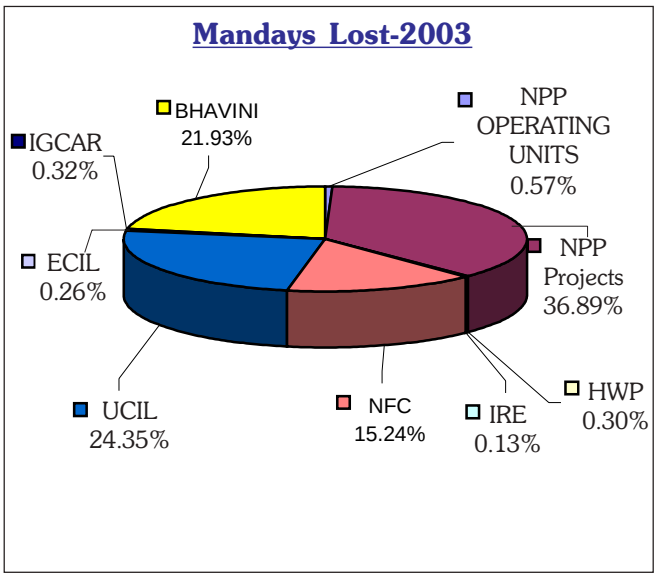
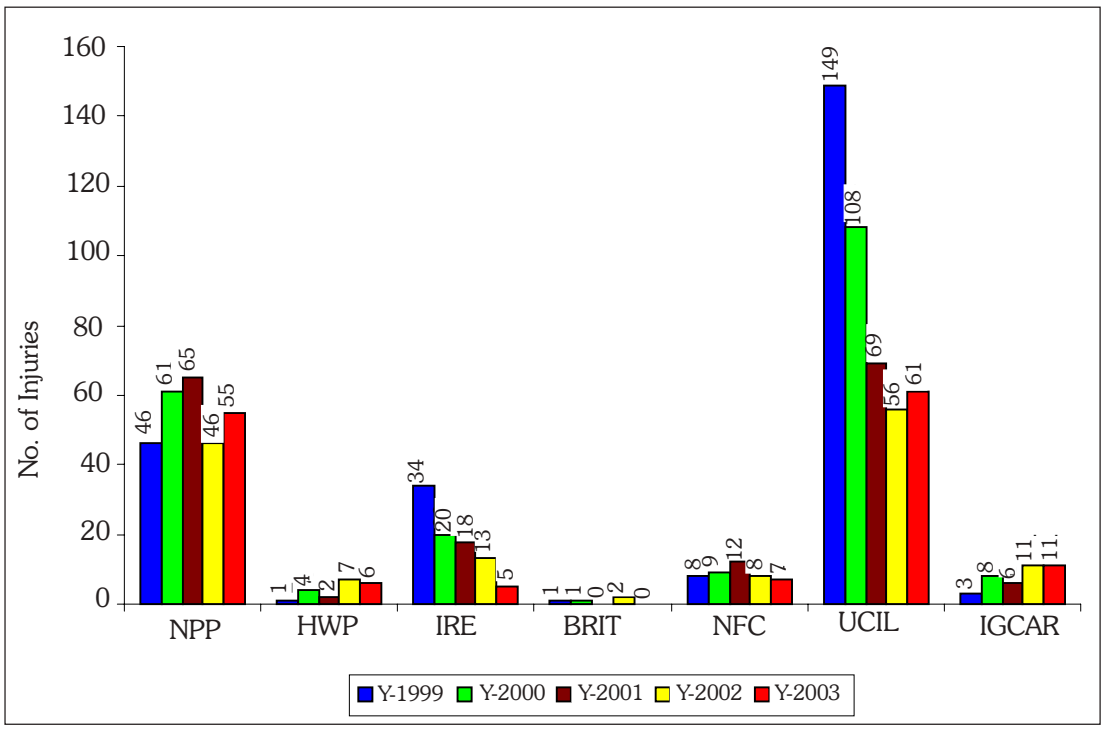


Fig.8 Number of Lost-Time Injuries in Different Years (1999-2003)



12.8 OTHER ACTIVITIES

12.8.1 Advisory Committee on Fire Safety

Advisory Committee on Fire Safety visited and reviewed existing fire safety arrangements at the following units:

(a) IREL, Udyogamandal, Chavara, Manavalakuruchi and OSCOM

(b) Heavy Water Plant, Tuticorin and Heavy Water Plant, Talcher

12.8.2 Fire Safety Training/Workshop

Two days Training programme for sub-officers of DAE fire stations was arranged on May 27–28, 2003 at TAPS 1&2. Around 25 delegates consisting of sub-officers, leading firemen from various units of DAE, viz., NPCIL, HWP, NFC, CAT, IGCAR and BARC participated in the programme.

Two days workshop on strengthening the capability of fire fighting for firemen of all DAE units was arranged on February 20-21, 2004, at HWP, Kota. Thirty-two participants from all DAE units attended the programme.

12.8.3 Fire Safety Review of MAPS

A Committee was constituted by SARCOP for fire safety review of MAPS-2 before giving clearance for restart after the En-Mass Coolant Channel Replacement. The committee reviewed the provisions for fire safety along with the augmentation measures taken up by the unit. Based on the requirement as per the AERB Safety Guide on Fire Safety, the committee suggested measures like the following.

- Installation of optical type smoke detector in fuelling machine vault.
- Installation of water sprinkler in cable spreading gallery.
- Provision of alarm in the control room for loss of ventilation in the battery room.
- Electrical fittings in the hydrogen addition area of turbine building shall be of Class-II C type.
- Provision of alarm in the Main Control Room for indicating running of fire pumps, power failure or failure to start up.
- Fixed barriers are to be provided in between two

parallel cable trays over the panels in both MCC and switchgear rooms.

- Toughened glass of 3 h fire rating is to be provided instead of normal glass window in 645 AH battery room near MCC room.

12.8.4 Fire Safety Review of RAPS 1

Review of proposal for Fire Safety Up-gradation in RAPS-1 was carried out. Some of the measures suggested are:

- The detection system shall also annunciate audible and visual alarms in the fire station.
- Cable and cable tray penetrations fire barriers (vertical and horizontal) shall be sealed.

12.8.5 Fire Safety in Resin Fixation System at KAPS

A fire safety and industrial safety aspects review related to resin fixation systems set at KAPS was carried out. Some of the measures suggested are:

- The chemical addition room, chemical feed tank and the feed preparation room should have suitable fire detection system, with audio/visual alarm at fire station/ control room and access to fire hydrant point.
- Both feed preparation and chemical addition rooms should be provided with adequate ventilation system with Class III power supply.

CHAPTER 13
OFFICIAL LANGUAGE IMPLEMENTATION

AERB staff celebrated Hindi Week from September 22-26, 2003. During Hindi Week, various Hindi competitions were organized. These included Hindi Typing, Essay Writing, Elocution, Debate, Puzzle, Memory Test, Hindi Slogan, Hindi Dictation and Translation competitions.

Staff from AERB also participated and won prizes in the Hindi competitions organized from September 17 - 19, 2003 jointly by AERB, HWB, DPS, DCSEM and BRIT located at Anushakti Nagar, Mumbai.

Hindi Workshop was organized by the Official Language Implementation joint Co-ordination Committee of Anushakti Nagar based five organizations. Two employees from AERB participated in the above Hindi Workshop.

The Incentive Schemes of DAE for promoting the use of Hindi in official work are implemented in AERB and four employees and one officer participated in these schemes.

Annual Report, AERB Newsletter and AERB Brochure have been published in Hindi and English. The annual Hindi journal "Niyamika" was published. Press Communique were issued in Hindi and published in newspaper. Licences, authorizations and inspections reports were issued in Hindi. Three hundred and ten Hindi Books on various subjects were purchased for the use of AERB officials. As per advice of DAE, ISM 2000 Office Software developed by C-DAC, Pune were purchased and loaded on 50 PCs. of AERB for day-to-day official work. Entries are made in Hindi in all Service Books of officers and staff. Suitable action has been taken to translate all the Codes/Guides/Manuals etc. and print them in Hindi.

A total number of fifty-eight letters as X-ray unit registration (licence) certificates and laboratory accreditation certificates were issued in Hindi.

Vice-Chairman, AERB accompanied by Shri N.S. Nair, A.O.III, Shri Narsing Ram, Hindi Officer on the Dais at the occasion of Hindi Prize Distribution.

CHAPTER 14
AERB PERSONNEL
(31.03.04)

Sr. No.	Name	Designation/ Grade
1	Sukhatme S.P. (Prof.)	Chairman
2	Sharma S.K.	DS
3	Chande S.K.	OS
4	Ghosh P.K.	Scientific Officer H+
5	Singh Om Pal (Dr.)	”
6	Gujarathi R. I.	”
7	Basu P.C. (Dr.)	”
8	Dave D.K.	”
9	Warrier S.K.	H
10	Hajra P.	”
11	Venkataraman R.	”
12	Sukeshwala S.A.	”
13	Nandakumar A.N. (Dr.)	”
14	Patwegar I.A.(Dr.)	Scientific Officer(G)
15	Chugha R.K.	”
16	Pande V.V.	”
17	Prasad J.	”
18	Ramakrishna A.	”
19	Rao S.N.	”
20	Agarwal S.P.	”
21	Bhattacharya R.	”
22	Fedric Lall	”
23	Krishnamurthy P.R.	”
24	Chauhan B.S.	”
25	Shah Y.K.	”
26	Srivasista K.	”
27	Singh R.P.	”
28	Subbiah K.V.	”
29	Bhattacharya S. (Smt.)	Scientific Officer F
30	Kanta Chhokra (Smt.)	”
31	Ashraf S.A.H	”
32	Bishnoi L.R.	”
33	Khan S.A.	”
34	Shirva V.K.	”
35	Swamy S.T.	”
36	Raghavendran C.P.	”
37	Ramprasad K.	”
38	Sasidhar P. (Dr.)	”
39	Paul U.K.	”
40	Janakiraman G.	”
41	George Thomas	”
42	T.S. Padmanabhan	”
43	Arun Kumar	”
44	Harikumar S.	”
45	Nagalakshmi B (Smt.)	Scientific Officer E
46	Nehru R.M.	”
47	Sonawane A.U.	”
48	Deepak Ojha	”

Sr. No.	Name	Designation/ Grade
49	Koley J.	E
50	Pushpangadhan K.D.	”
51	Gupta R.P.	”
52	Upadhayay K.C.	”
53	Natarajan G.	”
54	Dash Sharma P.K.	”
55	Senthil Kumar C.	”
56	Asokan Pillai N.G.	”
57	Parmar R.U.	”
58	Mahale L.B.	”
59	Titto E.R	”
60	Raut V.V.	”
61	Kulkarni H.K.	”
62	Bhave S.R.	Scientific Officer D
63	Shylamoni P. (Smt.)	”
64	Iyer V.S.	”
65	Roshan A.D.	”
66	Singh R.K.	”
67	Vijayan P.(Dr.)	”
68	Valivetti L.N.	”
69	Rao R.S.	”
70	Solanki R.B.	”
71	Utkarsh S.C.	”
72	Bhattacharya D.	”
73	Suneet K.	”
74	Vivek	”
75	Virdi P.S.	”
76	Pisharady A.S.	”

Sr. No.	Name	Designation/ Grade
77	Dubey S.K	”
78	Srikrushna Kumar Pradhan	”
79	Tripathi S.K	”
80	Mahendra Prasad	”
81	Gurumurthy	Scientific Officer C
82	Anuradha V (Smt.)	”
83	Inamdar M.V. (Smt.)	”
84	Sunil Sunny C.	”
85	Mishra J	”
86	Amit Sen	”
87	Pimpale D.V.	”
88	Pradhan S.K.	”
89	Sahani G.	”
90	Gholap V.P.	”
91	Singh B.K.	”
92	Kodolkar S.M.	”
93	Rane D.M.	”
94	Senthil Kumar M.	”
95	Kulkarni Arti R (Kum.)	”
96	Choudhary Dipali (Kum.)	”
97	Patil Pravin	”
98	Ingavale B (Smt.)	Scientific Officer SB
99	Vadivala R.N. (Smt.)	Scientific Assistant E
100	Sivaraman G.	Scientific Assistant D
101	Chodankar N.M.	”
102	Dhotre V.R.	”
103	Kavi Upreti	Scientific Assistant C
104	Soumya George (Kum.)	Scientific Assistant B

Sr. No.	Name	Designation/ Grade
105	Jayalakshmi D (Kum.)	B
106	Bokade Dipika P (Smt.)	”
107	Bapat A.P.	Tradesman, F
108	Bhoite S.S.	Asstt. Foreman
109	Salgaonkar R.D.	Tradesman, D
110	Kajania B.D.	Tradesman, B
111	Puran Singh	”
112	Nair N.S.	Administrative Officer
113	Sarojini L. (Smt.)	Principal Pvt. Secretary
114	Palamattam R.J.	Senior Pvt. Secretary
115	Nalini Venugopalan	PS (NS)
116	Vijayan C.K.	Adm. Officer -II
117	Kuriakose V.P.	Asst. Personnel Officer
118	Narsingh Ram	Assistant Director OL
119	Sumambika Panicker (Smt.)	Asstt.
120	P. Chandrasekhar (Smt.)	Steno I
121	Sheela K. Menon (Smt.)	”
122	Mallika Nair (Smt.)	Steno II
123	Narayanan P.	”
124	Radha Raghavan (Smt.)	”
125	Latha Mohandas (Smt.)	”
126	Sathe M.S.	PRA
127	Shukla M.K.	JR. H.T.
128	Neena J. (Smt.)	Steno III
129	Moopanar G M	”
130	Shelar P.A. (Smt.)	UDC
131	Koli R.R.	”
132	More J.K.	LDC
133	Shettigar S.M. (Smt.)	”
134	Vaibhavi R. Dalvi (Smt)	”
135	Parab Priya P (Smt)	”
136	Naktode J.S.	HINDI TYPIST
137	Elsie T.M.(Smt.)	Dy. Controller of A/c
138	Samuel P.(Smt.)	Accounts Officer
139	Nair S.M.(Smt.)	Asstt. Accounts Officer
140	Javed Jafri	Assistant Accountant
141	Prakash K.V.	UDC
142	P. Harinarayanan (Smt.)	UDC
143	Satwilkar V.V.	UDC
144	Randhe V.R.	Driver OG
145	Shaikh F A A A	Driver OG
146	Leo Babu Joseph	Helper A T
147	Kamble N.G.	Driver
148	Patil P.S.	Driver
149	Karande S.A.	Driver
150	Kanse S.S.	Driver

During the year, following officers retired on superannuation from AERB.

1. Dr. K.S. Parthasarathy, Secretary, AERB and Director, ITSD.
2. Shri Deepak De, Director, NPSD.
3. Shri S.K. Agarwal, Director, SADD.
1. Shri K.K. Chandrakar, SO/G, OPSD.

The following officers joined AERB.

1. Shri R. I. Gujarathi from Reactor Group, BARC in July 2003 and appointed as Director NPSD in November 2003.
2. Dr. Om Pal Singh, Formerly Head Reactor Physics Division, Kalpakkam IGCAR, Tamilnadu in February, 2004 and appointed as Director, ITSD in March 2004 and Secretary AERB from Oct. 1, 2004.

The following officer left AERB

1. J. P. Jena, SO/D, OPSD.

APPENDIX
LIST OF ABBREVIATIONS

ACCGORN	:	Advisory Committee on Preparation of Code and Guides on Governmental Organization for Regulation of Nuclear and Radiation Facilities
ACCGASSO	:	Advisory Committee for Codes, Guides & Associated Manuals for Safety in Operation of NPPs
ACCGQA	:	Advisory Committee for Codes, Guides & Associated Manuals for Safety in Operation of NPPs
ACHF	:	Augmentation of Cobalt Handling Facility
ACNS	:	Advisory Committee on Nuclear Safety
ACPSR	:	Advisory Committee for Project Safety Review
ACOH	:	Advisory Committee on Occupational Health
AERB	:	Atomic Energy Regulatory Board
AFR	:	Away From Reactor
AHWR	:	Advanced Heavy Water Reactor
AMD	:	Atomic Minerals Division
ASME	:	American Society of Mechanical Engineers
BARC	:	Bhabha Atomic Research Centre
BRIT	:	Board of Radiation and Isotope Technology
BSA	:	Blanket Sub Assembly
CAT	:	Centre for Advanced Technology
CESC	:	Civil Engineering Safety Committee
CESCOP	:	Civil Engineering Safety Committee for Operating Plants
CFFP	:	Ceramic Fuel Fabrication Plant
CSIR	:	Council for Scientific and Industrial Research
CT	:	Computed Tomography
DAE	:	Department of Atomic Energy
DBR	:	Design Basis Report
DRDO	:	Defence Research and Development Organisation
ECCS	:	Emergency Core Cooling System
ECIL	:	Electronics Corporation of India Ltd
ECSQ	:	Expert Committee for Seismic Qualification
EFPY	:	Effective Full-Power Years
ERS	:	Event Reporting System
FBTR	:	Fast Breeder Test Reactor
FRERP	:	Fast Breeder Fuel Processing Plant
GAN	:	GOSATOMNADSOR
HWB	:	Heavy Water Board
HWP	:	Heavy Water Plant
IAEA	:	International Atomic Energy Agency
ICRP	:	International Commission on Radiological Protection
IGCAR	:	Indira Gandhi Centre for Atomic Research
INES	:	International Nuclear Event Scale
IREL	:	Indian Rare Earths Limited
IRS	:	Incident Reporting System
ISI	:	In-Service Inspection
KAMINI	:	Kalpakkam Mini Reactor
KAPS	:	Kakrapar Atomic Power Station
KGS	:	Kaiga Generating Station
KK-NPP	:	Kudankulam Nuclear Power Project
LMC	:	Lead Mini Cell
MAPS	:	Madras Atomic Power Station
MOU	:	Memorandum of Understanding
NAPS	:	Narora Atomic Power Station
NFC	:	Nuclear Fuel Complex
NOC	:	No-Objection Certificate
NPCIL	:	Nuclear Power Corporation of India Limited
NPP	:	Nuclear Power Project
NUOFP	:	New Uranium Oxide Fabrication Plant
OSCOM	:	Orissa Sand Complex
PDSC	:	Project Design Safety Committee
PFBR	:	Prototype Fast Breeder Reactor
PHT	:	Primary Heat Transport
PHWR	:	Pressurised Heavy Water Reactor
PSAR	:	Preliminary Safety Analysis Report
QA	:	Quality Assurance
RAPP	:	Rajasthan Atomic Power Project
RAPPCOF	:	Rajasthan Atomic Power Project Cobalt Facility

RAPS	:	Rajasthan Atomic Power Station
RCB	:	Reactor Containment Building
RSO	:	Radiological Safety Officer
SARCAR	:	Safety Review Committee for Applications of Radiation
SARCOP	:	Safety Review Committee for Operating Plants
SC	:	Safety Committee
SCHWOP	:	Safety Committee for Heavy Water Operating Plants
SPND	:	Self Powered Neutron Detector
SER	:	Significant Event Reports
SFSB	:	Spent Fuel Storage Bay
SGTF	:	Steam Generator Test Facility
SRI	:	Safety Research Institute
SSSF	:	Solid Storage Surveillance Facility
TAPS	:	Tarapur Atomic Power Station
TAPP	:	Tarapur Atomic Power Project
LTTMZ	:	Low Trajectory Turbine Missile Zone
Type B (U)	:	Type B (Unilateral)
UCIL	:	Uranium Corporation India Limited
VECC	:	Variable Electron Cyclotron Centre
VVER	:	Water Water Energy Reactor
USNRC	:	United States Nuclear Regulatory Commission
WIP	:	Waste Immobilisation Plant
ZSP	:	Zirconium Sponge Plant

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