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) and Advisory Committees for Project Safety Review (ACPSRs). ACPSR recommends to AERB issuance of authorisations at different stages of plants of the Department of Atomic Energy (DAE), after reviewing the submissions made by the plant authorities, based on the recommendations of the associated Design Safety Committees. The SARCOP carries out safety surveillance and enforces safety stipulations in the operating units of the DAE. The SARCAR recommends measures to enforce radiation safety in medical, industrial and research institutions which use radiation and radioactive sources. AERB also receives advice on codes and guides and on generic issues from the Advisory 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 institutions and governmental agencies.

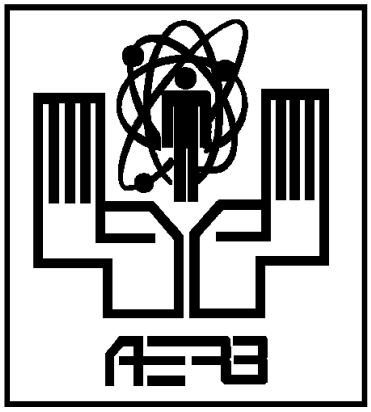
The AERB Safety Research Institute at Kalpakkam organises several activities to promote safety research. Besides carrying out research in various safety related topics, SRI holds seminars, workshops and discussion meetings of specialists.

AERB Secretariat has eight divisions. The Heads of Divisions constitute the Executive Committee which meets every month with Chairman, AERB in the Chair and takes decisions on important policy matters related to the management of the Board Secretariat.

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

ANNUAL REPORT
2002-2003



GOVERNMENT OF INDIA
ATOMIC ENERGY REGULATORY BOARD
NIYAMAK BHAVAN
MUMBAI-400 094
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CMYK

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;
- Funding 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.

CONTENTS

INDEX TO TABLES

INDEX TO FIGURES

SECTION 1 - GENERAL

1.1 COMPOSITION OF THE BOARD

(From April 1, 2002 to December 31, 2002)

1.	Prof. S. P. Sukhatme	...	Chairman
2.	Shri. G.R. Srinivasan Vice Chairman, AERB	...	Ex-officio Member
3.	Dr. M.V.S. Valiathan Honorary Advisor Manipal Academy of Higher Education, Manipal	...	Member
4.	Dr. K.V. Raghavan Director Indian Institute of Chemical Technology, Hyderabad	...	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 Head Information and Technical Services Division, AERB	...	Secretary

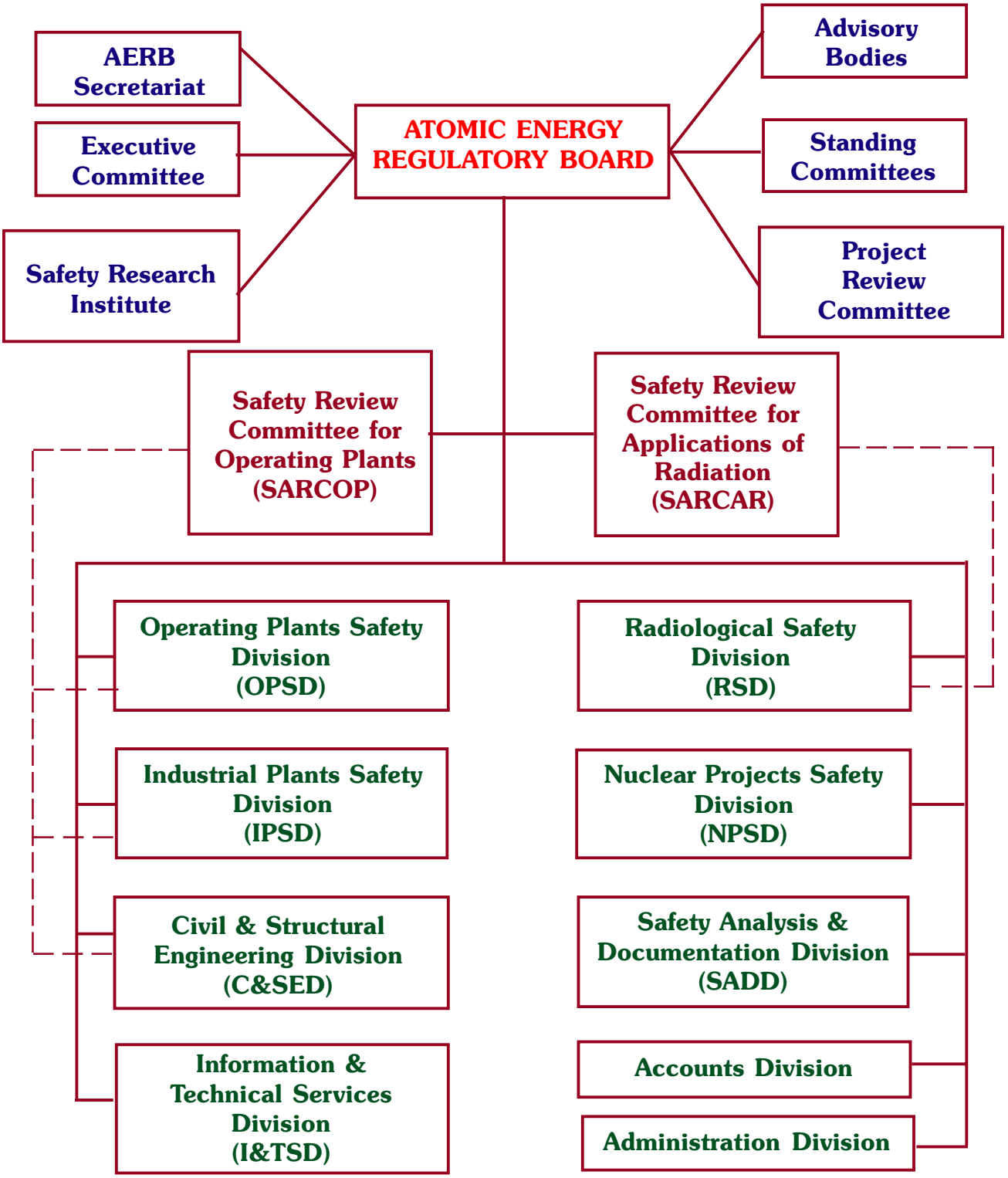
COMPOSITION OF THE BOARD

(From January 1, 2003)

1.	Prof. S. P. Sukhatme	...	Chairman
2.	Shri. S.K. Sharma Vice Chairman, AERB	...	Ex-officio Member
3.	Dr. M.V.S. Valiathan Honorary Advisor Manipal Academy of Higher Education, Manipal	...	Member
4.	Dr. K.V. Raghavan Director Indian Institute of Chemical Technology, Hyderabad	...	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	...	Secretary

1.2 ORGANISATION CHART

ATOMIC ENERGY REGULATORY BOARD



1.3 SUMMARY

During the year AERB carried out its chartered functions with the support of its secretariat and specialist committees. The Board met four times during the year.

Shri G.R. Srinivasan retired on December 31, 2002 after serving AERB with distinction as Vice Chairman. Shri S.K. Sharma, Director, Reactor Group and Engineering Services Group, BARC joined the Board as Vice Chairman from January 1, 2003.

The nuclear power programme in India started with the commissioning of Tarapur Atomic Power Station (TAPS) Unit 1& 2 in 1969. These are Boiling Water Reactors constructed as turn key projects by the General Electric Company of USA. However, the Indian nuclear power programme is mainly based on Pressurized Heavy Water Reactors (PHWRs) and 12 such reators have so far been set-up at Kota, Kalpakkam Narora, Kakrapar and Kaiga. With this, the installed nuclear power generation capacity in India is 2720 MWe presently.

Currently, NPCIL is constructing two pressurized heavy water reactors of 540 MWe each at Tarapur and four pressurized heavy water reactors of 220 MWe each (two each at Kota and Kaiga). Two light water moderated and cooled reactors (VVER) of 1000 MWe of Russian design are under construction at Kudankulam. Excavation work for India's first Prototype Fast Breeder Reactor (PFBR) of 500 MWe has been started at Kalpakkam. Thus, the nuclear power programme in India is poised for a significant growth in the next few years.

AERB has evolved appropriate mechanisms to carry out safety review of these reactors of new and diverse designs that are under construction and to issue authorisations at various stages of these projects. AERB draws liberally from the pool of personnel with vast experience and expertise that exist in the country to meet the challenge.

Safety Review of Nuclear Power Projects

The safety review of all ongoing nuclear power projects was continued through the muti-tier review mechanism and various clearances for different stages of construction of the projects were given.

Fond Farewell to Shri G.R. Srivinivasan, Vice Chairman AERB

On April 9, 2002, AERB issued authorisation for the first pour of concrete of the two VVER reactors being constructed at Kudankulam. While issuing this clearance, the Board stipulated that prior to constructing the cylindrical portion of the containment, an inter-comparison of codes used by Russian Federation designers and those used by other countries in civil engineering design was to be conducted through examining the design at different locations of each reactor building. A team of AERB officials held discussions with Russian designers on topics such as materials for construction, general design methodology followed for safety-ralated structures of nuclear power plants and design methodology of inner and outer

containment structures adopted for the design of Kudankulam reactors.

As a part of the training for Kudankulam nuclear power plant systems, four AERB engineers successfully completed the first phase of training. They will now be trained at a Russian operating nuclear power plant during the second phase of their training.

The safety review of Prototype Fast Breeder Reactor (PFBR) progressed satisfactorily. On July 13, 2002 the Board issued Excavation clearance for PFBR.

AERB issued clearance for the First Pour of Concrete for RAPP-5 and 6 on September 24, 2002 and February 13, 2003 respectively. The safety review of this project by the Project Design Safety Committee and the Advisory Committee for Project Safety Review is continuing satisfactorily.

AERB teams of inspectors carried out 19 general inspections of the projects and 12 separate site inspections dealing with civil engineering safety. Aspects of industrial safety were also covered under regulatory inspections and based on recommendations arising from the inspections, AERB directed NPCIL to set up a dedicated industrial safety section at each site.

Safety Review of Operating Nuclear Power Plants

All nuclear power plants operated safely during the year. The AERB's Safety Review Committee for Operating Plants (SARCOP), the apex committee for overseeing safety in operating plants met 26 times in 2002-2003. The radioactive releases from the nuclear power plants were well within the limits prescribed by AERB. The radiation dose to public due to the release is too small to be measured directly and is, therefore, estimated through analysis of samples of air, water, soil and food items, collected around each power plant site. The estimated value at each staion is a small fraction of the dose limit prescribed for the public. The radiation doses to workers indicated near total compliance with the limits prescribed by AERB. Only two persons out of about 14,000 radiation workers in nuclear power plants exceeded the annual dose limit of 30 mSv prescribed by AERB.

A trained industrial radiographer at the Madras Atomic Power Station received a dose of 151.3 mSv. A special investigation committee investigated the incident. The committee concluded that the exposure occurred due to human error, non compliance with safety precautions and inadequate supervision. In light of this incident, the Safety Review Committee for Operating Plants (SARCOP) directed that all power stations must arrange periodic refresher training on safe radiography work procedures for all radiographers. SARCOP also directed that the management should strengthen supervision to ensure that the workers adhere strictly to safe work practices.

One worker received a radiation exposure of 30.97 mSv at NAPS during the in service inspection work. AERB has specified a lower limit of 15 mSv for contractors' workers in place of 30 mSv for regular workers. The overexposure was investigated by a committee.

During the year the station management at NAPS took up a large quantum of jobs related to in-service inspection and maintenance. Of the 900 workers deployed for the job, 35 temporary workers exceeded the regulatory limit of 15 mSv prescribed for temporary workers (AERB has prescribed lower limits for temporary workers as a matter of caution). According to the station management, the work areas of the jobs were highly congested and there were unexpected changes in radiation fields. There were a few instances of non-observance to the time limits, non use of protective equipment

and lack of supervision. SARCOP directed that in case of such violations and deficiencies, the station health physicists and station management should take immediate steps including stopping of work to rectify the deficiencies and to prevent violations.

At the Madras Atomic Power Station an incident in which a worker handled a radioactve garter spring inadverently occurred. The worker mistook the instructions of the supervisor and tried to clean the active spring instead of the surface of the shielded container as instructed by the supervisor. A radiation alarm from the field alerted a health physicist who asked the worker to drop the spring into the shielded container. Though the dose to the worker was less than the dose limit prescribed by AERB, the Board arranged a special regulatory inspection to closely scrutinize the work practices and the administrative controls at MAPS with respect to employing contractors' workers in active areas. The inspection team made several observations on the basis of which SARCOP gave directions to MAPS to prevent such incidents.

As units 1 & 2 of the Tarapur Atomic Power Station have completed over 30 years of operation AERB had directed NPCIL/TAPS to carry out comprehensive studies on the safety of the reactors. The studies covered current condition of the plant vis a vis the present day safety requirements and included review of design basis, safety analysis, operating experience feed-back, ageing management, Probabilistic Safety Analysis and Seismic Re-evaluation. These tasks were completed. The detailed reports submitted are presently under review in AERB. The studies have identified retrofitting requirements and safety up-gradations that need to be implemented for TAPS. Detailed designs for this are being prepared and a schedule for their implementation is being finalized to complete these jobs by end of 2005.

During the last year, AERB had decided that the operation of Unit-1 of RAPS, the first pressurized heavy water reactor constructed in the country, will be stopped by April 30, 2002, for implementing safety up-gradations. Accordingly RAPS-1 was shut down on April 30, 2002. NPCIL is carrying out several safety upgradation activities for RAPS-1 and these are being regularly reviewed in AERB. In its meeting held in February 2003, the Board reiterated that all the safety upgradation activities should be completed before start up of RAPS-1 can be considered.

During the year, there was an incident of partial blockage in one of the coolant channels in Unit-3 of the Rajasthan Atomic Power Station. AERB directed that the offending material be located and removed before restart of the reactor can be considered. NPCIL developed the necessay inspection and remote handling gadgets and the obstruction in the form of a welding dam could be removed whereafter reactor operation was resumed.

MAPS-2 is currently carrying out extensive safety upgradation including en masse coolant channel replacement. Replacement of existing coolant channels made of Zircaloy-2 by new coolant channels made of Zirconium-2.5% Niobium alloy, use of four tight fitting garter springs in place of two loose-fitting garter springs used earlier, retrofitting of high pressure coolant injection system in the emergency core cooling system, incorporation of supplementary control room, installation of sensitive leak detection systems for the coolant channels, up-gradation of fire/smoke detection systems, installation of fire barriers, fire walls and doors in critical areas and segregation of power and control cables for safety related systems are the major upgradation works being carried out. MAPS-2 which is shutdown since January 9, 2002 for these jobs, is likely to be ready for restart by middle of 2004.

In the Fast Breeder Test Reactor at the Indira Gandhi Centre for Atomic Research,

there was a minor incident of sodium leak from the primary purification system. The plant management identified the reasons for the leak and promptly instituted remedial measures.

AERB officials continued to conduct regulatory inspections of the operating nuclear power plants, the research reactors Kamini and FBTR and the Rajasthan Atomic Power Project Cobalt facility. Deficiencies observed were brought to the notice of the station management and safety committees for follow-up. None of the deficiencies found was of a nature to warrant regulatory restrictions on any plant.

AERB officials participated in the licensing process for 121 operations staff from various plants. The operating staff of nuclear power plants are required to be formally licensed to ensure that plants are operated by trained and qualified staff at all times. They are also required to be re-trained and relicensed every three years.

AERB continued to enforce industrial safety provisions in various plants of the Department of Atomic Energy. AERB designated Competent Persons under various sections of the Factories Act 1948 in the Heavy Water Plants at Thal and Kota and the IRE plants at Chavara, Orissa and Manavalakurichi. AERB also approved nine physicians as Certifying Surgeons under the Factories Act 1948.

During the year, there were six work-related fatalities due to industrial accidents. Taking this development in to consideration, AERB issued a directive specifying the minimum number of safety officers required at construction sites.

Safety Surveillance of Radiation Facilities

All radiation facilties located in different parts of the country operated safely. The Safety Review Committee for Applications of Radiation held five meetings. AERB issued type approvals to 178 pieces of radiation equipment. A type approved equipment has all the required built-in safety features. AERB also approved 217 persons at various radiation facilities as Radiological Safety Officers.

AERB staff carried out regulatory inspections of radiation installations nation wide. These include 23 teletherapy installations, 129 medical X-ray units, 101 industrial radiography sites and installations, 12 institutions handling nucleonic gauges and 7 companies making gas mantles containing thorium.

AERB conducted a radiation protection surveillance campaign in all the cancer hospitals in the North-East. Certain violations were observed in one hospital, which had potential to cause serious exposure to the patients. This compelled the immediate stoppage of a teletherapy unit in the concerned hospital. Patient treatment was restored only after the hospital complied with the directions issued by AERB. Operation of a high energy accelerator in another hospital was suspended as dosimetric equipment was not available in the institution. Operation of the unit was permitted after the hospital arranged to make the requisite measurements regularly.

AERB officials found that one nuclear medicine laboratory had violated safety requirements. The violations were alteration in the approved plan, nonavailablity of an approved Radiological Safety Officer, non-submission of annual safety status reports and not obtaining authorisation to dispose of radioactive waste. AERB issued appropriate directives against the institution. Such violations are occasionally seen in institutions handling very low activity sources and generally do not involve any significant radiation doses to patients or members of the public.

Seven oil well-logging sources belonging to various companies got stuck in wells while they were being used. Following international practice, the wells were sealed so that

the source would not pose any hazard.

An industrial radiography exposure device containing an iridium-192 source of strength 19.7 Curie was lost in transit from Lakhimpur to Digboi in Assam. The camera is a shielded container made of depleted uranium. It would not pose significant hazard so long as the source is inside the container. AERB suspended the authorisation issued to the radiography institution for six months.

AERB staff observed that six radiography institutions had violated the regulatory provisions. The violations included loaning of radiography devices containing a source without prior approval of AERB, unauthorised source movements from one site to another,carrying out radiography at an unauthorised site by trainee radiographers, non use of personnel monitoring devices while handling sources, etc. Regulatory action of AERB in such instances included issuance of warning letters, suspension of radiography work of the erring institutions and withdrawal of certificates of radiography personnel.

AERB refused operating consent for a high energy medical accelerator as the institution constructed a treatment room which deviated significantly from the one approved. The institution used low density cement to construct parts of a shielding wall that caused unacceptably high levels of radiation in some parts of the occupiable areas. The institution has been directed to redesign and reconstruct the treatment room. The institution used nearly 300 tons of steel to ensure adequate shielding.

During the year, AERB published 9 Safety Guides covering areas related to safety of nuclear installations.

Safety Research

AERB supported seven new safety research projects and renewed 15 ongoing projects. The Board also extended financial assistance to 22 organisations and institutions to conduct safety related seminars, symposia and conferences.

International co-operation

AERB participated in the Indian Delegation that visited France during January 2003 to hold the fourth Indo-French dialogue on nuclear safety co-operation.

Chairman, AERB met former Chairmen of AERB. (from left) Prof. A.K. De, Shri S.D. Soman, Dr. A. Gopalakrishnan and Prof. S.P. Sukhatme

A team led by Yuri G. Vishnevskiy, Chairman, GOSATOMNADSOR (GAN), the Russian Regulatory Authority visited India during January 2003. During the visit GAN and AERB signed an agreement on "Co-operation in the Field of Safety Regulation of Nuclear Energy Use for Peaceful Purposes" in regard to the Kudankulam reactors.

Dr. Richard. A. Meserve, Chairman, United States Nuclear Regulatory Commission (USNRC) accompanied by a team of 15 officials visited AERB in February 2003. The technical team of USNRC had discussions with AERB team on various safety related subjects of mutual interest.

SECTION 2
SAFETY SURVEILLANCE OF NUCLEAR FACILITIES

2.1 NUCLEAR POWER PROJECTS

2.1.1 Project Safety Review

The nuclear power plants under construction in India include pressurized heavy water reactors (of capacity 220 MWe and 540 MWe), water moderated, water cooled reactors (two VVERs of 1000 MWe each from Russia) and a prototype fast breeder reactor (of 500 MWe of indigenous design). AERB has evolved appropriate technical and administrative mechanisms to carry out safety review of these reactors and to issue related authorisations to NPCIL at different stages of the projects. The Board draws liberally upon the experience and expertise that exist in the country to meet the challenge.

AERB carries out the safety review of on-going nuclear power projects through a multi tier review mechanism. The Project Design Safety Committee (PDSC) is the first tier of review consisting of specialists. The Advisory Committee for Project Safety Review (ACPSR), which acts as the second tier, reviews the recommendations of the PDSC. ACPSR has specialist members from the Ministry of Environment and Forests, Boilers Board, Central Electricity Authority and educational/research institutions.

AERB issues authorisation for various projects at different stages based on the recommendations of PDSC and ACPSR. The process of Safety Review is not only being done by the three tier safety committees as detailed above but also by safety audit. Safety audit is carried out through regulatory inspection and by verifying compliance by the utilities with the requirements prescribed by AERB. AERB maintains a list of stipulations systematically as a data base to make the process very effective.

Tarapur Atomic Power Project Units-3&4

The Tarapur Atomic Power Project Units 3&4 are two pressurized heavy water reactors of capacity 540 MWe the design of which evolved from the 220 MWe capacity PHWR. The Project Design Safety Committee (PDSC) for TAPP-3&4 has held 213 meetings so far, 42 of these being during the year 2002-2003. The Advisory Committee for Project Safety Review (ACPSR) held 2 meetings during the year to deliberate on safety issues referred to it by PDSC.

PDSC has completed its review of 71 Design Basis Reports (DBR) out of 83 submitted. PDSC has also reviewed 51 Preliminary Safety Analysis Reports (PSARs) out of 64 submitted. The following important documents have been reviewed during the year:

(i) Design Basis Reports (DBRs) on-

- Fueling Machine and its Associated Systems
- Active Process Water System
- Instrumentation and Control of End-Shield Cooling System, Calandria Vault Cooling System
- Process Instrumentation of Liquid Zone Control, Liquid Poison Injection System
- Containment Isolation Provisions for Spent Fuel Transfer System
- Vertical, Horizontal Flux Units and Flux Mapping System
- Steam Generator Pressure Control
- Steam Generator Level Control System
- Primary Containment Cleanup System
- Failed Fuel Monitoring System
- Reactor Start-up Instrumentation

(ii) Preliminary Safety Analysis Reports (PSAR) on

- Steam Generator Pressure Control System
- Steam Generator Level Control System
- Failed Fuel Monitoring System

(iii) In addition, AERB carried out special reviews and made recommendations in the following areas:

Tarapur Atomic Power Project Units - 3 &4

- NPCIL Report on Compliance to AERB Code (AERB/SC/D) for TAPP-3&4 Design
- Review of Shielding Requirements of End Shields for TAPP-3&4
- NPCIL Response to PDSC Recommendations on Reactor Regulating System
- Design Note on Valving in of S/D Cooling System at 150°C
- Notes on Calibration of Seismic Instruments
- Note on Seamless Calandria Tubes
- Computer Based Systems of TAPP-3&4
- Radiation Emergency Preparedness Plan for TAPP-3&4

Some of the important issues:

- During a regulatory inspection it was observed that the radiometry of all the end-shields was not carried out as per the requirements of AERB. Committee viewed the requirement and referred the matter to ACPSR also. It was stipulated that experiments for void fraction measurements be carried out.
- PDSC formulated the methodology to verify and validate computer based systems and review of the corresponding safety systems and safety related systems were formulated. This involves coordination of NPCIL group, SARCOP standing committee and PDSC and its working group.
- In view of the spent fuel storage tube being embedded in the floor-slab of calandria vault as a new design, radiometry of the available shielding has been recommended to ensure that there is no increase of background dose in the accessible areas of the passages below the calandria vault.
- Review of NPCIL report on compliance of AERB Design Code for design of the safety related systems was carried out by the PDSC.
- NPCIL was advised to provide high range gross gamma-beta monitors in order to detect gross fuel failure.
- Adequacy of shielding provisions in the secondary containment was studied to assess habitability in main control following a Design Basis Accident.
- For TAPP 3&4, Self Powered Neutron Detectors are being used for the Regulatory System and Protection System using cobalt and vanadium detectors. PDSC recommended that performance evaluation of these new systems must be carried out at 15% Full Power (FP).
- The Liquid Poison Injection System is a new system in place of the Secondary Shutdown System of the reactors of capacity 220 MWe. A dynamic test has been recommended to assess its shut down capability and shutdown margin.

KGS-3 & 4 and RAPP- 5 & 6

The twin units at Kaiga Generating Station, Unit 3&4 and the twin units at Rajasthan Atomic Power Project Units 5&6 are a 'repeat design' of KGS 1&2 and RAPP 3&4 with minor differences. PDSC has concentrated mainly on differences in the design. The differences between KGS-3&4 and KGS-1&2 and also with respect to RAPP 3&4 and RAPP 5&6 have been brought out by NPCIL. PDSC reviewed these with the support of specialists.

Kaiga Atomic Power Project Units - 3 &4

The Project Design Safety Committee has held 26 meetings so far, 14 of these meetings were held during 2002-2003. PDSC completed review of Preliminary Safety Analysis Report Vol. I (Design Description) for KGS 3&4 and RAPP 5&6. The review of Preliminary Safety Analysis Report Vol. II (Accident Analysis) is in progress. 10 Working Groups constituted by PDSC are reviewing the identified detailed design reports.

The major observations/recommendations for KGS-3&4 are as follows:

- Higher than expected radiation fields were observed in the Main Air Locks of similar design during transfer of spent fuel. Change in the shielding design was recommended

incorporating additional heavy concrete to reduce the dose in the Main Air Lock to less than 10 mSv/hr (1mR/hr) during a fuel transfer.

- Due to the high dilution in the Main Out Fall flow, it was pointed that the concentration of the discharged activity was below the detection limit. As a result inadvertent discharge would go un-noticed. PDSC has recommended additional interlocks on the liquid waste discharge system, apart from the administrative measures to be incorporated to prevent such events.
- Regulatory inspection revealed damage to the six numbers of nozzles of the Calandria. PDSC recommended that damage to the major equipments in the reactor core or in the accessible area should be reported to AERB. Further, procedure for handling large equipment should be reviewed and the re-qualification of the damaged equipment should be undertaken to the satisfaction of AERB to ensure that quality is not degraded.
- Emergency Preparedness – Emergency Preparedness Plan document of KGS-1&2 requires change as it has to take into account the presence of construction workers of KGS-3&4 at the site. Computerised attendance for KGS 3,4 construction workers have been established, which will be incorporated in the Emergency preparedness program for accounting purpose.
- Labour Camp – Adequate fencing on both sides of the road connecting labour camp which houses construction workers to the main road has been provided. Site will provide adequate procedures to prevent movement of people during an emergency.

The major observations / recommendations for RAPP-5 & 6 are as follows:

- The design of Inner Containment Wall must take into account conditions such as jet impingement and pipe whip on account of Main Steam Line break. The necessary design requirements will have to be met with before obtaining next clearance for construction.
- Emergency Preparedness Plan has been prepared taking into account; - Increase in number of construction worker for RAPP-5,6

  – Operating Reactors RAPS-1,2 & 3,4

  – H_2S release from Heavy Water Plant Kota

  The plan for RAPP-5, 6 was reviewed by PDSC
- During regulatory inspection, it was observed that the Pour of Concrete for RB 6 had commenced ahead of written authorization issued by AERB. Design safety review of RAPP 5&6 has been suspended till a satisfactory resolution of this administrative violation of safety practices is arrived at. Since the violation did not cause any impairment of safety and NPCIL had fulfilled all technical requirements, AERB did not direct NPCIL to stop construction. The Board will take a view on this matter in its next meeting.

Kudankulam Project

The construction and the safety review of the two nuclear power reactors for the Kudankulam project is progressing satisfactorily. The design is as per the Russian Normative Technical Documents (NTDs) with the additional requirements of AERB being fulfilled.

AERB Co-ordination Group along with the Specialist Groups carries out the first level of review. The ACPSR at the second level reviews the comments prepared during the review of Preliminary Safety Analysis Reports (PSAR) along with responses from NPCIL with the categorization. Applicable clauses of relevant AERB codes/guides and relevant IAEA documents are used during the review process.

Kundankulam Atomic Power Project Units - 1 & 2

Based on the recommendations of ACPSR, AERB considered the application for First Pour of Concrete of

Reactor Buildings and issued consent for first pour of concrete of Reactor Buildings of Unit No. 1 and 2 in April 2002. By the end of the year, civil construction of bottom raft of Reactor Buildings, raft of Reactor Auxiliary Buildings has been completed and work on Turbine Buildings have started. During the year, AERB undertook several regulatory inspections of Kudankulam site and ascertained that the work was progressing according to AERB stipulations.

Manufacture of major equipment for the project at Russian Federation has commenced. AERB is ensuring that the manufactured equipment will meet all safety and functional requirements through the Quality Assurance systems established by NPCIL.

During clearance for First Pour of Concrete, AERB had stipulated that prior to taking up construction of the hermetic portion of the containment, an inter comparison of codes (ICC) used in civil engineering design was to be conducted at various locations. It was observed that the design of the civil structures was not meeting the requirements as per AERB documents written for the Civil Engineering Design.

In order to understand the Safety in the design of the civil structures in comparison with the AERB requirements, members of the Civil and Structural Engineering Division of AERB visited the Russian Federation. However, the issues were not resolved. The Civil Engineering Safety Committee of AERB which was asked to look into the issues, confirmed the assessments. ACPSR also concurred with the results.

After reviewing the results of the ICC study and specific responses to comments made on the design of civil structures, which have a bearing on the construction beyond bottom raft, AERB accorded clearance for construction of hermetic portion of the containment in March 2003. Further, a Task Force was formed to carry out detailed work in this regard and to recommend necessary changes if required. The work is in progress.

Chairman, AERB (fifth from left) visiting project site at Kudankulam

Some of the other observations/recommendations are as follows:

(i) A large number of computer codes have been used in the justification of design and also for safety evaluation for the nuclear power plant systems. Further, some of the engineered safety protection and control functions use software for their operation. In order to have adequate confidence in these codes/software employed, AERB has stipulated that before these are implemented, NPCIL should submit proper justification and verification reports.

(ii) In order to enhance the confidence in design, AERB decided that a first order independent checking of various results as presented in respective PSAR related to Containment Design, Loss of Coolant Accident, Reactor Physics calculations, Shielding and Fission Product Activities in primary circuit be carried out. Work on this is in progress at BARC and NPCIL. Preliminary results are presented in PSAR.

(iii) The design of the reactors to be installed at Kudankulam incorporates all the essential safety systems. Besides these, several first-of its- kind safety systems such as the Steam Generator Emergency Cool-down and Blow down System, Passive Heat Removal System are also included in the design. These have not been incorporated in any operating nuclear power plants. These are additional advanced safety features. AERB is trying to get the basis of acceptance of the above systems, based on analysis and testing. The effectiveness of these systems in mitigating accident consequences is being checked during the review of PSAR on accident analysis.

(iv) Leaks from Reactor Pressure Vessel (RPV) head penetrations for control rod drive mechanisms have been a generic problem in pressurized water reactors (PWR), though this problem has not been reported from any VVER type reactor, AERB wanted to know the actual position with respect to VVER reactors.

(v) As the RPV is assigned the highest safety class in VVER design, AERB is assessing the design philosophy, material behavior at high neutron irradiation and manufacturing technology with regard to welds in the core region, specific requirements of fabrication, quality assurance and in-service inspection requirements.

Shri S.K. Agarwal, Project Director, Kudankulam, Atomic Power Project briefing Chairman, AERB.

As a part of the training and qualification of AERB engineers for Kudankulam nuclear plant systems, four engineers have successfully completed the first phase of training. Shortly, AERB will depute them for in-plant training at a Russian operating nuclear plant for the second phase of training.

In January 2003, a delegation of Russian Nuclear Regulatory Body known as Gosatomnadzor (GAN) of Russia visited AERB. An Agreement was signed for exchange of information and of co-operation in the field of safety regulation for peaceful use of nuclear energy. In particular this Agreement was mainly for having interactions with GAN during the safety review of Kudankulam Project. Mutual exchange of information and experience will cover regulatory documents used for the design and for all subsequent phases of the nuclear power project, methodology adopted to validate computer codes and comparison of the results, and GAN's approach in licensing of NPP operating personnel.

Prototype Fast Breeder Reactor (PFBR)

As part of the programme for utilizing the abundant deposits of thorium in India, Department of Atomic Energy has taken up several projects. Prototype Fast Breeder Reactor (PFBR) being constructed at Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam, Tamilnadu is one such project. Project Design Safety Committee (PDSC) has been carrying out safety review of this project in great detail, as it is the first of its type. During 2002-2003, PDSC-PFBR held 3 meetings.

PDSC-PFBR reviewed Preliminary Safety Analysis Report (PSAR) on Radiation Protection. With this review, PDSC-PFBR completed first review of all the 18 chapters submitted by IGCAR.

Director, IGCAR submitted an application seeking clearance for excavation for PFBR at Kalpakkam site. Site clearance was earlier granted to IGCAR on October 9, 2000.

As per the consenting process formulated by AERB, the construction is required to be cleared in three identified stages, viz. site excavation, first pour of concrete and installation of major equipment. For granting clearance for excavation, the following PSAR chapters were reviewed by PDSC-PFBR and Civil Engineering Safety Committee (CESC):

- General Description
- Site Characteristics
- Design Basis of Structures, Components, Equipment and systems
- Plant Layout

Based on the review of PDSC-PFBR, CESC and the requirements specified for industrial safety, IGCAR application for excavation clearance was considered by the Board during its 75th meeting. The Board granted permission for excavation subject to satisfactory compliance/implementation of certain stipulations.

Regarding compliance of AERB Safety Criteria for design of PFBR in PSAR, PDSC carried out the initial review of major design of irreversible nature. Further work on the in-depth review of the rest of the design basis reports and preliminary safety analysis reports (PSARs) is in progress.

PDSC-PFBR completed the review of the design on Reactor Containment Building with reference to the sodium release and pressure release during a probable core disruptive accident. PDSC recommended that the design pressure of the Reactor Containment Building should not be less than 30 KPa.

The PDSC accepted the proposal to monitor the temperature of the Blanket Sub-Assembly (BSA) with following stipulations:

- Flow measurement in BSA should be carried out during commissioning to preclude any blockage to the start.
- Flow measurement in BSA should be carried out in reactor shutdown state during fuel handling campaign.
- Temperature monitoring of few BSA in the first row should be available.

2.1.2 Civil Engineering Safety

Civil Engineering Safety Committee (CESC) met 11 times for the review work related to Kaiga 3&4, RAPP 5&6, TAPP 3&4, and Prototype Fast Breeder Reactor (PFBR).

After satisfactory completion of relevant review work, CESC recommended to Chairman, AERB to grant permission for first pour of concrete of Kaiga 3&4 and RAPP 5&6 and for commencement of excavation for foundations of main plant buildings of PFBR.

The working groups of CESC met five times to review documents related to design basis ground motion parameters and various design reports of safety related civil engineering structures of RAPP 5&6, Kaiga 3&4, TAPP 3&4 and PFBR and submitted their review reports to CESC.

As part of the review of Preliminary Safety Analysis Report of Kudankulam Nuclear Power Project (KK-NPP), AERB staff carried out inter comparison of codes (ICC) and design approach used by Russian Federation for safety related civil engineering structures of KK-NPP and the codes and standards accepted by AERB as review basis. The objective of the exercise was to assess the design of civil engineering structures of KK-NPP, as performed following Russian codes and approach, with respect to the codes and guides accepted by AERB.

The team members visited Russian Federation during May 2002 and had discussions on topics such as materials of construction, the general design methodology followed by Russian designers for safety related structures of NPP and design methodology of inner and outer containment structures adopted for design of KK-NPP. The report on ICC exercise was reviewed by CESC. CESC met 5 times for this review work. A Task Group was constituted to resolve the issues brought out during ICC exercise.

AERB staff reviewed the packages covering the site characteristics, plant layout, classification of structures, systems and components, seismic analysis and design of structures important to safety of Kudankulam nuclear power plants. The staff identified important issues on the design to be resolved before commencement of construction of containment boundary of the reactor building. Discussion with the Russian designers are in progress for satisfactory resolution of these issues before granting further clearances. Specialist Groups had 20 meetings to review some of the aspects of civil engineering safety of KK project.

2.1.3 Authorisations/Licences Issued

1. Clearance for First Pour of Concrete (FPC) for Reactor Building of Kudankulam Nuclear Power Project (KK NPP) Units-1&2 (April 09, 2002).
2. Excavation Clearance for PFBR at Kalpakkam (July 13, 2002).
3. Clearance for Pour of Concrete of Reactor Building, RAPP Unit-5 (September 24, 2002).
4. Clearance for Pour of Concrete of Reactor Building, RAPP Unit-6 (February 14, 2003).

2.1.4 Regulatory Inspection of Projects

Regulatory inspections of the nuclear power projects were carried out as a safety audit to ensure compliance with the AERB stipulations during construction and compliance to the design requirements as laid down in the PSARs.

The number of regulatory Inspections carried out in various projects is given in Table-1.

Table-1: Regulatory Inspections of Nuclear Power Projects

Site	No. of Inspections
Tarapur Atomic Power Project- Units 3&4	5
Kudankulam Atomic Power Project- Units 1&2	7
Kaiga Generating Station – Units 3&4	4
Rajasthan Atomic Power Project –Unit 5&6.	3
Prototype Fast Breeder Reactor	0

The inspections covered activities such as civil

construction, industrial safety, quality assurance and other site related issues including design issues related to site construction work. Special inspections were also conducted for KK Project, Kaiga Project Units 3&4 and RAPP 5&6 for giving clearances for concrete pouring.

In TAPP 3&4, the inspections covered mainly organisational aspects of safety section, quality assurance section and project management. The inspectors noted that NPCIL has put in efforts to inculcate the Quality Assurance (QA) concept in all contract works. AERB inspected the QA activities to verify the effectiveness of this self-QA concept with the overall supervision of the project management. During the inspections, the team identified several design related issues and put them up to the respective safety committees for specific attention/ review. The inspection team from AERB noted that radiometric examinations of the end-shields were not carried out as per AERB requirement.

AERB teams inspected the KK Project mainly with regard to the civil construction work and related industrial safety requirements. AERB noted implementation and follow-up of the construction QA manual.

AERB team carried out a special inspection at Kaiga Project Units 3&4 to check civil engineering safety aspects, safety organization and industrial safety measures. The damage to the moderator inlet nozzles of the calandria shell was revealed during the regulatory inspection.

AERB team inspected the RAPP 5&6 site before and after giving clearance for the First Pour of Concrete. It was found out that the Project authorities had started the Pouring of Concrete for RAPP 6 much before receiving the AERB authorization, creating a serious administrative violation to the safety practices. The Board will review this matter in its next meeting.

Civil and Structural Engineering Division of AERB conducted twelve site inspections of various stages of construction at TAPP 3&4, Kaiga 3&4, RAPP 5&6, Kudankulam and PFBR with regard to the implementation of AERB stipulations pertaining to civil engineering aspects made while granting various regulatory clearances to these projects and relevant quality requirements.

2.1.5 Industrial Safety

During 2002-2003, AERB staff carried out regulatory inspections on industrial safety aspects in the following nuclear power projects:

a) Tarapur Atomic Power Project 3-4
b) Kaiga 3&4
c) Kudankulam Atomic Power Project
d) Rajastan Atomic Power Project 5 & 6

In each case, AERB sent a detailed inspection report to the concerned unit. AERB directed that NPCIL should set up a dedicated industrial safety organisation at each project site. The Board asked NPCIL to conduct Job Hazard Analysis. AERB also wanted NPCIL to ensure that the workers at all sites use protective equipment.

2.2 NUCLEAR POWER PLANTS AND RESEARCH REACTORS

The safety review of operating nuclear power plants and research reactors is carried out by the Operating Plants Safety Division of AERB, the Safety Review Committee for Operating Plants (SARCOP) and the Unit Safety Committees set up by SARCOP. All nuclear power plants and research reactors operated safely during the year.

An area of concern receiving attention is the ability of NPPs to withstand seismic disturbances. The new NPPs in India are designed to withstand an earthquake based on the seismic potential of the sites. However, the adequacy of design of the older NPPs (TAPS, RAPS1&2 and MAPS) in this respect is not known.

Meeting of the Safety Review Committee for Operating Plants (SARCOP).

Following the Bhuj earthquake on January 26, 2001, AERB/SARCOP had asked NPC to review/analyze the design/design basis of critical structures and equipment of older plants to ascertain the extent of seismicity these plants can withstand and to identify the need for strengthening and retrofitting for seismic qualification of these plants.

Accordingly, NPCIL has initiated an action plan for

seismic reevaluation of the older NPPs. The action plan identifies the important systems of these plants, for which seismic re-evaluation is being done by extensive analysis and testing to assess the seismic margins available. The critical systems identified for evaluation in these plants include:

a) Reactor shutdown systems
b) Decay heat removal systems
c) Containment systems
d) Emergency power supply systems
e) Spent fuel storage
f) Liquid waste storage tanks

This seismic margin analysis is being complemented by Probabilistic Safety Assessment of the plants, considering earthquake as an external event.

The systems of the plants other than safety systems are being assessed and qualified through a 'walk down' of the plant to identify the need for strengthening. The 'walk down' is essentially a detailed inspection of the plant by a team of experts in seismic/structural design and analysis. The objective of the walk down is to assess through visual examination, the 'as is' state of the structures and components and their robustness to withstand seismicity. This walk down is being done as per the guidelines established by the International Atomic Energy Agency (IAEA).

The job of reevaluation including analysis, testing, walk-down, etc., is expected to be completed for TAPS by May 2003. Similar work for MAPS is expected to be completed by December 2003 and for RAPS 1&2, it will be taken up subsequently. The schedules for actual retrofitting jobs will be finalized after completing plant wise evaluation. The seismic instrumentation in the plants also will be upgraded and retrofitted as part of this reevaluation programme.

2.2.1 Tarapur Atomic Power Station (TAPS)

TAPS was operational up to a power level of 160 MW(e). TAPS Unit-2 was shut down for the 17th refueling from 31.3.2002 to 27.4.2002 (27days). This was the shortest refueling outage achieved in the history of TAPS.

Continued long term operation of TAPS Units - 1&2

TAPS Units 1&2 have completed more than 30 years of operation. The present interim authorization for operation of TAPS is valid up to May 2003. As directed by AERB, NPCIL/TAPS has carried out a comprehensive review of safety of TAPS units for continued long term operation. This review takes into account the actual condition of the plant vis-à-vis the present day safety requirements and covers the design review, safety analysis, and operating experience feedback and ageing management. A probabilistic safety analysis (PSA) of level-1 has also been carried out.

NPCIL/TAPS have already submitted the reports on the above reviews. Review of the reports on operational performance and ageing management has been completed. Reports on review of design basis and safety analysis and the probabilistic safety assessment are under review. Based on these reviews, the requirements of any modifications/up-gradations, additional inspections in plant systems and equipment in TAPS and the time schedules for implementing the same will be finalized. This is expected to be completed by May 2003. The extension of authorization for TAPS units beyond May 2003 will be considered by AERB based on the above.

2.2.2 Rajasthan Atomic Power Station (RAPS)

RAPS Unit-1 was operational up to a power level of 160 MW(e) till end of April 2002. The unit was shut down on April 30, 2002 for coolant channel life management and safety up-gradations as directed by AERB.

RAPS Unit-2 was operational up to a power level of 220 MW(e).

RAPS Unit-3 &4: The new units which became operational during 1999-2000, operated normally during the year up to a power level of about 220 MW(e). RAPS Unit-3 remained shutdown from April 9, 2002 to May 27, 2002 for annual shut down activities and subsequently for removal of a flow blockage in channel S-08 in Primary Heat Transport system.

Action plan for RAPS Unit -1

As reported last year, AERB had decided that operation of RAPS Unit-1 in the existing state shall be limited to 7 Effective Full Power Years (EFPY) or till April 30, 2002, whichever is earlier.

Accordingly, RAPS Unit-1 was shut down on April 30, 2002. Being built more than thirty years ago, RAPS Unit-1 requires up-gradations in some of its safety related systems. Some of the equipment of the plant such as moderator heat exchangers have shown signs of ageing. Also since the reactor has seen about 7 EFPYs of operation, comprehensive inspection and health assessment of

coolant channels are required for permitting further operation.

NPCIL has now proposed an action plan for RAPS Unit-1 involving

i) Extensive inspection, health assessment and life management of coolant channels.

ii) Replacement of the degraded moderator heat exchangers and inspection of other heavy water heat exchangers.

iii) Safety related up-gradation activities including high pressure injection of emergency coolant, Supplementary control room, installation of additional diesel generator to cater to important loads under a postulated flooding at the site, up-gradation of fire/smoke detection system, common cause failures, etc.

iv) Ageing assessment of important systems, structures and equipment.

After completion of the above, NPCIL has proposed to continue operation of RAPS Unit-1 up to about 9-9.5 EFPY, i.e., about 3-4 years, after which the plant will undergo replacement of old coolant channels.

After review, SARCOP and AERB accepted the action plans prepared by NPCIL and reiterated that all the safety up-gradations activities should be completed before restart of RAPS Unit-1, under this plan. AERB further directed that ageing studies on all safety related systems, structures and equipment should be carried out.

Presently RAPS Unit-1 continues to remain shut down and the activities as per the action plan are in progress. The highlights of the activities are as follows.

Extensive inspection and scrape sampling for health assessment of the coolant channels had been completed. Campaign for re-positioning of garter spring spacers between pressure tube and calandria tube to extend the life of coolant channels is in progress. Based on the results of this campaign, it is planned to replace a limited number of degraded coolant channels, with the objective of assuring health of all the coolant channels in the core for operation up to the projected period.

Replacement of degraded heavy water heat exchangers such as both moderator heat exchangers, bleed cooler, shut down coolers and gland coolers has been completed. The remaining heavy water heat exchangers have been inspected extensively to assess their health for further service.

Detailed engineering design and procurement activities relating to the major up-gradation activities are in progress.

Leakage of tritiated water from downgraded heavy water storage tank

During May 2002, there was an incident of leakage of tritiated water from one of the downgraded heavy water storage tanks at the tank farm of RAPS 1&2. The leak was detected on June 1, 2002 during monthly inventory check on the tanks. The downgraded heavy water leaked into the common dyke area through a temporary level gauge installed in the tank due to passing of its isolating valve. After plugging the leak, water contained in the dyke was recovered. It was estimated that about 22.2 Curies of tritium activity got released to the environment, due to the incident. During the months of May and June, the climate of Rawatbhata was very warm and dry; and the assessment carried out suggests that most of the leaked water could have escaped through evaporation. Thus, there was no off-site/on-site environmental impact.

Subsequent to the incident, the frequency of checking inventory of the tanks in the tank farm was also increased from monthly to daily basis. Also, waterproofing of the dyke was carried out as an abundant precaution. During review of the incident, SARCOP had asked RAPS to install a proper monitoring system in the tank farm, for early detection of any leakages in future.

Additional facility for storing spent fuel at RAPS 1&2

NPC has sought approval from SARCOP for construction of an AFR (Away from Reactor), spent fuel wet storage facility at RAPS 1&2 This facility is proposed to cater to storage space requirement for the spent fuel that gets generated due to continued operation of RAPS 1&2. The existing spent fuel storage pool at RAPS 1&2 is close to its full capacity.

The design of the proposed AFR facility follows the requirements specified in the AERB safety guide on Design of Fuel Handling and Storage systems (AERB/SG/D-24) .

SARCOP accepted the proposal in principle and has asked NPCIL to submit detailed design reports on the proposed AFR facility and an application for construction clearance.

Partial flow blockage in a coolant channel of RAPS unit-3

On May 15, 2002, when RAPS Unit-3 was being restarted after annual shut down, a flow blockage was detected in one coolant channel of the Primary Heat Transport system. Investigations indicated that some loose foreign material in the reactor coolant inlet header was partially blocking the entrance to the channel, thus reducing the coolant flow into the channel. RAPS had requested permission to restart the reactor after de-fueling and wet quarantining of the affected channel. SARCOP observed that if the foreign material were left in the header, other channels would also be susceptible to similar flow blockages in future. In view of this SARCOP did not agree with the proposal of restarting the unit after quarantining the affected channel and asked RAPS to remove the offending material before restart of the reactor.

Subsequently, after extensive preparations and mock-up trials, the inlet feeder to channel S08 was cut near the header to facilitate access to the header and carrying out inspections. After detailed inspections with fibroscope and miniature camera, the foreign object was located. The object was removed from the header using special tools. It was a piece of a welding dam made of galvanized iron sheet, which might have been left inside during construction. The radiation field on the dam was about 0.2 mR/hr. Handling of this material did not cause any significant exposure to workers.

Subsequently, the reactor was restarted on May 29, 2002.

2.2.3 Madras Atomic Power Station (MAPS)

After completing 9.5EFPY (Effective Full Power Years) of operation MAPS Unit-1 remained shut down from July 22, 2002 to October 28, 2002 for coolant channel life management activities and other maintenance jobs. Subsequently, the unit remained operational up to a power level of 170 MW(e).

Madras Atomic Power Station Units - 1 & 2

MAPS Unit-2 is under shutdown since January 2002, for en-masse coolant channel replacement and other up-gradation jobs.

Health of coolant channels in MAPS Unit-1

In the older Indian Pressurized Heavy Water Reactors using Zircaloy-2 pressure tubes and two loose fit garter spring spacers between the pressure tube and the Calandria tube, the safe life of the pressure tube is limited. This is because the tube picks up hydrogen from the reactor coolant, resulting in degradation of mechanical properties. Hence, it is necessary to periodically inspect and assess the health of coolant channels and carry out life management activities such as repositioning of garter spring spacers in some channels.

In any case, the pressure tubes in these reactors require en-masse replacement after about 8-10 EFPY of operation, depending on reactor specific status of coolant channels. MAPS-1, which was operational at 170MWe, was shut down on July 22, 2002 after completion of 9.5 EFPY of operation authorized based on previous inspection and assessment campaign in 2001.

The station management used period of shut down mainly for health assessment and life management of coolant channels, including in-service inspection, scrape sampling, garter spring repositioning, and removal of one pressure tube for Post Irradiation Examination for assessment of material properties. Based on extensive review of the results of the above activities and health assessment of coolant channels, MAPS Unit-1 was permitted to operate up to 10.5 EFPYs. MAPS Unit-1 was restarted on October 28, 2002.

En-masse coolant channel replacement and Up-gradation jobs in MAPS Unit-2

MAPS Unit-2, which had operated for 8.5 EFPY, had been shut down on January 9, 2002 for en-masse replacement of coolant channels and to carry out safety up-gradation jobs. 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, as was done for RAPS Unit–2 earlier during 1994-1998. The

new coolant channels are expected to have a much higher life span as compared to earlier Zircalloy channels owing to lower hydrogen pick up in the coolant channels during operation and reduced possibility of movement of garter springs from their desired locations.

Presently the job of replacement of coolant channels has been completed in MAPS Unit-2.

A number of safety related up-gradation jobs are also being implemented in MAPS Unit-2 in the current shut down. These include

a) retrofitting of high pressure injection in Emergency Core Cooling System,

b) incorporation of Supplementary Control Room, for use in case the main control room becomes uninhabitable,

c) incorporation of sensitive leak detection system for coolant channels,

d) up-gradation of fire/smoke detection system,

e) installation of fire barriers, fire walls/doors in critical areas,

f) segregation of power and control cables for safety related systems.

These up-gradations will bring MAPS Unit-2 to the current safety standards in many areas. SARCOP reviewed all these up-gradations extensively for acceptability.

Taking advantage of the current long outage, MAPS has also taken steps to implement some modifications, which will improve performance and availability of the Unit. The important among these are as follows:

1) Since 1995, there have been five incidents of steam generator tube leaks in MAPS Unit-2. Prior to the shutdown in January 2002, MAPS Unit-2 was operating with some heat exchangers of the steam generator removed from service due to tube leaks. (four out of 11 heat exchangers for steam generator-5 and one heat exchanger for steam generator–7) Metallurgical examinations carried out on some of the leaked tubes indicated that under-deposit corrosion and pitting had been the cause of such tube leaks. Statistical evaluation based on this had indicated substantial fall in the life expectancy of the existing steam generators. In view of this, NPC has decided to replace all the 88 heat exchangers of all the Steam generators (11 heat exchangers each in the eight steam generators) during the current outage. Presently the job of replacement of these heat exchangers of steam generators is nearing completion.

2) Following the failure of moderator inlet manifolds in the calandria of MAPS units 1&2 in 1988-89, the MAPS units were being operated with a modified moderator flow configuration, in the calandria. Since then, AERB restricted the operation of MAPS units to 75%of full power. To restore the original moderator flow configuration inside and operate the unit at full power NPC/MAPS have decided to install three moderator inlet spargers in the calandria.

NPCIL and BARC finalized the design of the spargers after a great deal of analysis work and after extensive reviews; SARCOP has accepted the design and the related modifications in the moderator system.

Incident of handling of irradiated garter springs by contractor person

During the en-masse replacement of coolant channel at MAPS Unit-2, highly irradiated components from the reactor like coolant channels garter springs etc; are remotely transferred into thick, shielded flasks. These flasks are designed to maintain the radiation fields on the out side considerably low so as to permit safe handling and transportation of radioactive material.

On 9th July 2002, highly radioactive garter springs were put in one such shielding flask and placed in the decontamination center, awaiting transportation to the disposal site.

A contractor's supervisor gave instructions to his worker to decontaminate the outside surface of the flask. The worker mistook this as an instruction to clean the garter springs contained *inside* the flask and accordingly, removed the active garter springs from the flask.

An area radiation monitor placed at the location, alarmed at once, due to the rise in radiation field. A health physicist who was present nearby got alerted and he immediately instructed the worker to put back the garter springs inside the flask and come out of the area; The worker quickly complied with this instruction.

The worker's personal dosimeter was sent for urgent processing, which revealed that he received a whole body

dose of 5.1 mSv which is well within the annual limit of 15mSv for contract workers.

The dose received by his hands and skin (extremities) was conservatively estimated as 420 mSv. The regulatory limit on skin/extremity dose for contractor's workers is 250 mSv whereas for regular employees it is 500 mSv. The person was medically examined and no abnormal symptoms were noticed.

Following the incident, AERB carried out a special regulatory inspection to closely scrutinize the work practices and administrative controls at MAPS, with respect to employing contractor's personnel for jobs in active areas.

Based on the observations made during this special inspection, MAPS took steps to:

a) Strengthen training of contractor's personnel,

b) Provide refresher training to contractors engineers and supervisors,

c) Ensure departmental supervision for all jobs in active areas.

2.2.4 Narora Atomic Power Station (NAPS)

Both units of NAPS operated normally up to a power level of 220MW(e). NAPS Unit-1 was under Annual shut down during July 1-27 2002.

In-service Inspection (ISI) during the Annual Shut down of NAPS Unit-1.

In service inspection (ISI) programmes have been established for all Nuclear Power Plants in India. The objective of the programme is to examine important plant components and systems for possible deterioration in their integrity, to assess the safety margins available and to ensure their acceptability for continued operation of the plant. Based on the ISI assessments, corrective actions are taken as necessary. The approved ISI Manual in each plant identifies the safety significant components/systems to be inspected, and their frequency and method of inspection.

A recent review carried out by AERB staff at NAPS and KAPS, had shown that there was considerable backlog in compliance to the ISI requirements in these units. After review of the status of ISI, SARCOP has directed that in the forthcoming Annual Shut downs of these units, comprehensive ISI campaigns should be taken up to cover the backlog.

Accordingly during the Annual Shut Down (ASD) of NAPS Unit-1, from July 1-27, 2002, and during ASD of KAPS Unit-2, from September 2-20, 2002, extensive ISI of various systems and equipment were carried out. Similar extensive ISI will be taken up in NAPS Unit-2 and KAPS Units also, during their forthcoming ASDs.

Violation of radiation protection practices in NAPS

As indicated above, during the annual shut down of NAPS Unit-1 in July 2002, the management took up a large quantum of jobs related to ISI and maintenance activities. A large workforce of 900 workers was deployed for these jobs. During execution of these jobs, 35 temporary workers have received radiation exposures exceeding the regulatory limit of 15 mSv in a year. These cases have been investigated by overexposure investigation committee of NAPS.

As per station's assessment, the work areas of the jobs were highly congested and there were unexpected changes in radiation fields after opening some of the contaminated equipment for maintenance and inspection. Certain cases of non-observance to the time limits and use of protective equipment prescribed by the health physicists while working in radiation levels and inadequate job supervision have also resulted in some of these cases. During review of these cases SARCOP observed that the station failed to take adequate steps to prevent these violations. SARCOP directed that in case of any such deficiencies and violations in any station, the station health physicist and station management should take immediate steps including stopping of work, if needed, to rectify the deficiencies and prevent violations.

2.2.5 Kakrapar Atomic Power Station

Both units of KAPS operated normally up to a power level of 220MW(e). KAPS Unit-2 had an Annual

Kakrapar Atomic Power Station Units - 1 & 2.

Shut Down from September 2-20, 2002.

Steam generator tube leak in KAPS Units

There have been a few instances of tube leaks in steam generators of two reactors at Kakrapar (twice in KAPS-1 and once in KAPS-2). The station management plugged these leaks. Apart from the leaky tubes those tubes showing varying extent of wall thinning were also plugged.

Similar leaks have been observed in unit-1 of Narora Atomic Power Station. SARCOP directed NPCIL to identify the root causes of tube leaks and to prepare tools and procedures to remove leaking tubes for further study.

2.2.6 Kaiga Generating Station (KGS)

Both units of Kaiga Generating Station were operational up to a power level of 220 MW(e).

Fuel handling incident at KGS Unit-1

In PHWRs, refueling of the reactor is carried out when the reactor is operating i.e. 'on-power'. Refueling is carried out with the help of sophisticated remotely operated fuelling machines. These fuelling machines approach the coolant channels one by one. The refueling of channels involves opening of the seal plug and insertion of fresh fuel by the upstream side fueling machine while simultaneously the spent fuel is discharged into the downstream side fueling machine. After closing the seal plugs the fueling machine are decoupled from the channels. In the 220MW(e) Indian PHWRs this refueling operation is carried out on an average of one channel per day.

On January 25, 2003, after refueling of a channel in KGS Unit-1, one of the seal plugs of the channel could not be closed back. Investigations done after shutting down the unit indicated that the end plates of the fresh fuel bundles being loaded into the fuelling machine were getting deformed due to a deficiency in one of the components in the fuel transfer system.

These fuel bundles with damaged end plates got loaded into the reactor. During refueling one fuel pencil from one of the damaged bundles got detached due to the high velocity flow in the coolant channel. This fuel pencil got lodged between two fuel bundles and caused obstruction during closure of the seal plugs of the channel.

After developing special procedures and tools, the fuel bundles and the detached pencil from the affected channel were retrieved. The retrieval operation was carried out under strict health physics coverage. Further investigations indicated that prior to the incident on January 9, 2003, one of the rams in the fuel transfer systems was replaced during normal maintenance activity. The stroke length of the new ram was about 3-4 mm less than normal. However, due to deficiency in the maintenance procedure this fault could not be detected. The misalignment caused by the reduced stroke caused mechanical interference and consequent deformation of fuel bundles during transfer operations.

KGS has refueled all the seven channels, which had been refueled with the defective ram. Some of the fuel bundles removed from these channels also had their end plates deformed.

The affected coolant channel was inspected and found to be free from any abnormality. However, as abundant caution, SARCOP recommended that this channel should be wet quarantined and monitored over the next three shutdown–restart cycles before it is put back into regular operation. SARCOP has also asked NPCIL to review all the maintenance procedures pertaining to critical equipment of fuel handling systems to ensure that all necessary maintenance tests and quality assurance checks are properly done.

2.2.7 Indira Gandhi Centre for Atomic Research (IGCAR)

The Fast Breeder Test Reactor operated up to a power level of 17.4 MWt. During April and July 2002, the reactor remained shut down following sodium leak in the primary purification system. The reactor remained shut down also during September to December 2002 for inspection of liquid metal seals and reactor vessel internals.

Enhancement of 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. Post Irradiation Examination (PIE) of the irradiated fuel sub-assemblies is also being carried out to study the in-reactor behavior of the fuel and to ascertain the permissible safe life of this fuel.

In September 2002, the FBTR fuel reached a

landmark peak 'burn-up' of 1,00,000 MWD/T (Megawatt-days per ton) without any pin failure. The fuel 'burn-up' in nuclear reactor refers to the energy extracted from the fuel before it is discharged from the reactor.

After review of the fuel performance so far and assessment of safety margins AERB/SARCOP has extended the limit on burn-up for FBTR fuel up to 1,22,000 MWD/T.

Sodium leak from primary sodium purification circuit at FBTR

The Fast Breeder Test Reactor uses liquid Sodium as the primary coolant. On 8th April 2002, there was an incident of leakage of about 75 kg of liquid sodium from the purification circuit of primary sodium system of FBTR. The leaked sodium had solidified on the floor of the purification cabin. The leak took place from the body of a motorized valve in the circuit. On detecting the leak, the reactor was shut down and sodium from the purification system was drained to a storage tank.

The major hazard with sodium is its tendency to catch fire on contact with air. Thus, after inerting the area with Nitrogen, the spilled sodium was removed.

The sodium leak had taken place from one of the blind holes on the body of the motorized valve. The blind holes were used by the manufacturer for machining and had insufficient thickness at the location. FBTR has replaced the affected valve. As a preventive measure, other similar valves in the sodium systems were repaired by welding seal plugs. FBTR has also installed additional instrumentation to monitor particulate activity in the purification cabin for early detection of any sodium leaks in future.

The operating management started the reactor in the second week of July 2002.

KAMINI

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

Authorisation for reprocessing irradiated FBTR fuel pins in lead mini cell facility at IGCAR

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

A committee constituted by SARCOP reviewed the design safety aspects of LMC in detail. After extensive review, clearance for progressive commissioning with un-irradiated natural uranium was given to LMC in February 2002. After review of the results of the commissioning trials, SARCOP authorized reprocessing of low burn up FBTR fuel pins for first two campaigns at LMC. Clearance for future campaigns in the plant would be considered based on feedback from the presently authorized campaigns.

Steam generator test facility

A Steam Generator Test Facility (SGTF) is presently under construction at IGCAR, Kalpakkam. This facility was set up to study the steam generator, which is a critical equipment of PFBR (Prototype Fast Breeder Reactor). The steam generator to be tested at this facility is a scaled-down model of the one that would be used in PFBR, with a shell and tube type system. It has sodium flowing on the shell side and water on the tube side.

SGTF would be used to test and optimize the heat transfer area margins and to generate thermal hydraulic data to verify the proposed design of Steam Generators for PFBR. In addition, the facility would be used for gaining operation related experience such as chemistry control and validation of instrumentation and control. After detailed review of the safety aspects of this facility, SARCOP has granted permission for commissioning of the SGTF.

2.2.8 Regulatory Inspections of Operating Nuclear Power Plants and Research Reactors

Regulatory inspection of operating NPPs and RRs are carried out periodically to:

- Check for any radiological and industrial unsafe conditions existing at the NPP/RR
- Confirm whether 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 programs
- Confirm proper maintenance of records/ documentation
- Check that deficiencies pointed out in earlier inspection have been rectified

AERB issued the Safety Guide on Regulatory Inspection and Enforcement in Nuclear and Radiation Facilities (AERB/SG/G-4) in September 2002. In order to streamline the entire activity of regulatory inspection in NPPs, a manual on Regulatory Inspections has been prepared covering various procedures, checklists and other requirements. The manual covers the methods and procedures to be followed from inspection preparations to report submission and enforcement. The manual is under review by Advisory Committee on Preparation of Code and Guides on Governmental Organization for Regulation of Nuclear and Radiation Facilities (ACCGORN) before issue.

Presently each twin unit nuclear power plant is inspected once in six-month and research reactors once in a year. During these inspections, the following areas are covered at least once in a year;

- Reactor start-up, shutdown and normal operation,
- Reactor physics, fuel management,
- Compliance to surveillance requirements,
- Reliability of safety and safety related systems,
- Maintenance activities, in service inspections and quality assurance,
- Radioactive waste handling,
- Emergency preparedness and exercises,
- Health and environmental aspects,
- Training activities and
- Industrial and fire safety

During the year 2002-2003, a total of 16 planned regulatory inspections were carried out.

All the observations during the inspections were categorized under 5 categories and the number of observations observed in the year 2003-2003 for various units under each category is shown in Table 2.

Table 2 : Categorization of Deficiencies found during Regulatory Inspections of Operating Nuclear Power Plants and Research Reactors in 2002-03

Unit	No. of Inspect-ions	Cat-I	Cat-II	Cat-III	Cat-IV	Cat-V
TAPS 1-2	2	Nil	3	7	26	8
RAPS 1-2	2	1	3	Nil	68	8
MAPS 1-2	2	1	3	3	34	14
NAPS 1-2	2	Nil	Nil	9	34	12
KAPS 1-2	2	Nil	4	12	61	11
KGS 1-2	2	Nil	2	3	54	14
RAPS 3-4	1	Nil	3	9	57	14
FBTR and KAMINI	1	Nil	Nil	2	5	9
RAPPCOF	1					
Total	15	2	18	45	339	90

Some of the typical findings of category I to III brought out during the inspections and follow up actions taken are mentioned below. Category IV and Category V findings covers procedural inadequacies/improvements and other observations including housekeeping. None of the issues in different categories was serious enough to warrant imposition of regulatory restrictions on the operation of the plants.

Listing and bringing the observations of the inspection teams to the attention of the operating management is an additional step which assists in enhancing the status of nuclear safety at every plant.

Category-I: Deviation from Technical Specifications requirements

During the year 2002-2003, there were no major deviations from approved Technical Specifications, except the following two minor deviations which have been addressed.

1. At MAPS, the corner adjuster rods were not maintained in the operating range of 50% to 90% as stipulated by SARCOP in the year 1997. NPC has approached the Safety Committee for modifying the requirement based on 5 years of operating experience.

2. At RAPS the fire fighting water system pressure was found to be less than Tech Specs requirement of 7 kg/cm^2. System pressure was improved by rectifying the deficiencies.

Category-II: Deficiencies in system/structures/ components of the plant

The performance of safety and safety related systems in the plants are closely monitored by AERB. Deficiencies observed are reviewed in detail in the safety committees for identifying the root causes and their rectification. Some of the issues identified during regulatory inspections in this year are as follows:

1. Water leakage at the rate of 300-400 kg/day from KAPS Unit –1 calandria vault liner was observed to be continuing, even after carrying out pressurized grouting. This water loss is being made up regularly.

2. Radiation fields and high temperature problems in F/M vaults:

   Gradual rise in gamma radiation fields in Fuelling Machine vault at KAPS, KGS and RAPS 3-4 units was observed. Maximum radiation field is observed in KAPS and KGS Unit - 2 south vaults. The modifications done in end shield cooling system at KAPS also did not help. The matter was discussed in SARCOP. NPCIL design group is reviewing the problem.

   High temperatures in F/M vaults were observed at all NPPs. Improvements in ventilation and feeder cabinet insulation have been carried out to reduce the temperature in some units. Temperature of process water used to cool the F/M vault is remaining high due to common system loads. Needs review for load segregation if required.

3. At KAPS Unit-1, one adjuster rod was not operating smoothly after replacement of the drive assembly. The ball screw was badly damaged between 60% and 80% of its location. Further investigations are in progress.

4. At MAPS Unit-1, there were two heavy water leak events, during which PHT storage tank level had reduced to 114.4 cm against the requirement of 120 cm.

5. In TAPS-1, drift in relief settings in two primary system relief valves was reported. These valves were replaced in 1999 with indigenous supply. On dismantling the valve, tangential cracks were found and the defective valve was replaced with the original make. NPC is discussing the matter with the supplier.

6. At TAPS, radioactivity from Away From Reactor (AFR) facility was inadvertently discharged to the sea through storm drain during heavy rains. AERB was not informed within 24 hrs through prompt notification and /or within 20 days through a detailed report as per reporting criteria. Subsequently the significant event report was submitted and discussed in SARCOP. Contaminated soil was disposed off as solid waste. The trench repair and water proofing is in progress. The radiological impact of this incident was insignificant.

7. At RAPS Unit–3, there was reduction in cooling of spent fuel bundle during spent fuel transfer operation, which resulted in the bulging of one fuel pencil. Corrective measures including change in operating procedures has been carried out.

8. At RAPS Unit –1, during in-service inspection, cracks were found in Primary Coolant Pump (PCP) stuffing box. Station was asked to carry out similar inspection on all the PCPs of both the units. Since then, inspection of all PCPs in both units has been done except for three pumps and no defect has been observed. Repair procedure qualification is in progress.

9. In RAPS-2, the emergency core cooling system (ECCS) one valve did not open during system demand. This failure did not affect the system availability as the redundant valve was available for operation. Station has been asked to submit a significant event report and rectify the deficiencies.

10. In RAPS-3, maintenance on first boundary valve of PHT system (3341-V-70) by ice plugging during Reactor Start-up with insufficient sub-criticality margin was carried out. This is against the established safe operating practices and NPC has been asked to submit their response along with corrective measures taken.

11. Inhibition of ALPAS (Automatic Liquid Poison Addition System) regulation mode to prevent auto

addition of poison during plant operation of both units of RAPS 3 & 4 was observed. This is in violation of Technical Specifications. NPC has been asked to submit the response along with corrective measures taken.

Category III: Shortcomings identified in the plant system design, based on operating experience

1. At KAPS, the reactor building primary containment ventilation flow was maintained at 5000 cu.m./hr against design requirement of 8500 cu.m./hr. This results in less air changes in accessible area. Design modifications are in progress to achieve the design flow.

2. At KAPS, water clarity in the spent fuel storage bay (SFSB) remained poor. Augmentation of purification flow is planned. At KGS and RAPS 3&4 SFSB, water temperature remains high due to higher process water temperature. Design modifications are planned.

3. At KGS-2, periodic creep measurement of coolant channels showed negative creep for four channels. Station was asked to get the data reviewed by the designer and safety committee.

4. At KGS, performance test of Emergency Core Cooling System pumps is not being conducted as no provision is made in design for testing the pumps for long periods. However pumps are tested for shorter periods for checking the availability. Station was asked to provide a minimum re-circulation line to facilitate the above requirement.

5. Neutron field was observed in accessible areas in KAPS-2 due to gradual draining of water from End-Shields resulting in inadequacy in shielding. Additional shielding has been provided in accessible areas to reduce the neutron field to acceptable levels.

6. At NAPS, on receiving the containment isolation valves of fuel shuttle transport tubes do not close as no provision has been made in design. Station has been asked to carry out the design change to meet the containment isolation criteria.

7. The external radiation field around the high integrity containers used to dispose of high active solid waste at NAPS were showing a higher dose. Efforts are needed to bring down the dose to permissible levels.

8. At FBTR, defective safety valve 807 was gagged to prevent opening during unit operation. It was replaced subsequently.

9. Biological shield temperatures at TAPS units have been reduced slightly after flow balancing and insulation work but are still higher than design values. Concrete sampling was done to confirm the strength. TAPS has been asked to cover this aspect under ageing management program.

10. At TAPS, the Reactor Building (secondary containment) has been provided with blow out panels to open out in case the building gets pressurized. Station informed that as there is no provision to test them at shop also. The panels would be replaced based on visual inspection.

11. In RAPS-2, air is used instead of nitrogen in ECCS accumulator. This was subsequently reviewed and approved by COSWAC and safety committee.

12. In RAPS-1, electrical up-gradation jobs are in progress to meet the requirements of segregation and separation as per IEEE-384. The batteries of 250 V and 48 V system are located in the same room and no segregation is planned. Station has agreed to carry out the feasibility study.

2.2.9 Waste Management

Under GSR-125, Atomic Energy (Safe Disposal of Radioactive Wastes) Rules 1987, AERB closely monitored the radioactive waste disposals from the units of NPCIL, IGCAR, UCIL, IRE and BRIT.

The quantity and radioactivity of the wastes disposed by these installations themselves or transferred to waste management agencies were all within the limits authorized by AERB.

Presently, AERB is prescribing the authorized limits under GSR-125, at much lower levels than the Technical Specifications limits. The Technical Specification limits are arrived at on the basis of ICRP limits on radiation dose to the public, due to radioactive discharges. AERB has adopted this philosophy in order to maintain tight control on waste disposals. If required, additional authorizations are given subsequently rather than giving the margins

initially. In addition, characterization and estimation of activity of solid waste before disposal have been made mandatory for the installations. This is in addition to measurement of surface dose rate of waste containment, which is the basis for disposal of solid waste.

AERB staff inspects all facilities to ensure that safe radioactive waste management practices are followed and also to verify the waste disposal records. Presently, AERB Safety Codes and Guides on Radioactive Waste Management are under preparation.

2.2.10 LICENSING OF OPERATING STAFF FOR OPERATING PLANTS.

As a part of the responsibility of the regulatory body the operating staff of the NPP are licensed for a specific period (generally three years) to ensure that competent and qualified persons operate the plants. The operating staff are retrained and re-licensed once in three years. A committee appointed by AERB checks for the competence of the operating personnel and authorizes issue of the license to various levels of operating staff. Similarly, the persons holding management posts in NPPs need to be qualified and authorized by AERB. For this, AERB appointed a higher level committee. This committee met 16 times in the year 2002-2003.

Table-3 below gives the details of licensing of operating personnel and management personnel at various NPPs and RRs during 2002-2003.

Licensing procedure for the upcoming TAPS 3&4 500 MW(e) PHWR units is being finalized for implementation before start of commissioning.

2.2.11 Significant Events

It is obligatory for all operating NPPs to report promptly to the Regulatory Body, certain events happening in the plant which have or may have an impact on operational safety. Earlier such events were called as Safety Related Unusual Occurrences (SRUOs). In order to strengthen the operational safety experience feedback and to make the reporting criteria uniform for all NPPs, a new Event Reporting System (ERS) was developed.

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

a) Events and
b) Significant Events

Table 3 : Number of Persons Licensed for Different Positions

Plants	No. of candidates cleared						Licensing committee meetings
	Management	SCE	ASCE	ASCE(F)	CE	CE(F)	
TAPS 1-2	-	7	-	-	2		2
RAPS 1-2	-	3	9	3	7	4	2
MAPS 1-2	-	3	2	1	2	1	2
NAPS 1-2	3	3	1	2	1	1	2
KAPS 1-2	1	5	4	2	11	4	2
KGS 1-2	-	1	5		3		2
RAPS 3-4		2	7	1	2	-	2
FBTR	-	-	7	-	7	-	2
Kamini	-	-	3	-	1	-	1
TOTAL	4	24	38	9	36	10	17

Abbreviations used:

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

The categorisation depends on the safety significance and importance to operational safety experience feedback. The new system was developed based on feedback from the discussion meet on feedback of Safety Related Unusual Occurrences & adherence to Technical Specifications which was organised by AERB at SRI (Safety Research Institute) in December 1999. The new system has been implemented with effect from April 1, 2002. The plant now submits what is known as the Significant Event Reports (SER) and Event Reports (ER).

In the year 2002-2003, a total of 29 significant events were reported from the operating NPPs. A Pie diagram showing the system wise break-up of significant events (IAEA-Incident Reporting System format has been followed) is given in Figure-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 t0 7) depending on their safety significance. The accident at the Chernobyl nuclear power station was rated at level 7. The incident involved core melt down with the consequences of large scale off -site radioactivity release. Events at level 4 and above are termed accidents. Events rated at level 2 and 3 are called incidents. An event at level 1 is an anomaly. Events at level 0 or below are called deviations.

The break up of the number of SERs and their levels on INES for the last few years are given in Table-4. There were five events at Level-1 and one event at Level-2 on INES. The event rated at level-2 on INES was of a radiographer receiving the radiation dose while carrying out radiography in the turbine building of MAPS (Refer section 4.2). The Kaiga incident of fuel handling system is a Level-1 incident (Refer section 2.2.6). Another incident rated at Level-1 was at KAPS-1 where the reactor had to be tripped when it was observed that the temperature on the end shields was higher than normal.

The plant wise classification of SERs for 2002-2003 on INES scales is given in Table-5. There were 11 event reports from KGS while 6 significant event reports were reported from NAPS. Out of these, 7 events were related to disturbances in the electrical grid (6 at KGS and 1 at NAPS). Two Significant events were reported from each of TAPS, RAPS 1&2, MAPS, and RAPS 3&4.

Figure 1: SYSTEM WISE CLASSIFICATION OF SERs in NPPs (2002-2003)

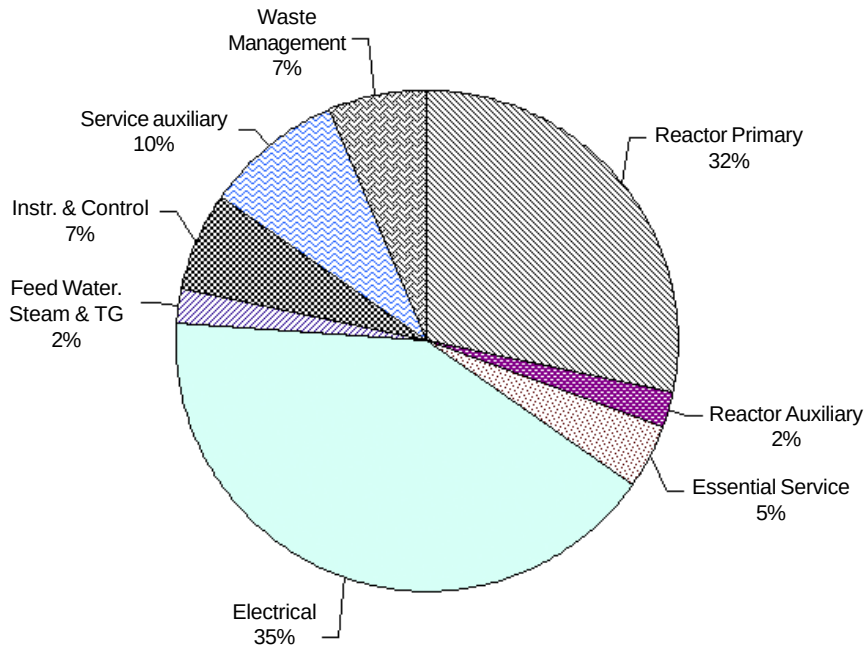


Table-4 Classification of SERs in NPPs as rated on INES

INES Levels	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003
Out of Scale	3	2	0	0	0
3	22	16	42	43	23
1	5	2	10	2	5
2	1	0	0	0	1*
3	0	0	0	0	0
>3	0	0	0	0	0
Total	31	21	54	45	29

Table-5 Classification of SERs in individual NPPs (2002-2003)

Plant Name	Out of Scale	International Nuclear Event Scale					
		0	1	2	3	>3	Total
TAPS		0	2	0	0	0	2
RAPS		2	0	0	0	0	2
MAPS		1	0	1	0	0	2
NAPS		5	1	0	0	0	6
KAPS		3	1	0	0	0	4
KGS		10	1	0	0	0	11
RAPS 3-4		2	0	0	0	0	2
	0	22	5	1*	0	0	29

* This level 2 event, which occurred in MAPS, involved overexposure of a radiographer while engaged in industrial radiography and was not connected with NPP operation.

2.2.12 Industrial Safety

Teams of inspectors from AERB carried out regulatory inspections on industrial safety aspects under the Factories Act, 1948 and Atomic Energy (Factories) Rules, 1996 in the nuclear power stations at Kalpakkam, Kaiga, Narora, Kakrapar, Kota and Tarapur.

In each case, AERB sent a detailed inspection report to the concerned unit. The points covered in the inspection report included augmentation in the staff strength of fire and safety section in some of the power stations, periodic load testing of electrically operated overhead travelling crane, enforcement for the use of personal protective equipment, medical examination of employees, improvement in the work permit culture, periodic inspection and maintenance of fire fighting equipment among others.

Similarly, AERB staff carried out regulatory inspections on industrial safety aspects in Kamini and the Fast Breeder Test Reactor and sent detailed inspection reports to the respective units. The reports covered various items such as fire emergency exercises, examination of eyesight and colour vision of crane operators and measurement of thickness of pressure vessels.

Chairman re-issued licence to Narora Atomic Power Station, in view of change of Occupier on (June19, 2002).

Chairman, AERB appointed Dr.T.S. Raikar of Kaiga Generating Station and Dr. Aravazhi Annal of Madras Atomic Power Station as Certifying Surgeons at the respective power stations.

2.2.13 Civil Engineering safety

AERB staff participated in regulatory inspections of Heavy Water Plant at Thal and Udyogamondal unit of Indian Rare Earths. They verified the implementation of the recommendations of Civil Engineering Safety Committee for Operating Plants (CESCOP). They also carried out a special inspection of NAPS with respect to the assessment of healthiness of the inner containment structure.

Civil Engineering Safety Committee for Operating Plants (CESCOP) reviewed a proposal for epoxy grouting of the stressing galleries of NAPS to control water leakages. The proposal was accepted for implementation.

AERB constituted an Expert Committee for seismic qualification of existing DAE installations (ECSQ). ECSQ met twice for discussing the draft document "Guidelines for seismic instrumentation of NPPs" and comments obtained on the document "Technical guidelines for development of review basis ground motions for seismic evaluation of existing nuclear facilities". The working group of ECSQ constituted for development of guidelines to determine the Review Basis Ground Motion using probabilistic seismic hazard analysis also met once during this period.

2.3 NUCLEAR FACILITIES OTHER THAN NUCLEAR POWER PLANTS

2.3.1 Nuclear Fuel Complex (NFC), Hyderabad

SARCOP reviewed the safety status of NFC during its 434th meeting held on April 3, 2002 and discussed the following safety issues:

- Air activity levels in the plant

- Management of pyrophoric waste
- Management of non-process effluent
- Handling and storage of uranium bearing waste
- Isolation of cooling water

On November 17, 2002 at 04:19 hrs an explosion occurred in the thermosyphon evaporator unit in NUOFP. Following the incident, AERB constituted an investigation committee and withdrew the authorisation for operation of the wet section of the plant.

The incident investigation committee has submitted its report and it is under review by SARCOP.

NFC Safety Committee has approved following proposals:

i) Revamping of CFFP pelletisation area for single entry and better ventilation along with design basis report, work is in progress.

ii) Isolation of cooling water lines in fuel plants along with detailed design basis report with lay out plan and completion schedule.

iii) Safety report of replacement, augmentation & modernisation of Zirconium Sponge Plant prepared by the plant.

iv) Proposal for trials processing of 1 MT of depleted uranium under certain stipulations.

v) Management of non-process effluent (hand wash, change room wash etc.) i.e. separate active waste water facility for fuel plants.

vi) Technical specifications of NFC.

A common on-site emergency plan for NFC is under review.

2.3.2 Heavy Water Plants (HWP)

Heavy Water Plant Safety Committee held meetings to review the following documents/reports:

- On-site Emergency Plan of Heavy Water Plant, Hazira and Heavy Water Plant, Thal.
- Report on Waste Heat Recovery System for Heavy Water Plant, Manuguru was reviewed and cleared by the Safety Committee for Heavy Water Operating Plants (SCHWOP) in its meeting held on May 13 –14, 2002 at BRP.
- Safety Report for Heavy Water Plant, Baroda Revival Project.
- Technical Specifications for Heavy Water Plant, Baroda Revival Project.
- Report on Adequacy of Fire Protection Systems for Heavy Water Plant, Baroda Revival Project.
- Emergency Plan for Heavy Water Plant, Baroda Revival Project.
- Report on Waste / Effluent Management for Heavy Water Plant, Baroda Revival Project.
- Hazard and Operability Study (HAZOP) report of BRP Phase II of HWP, BRP.
- Quantitative Risk Assessment (QRA) for Heavy Water Plant, Baroda Revival Project. The QRA consisted of Hazard Identification through Dow's Chemical Exposure Index method and Consequence Analysis for BRP.
- Report on component / equipment integrity assessment of Heavy Water Plant –BRP.
- Authorisation document for operation personnel of BRP

A sub-committee of SCHWOP reviewed the Safety Report of Heavy Water Plant, Baroda as per the requirements of AERB document 'Safety Report Format for Industrial Plants other than Nuclear Power Plants' and made the following major recommendations :

- Modification of Annexure related to Fire Water Supply System to reflect the actual number of fire hydrants;
- Consequences of failure of nitrogen supply to the junction boxes and the corrective action to be taken along with minimum quantities to be maintained in the plant to be specified;
- Plant operation only by authorised persons as one of the statutory requirements to be specified.

SCHWOP discussed the Quantitative Risk Analysis (QRA) report of Heavy Water Plant, Baroda Revival Project (BRP) in detail and the consequence analysis was redone using PHAST Professional software. The concentration profile was estimated for different scenarios and it was confirmed that there was no impact in the off-site domain.

Subsequent to the review in SCHWOP, commissioning clearance for Heavy Water Plant, Baroda Revival Project

was taken up in SARCOP

2.3.3 Indian Rare Earths Limited (IREL)

AERB staff carried out safety review of IREL plants through regulatory inspections, review of Tri-annual Safety, Health & Environment Reports, Quarterly and Annual Health Physics Reports for radiological aspects.

IRE Safety Committee held meetings to review documents and discuss the following issues :

- Safety Report on Zirconia Pilot Plant of IREL,OSCOM
- Safety Report on pumping of monazite tailings in earthen trenches at IREL, Manavalakurichi
- Proposal for construction of trenches to store insoluble mucks resulting from processing of monazite at IREL, Udyogamandal
- Proposal for selling of sodium nitrate solution from IREL, OSCOM to outside parties.
- Safety Report on Uranium Recovery Pilot Plant at IREL, Udyogamandal.
- Safety review on THRUST Project at IREL, Udyogamandal for retrieval and reprocessing of thorium and uranium from thorium concentrates stored in Silos 1-3.
- Health Physics Reports of all IREL plants.
- Revised Technical Specifications for IREL, Chavara, Udyogamandal, Manavalakurichi and OSCOM

The following Approval / Authorisations were issued by AERB:

- Chairman, SARCOP approved the Revised Technical Specifications of IREL, OSCOM based on the recommendations of IRE Safety Committee.
- Authorisation for selling of sodium nitrate solution from OSCOM to outside parties was issued by Chairman, SARCOP on December 5, 2002 with stipulations as suggested by the IRE Safety Committee.

2.3.4 Uranium Corporation of India Ltd. (UCIL)

Ventilation of Jaduguda Mine

There are five surface openings of Jaduguda mine termed as Adit 1-5 which are used for exhaust pathways for mine air. Out of five Adits, Adit 1 and 3 were closed for several years. Two exhaust fans of 45 cubic metres per sec capacity at Adit 2 and Adit 5 were used since eighties for removing the used air and the "shaft opening" is used as the main air intake path for the mines.

The design basis for Jaduguda mine ventilation rate is 150 cubic metre/sec which was not achieved since the inception of mines. Hence two committees were formed in 1985 and 1991 to look into the problem. The Committees reviewed the radiation exposure due to inadequate ventilation in the mine. The committees suggested to increase the ventilation in view of existing condition and also to the proposed mine depth up to 950 ML extension. A fan of capacity 75 cubic metre/sec has been installed and commissioned in July 2002,

Members of SARCOP visit UCIL mines.

Indian School of Mines, Dhanbad has done an extensive ventilation survey in 2001 in all the underground areas of Jaduguda Mines. The performance of the two fans of Adit-2 and Adit-5 with Adit 4 (newly installed) has been checked by computer simulation and a provisional decision was taken for removal of Adit 2 fan.

Better results were obtained with a combination of Adit 5 and Adit 4 fans at the two ends of the mine with a ventilation rate greater than 120 cu.m./sec.

A subcommittee was formed by SARCOP to look into the radiation dose of all the mines of UCIL. Though the radiation doses to workers were well below the limits, they were showing an increasing trend. SARCOP discussed the report of the sub-committee titled "Reviewing the Radiation Exposures and related Issues on Collective Doses for UCIL" in detail.

SARCOP wanted the management of UCIL to implement the following:

- Mine workers in the operational mines should be covered by personnel dosimetry.
- UCIL should carryout evaluation of ventilation system performance in Jaduguda mine with data on ventilation flow rate and airborne activity.
- UCIL should submit a schedule for improvement in ventilation.
- UCIL should establish a system for collective dose budgeting for all the mines.
- For future mine plant facilities, the air concentration of the activities in full occupancy area should not normally exceed 1/10th of the derived air concentration.

Technical Specification of Jaduguda Mines

Technical Specification Report approved by the Safety Committee was discussed in SARCOP meeting and was approved with some stipulations.

Treatment of Uranyl Nitrate Raffinate Cake at UCIL received from NFC

Uranyl Nitrate Raffinate Cake received from NFC containing some recoverable uranium was being processed at the mill of UCIL. As the full composition of the cake was not known, the matter was discussed in the Safety Committee and processing of the cake was suspended till the composition of the cake was known and the impact on the waste generated in the process established.

Audiometry survey in UCIL

About 1800 persons are exposed to noise level above 90 dBA in the Jaduguda Bhatin and Narwapahar Mines and the ore processing mill at Jaduguda. AERB has directed that workers must wear personal protective equipment in areas where the noise levels are high. In this context, UCIL medical division has accorded priority to do the audiometry test as per their working environment. The study consists of noise survey of the area and audiometry test of persons working at those locations.

2.3.5 Authorisations / licences Issued

Authorisations/licences were issued to the following units :

1. Nuclear Fuel Complex, Hyderabad

   Authorisation for regular operation of New Uranium Oxide Fuel Plant (NUOFP) was granted by Chairman, AERB on August 26, 2002

2. Heavy Water Plant (BRP) , Baroda

   Authorisation for operation of Heavy Water Plant - Baroda was granted by Chairman, AERB on October 22, 2002.

3. Indian Rare Earth Ltd, Udyogamandal

   Authorisation for construction for THRUST Project to retrieve and reprocessing of Thorium and Uranium values from Thorium concentrate stored in Silos 1-3 was granted by Chairman, SARCOP on December 5, 2002.

4. Indian Rare Earths, OSCOM

   Licence under Factories Act, 1948 renewed for a further period of five years, on May 28, 2002

5. Uranium Corporation of India Ltd.

   Authorisation for stage 2 of Turamdih mine i.e. " Development of the mine" has been granted by Chairman SARCOP on December 30,2002

6. Nuclear Fuel Complex, Hyderabad

   Licence under Factories Act, 1948 renewed for a further period of five years on August 21, 2002.

2.3.6 Licensing of Plant Personnel

Licensing of operating staff for Heavy Water Plants

Meetings of the Licensing Committee of Heavy Water Plants were held to authorise operation personnel at senior levels in various Heavy Water Plants.

2.3.7 Regulatory Inspections

AERB staff carried out regulatory inspections on industrial safety aspects under the Factories Act, 1948 and Atomic Energy (Factories) Rules, 1996 in the following industrial plants of DAE units:

Heavy Water Plants at Tuticorin, Thal, Hazira, Talcher, Kota and Manuguru Nuclear Fuel Complex, Hyderabad

IREL., Udyogamandal (2 times), Chavara and Manavalakurichi Uranium Corporation of India Ltd., Jaduguda

In each case, a detailed inspection report was sent to the concerned unit. Some of the major points covered

in the reports are given below.

Heavy Water Plants

Relocation of diesel tank inside the D.G. room, phasing out soda acid and Halon fire extinguishers, load testing of EOT cranes and medical examination of crane operators, colour coding of pipe lines and reporting of any violation of technical specifications.

Nuclear Fuel Complex

Surveillance checks on fire fighting system, augmentation of staff strength in the Fire Station, record keeping of various tests and examinations of equipment.

Indian Rare Earths Plants

Provision of guards to rotating parts, evaluation of ventilation system to reduce the internal exposure, replacement of heavily corroded structural steel supporting columns and platforms, barricading of floor opening, identification of area for future storage for monazite concentrates, preparation of radiation protection procedure manual, and prevention of oil leakage at High Speed Diesel storage.

Uranium Corporation of India Limited

Monitoring of acid mist at chemical house of mill, appointment of Competent Persons, augmentation of strength of fire staff, and non-conformance of the category of radioactive waste.

2.3.8 Appointment of Certifying Surgeons and Competent Persons

Chairman, AERB appointed the following medical officers as Certifying Surgeons under Section 10 of the Factories Act, 1948 :

i) Dr. Jayant Pawanarkar, Heavy Water Plant – Thal.
ii) Dr. F. N. Patnaik, Indian Rare Earths Ltd. - OSCOM.
iii) Dr. (Mrs) Susama Sahu, IREL - OSCOM
iv) Dr. Payoj Tiwari, Heavy Water Plant - Hazira.
v) Dr. Vijay Rao, Nuclear Fuel Complex – Hydrabad
vi) Dr. Millind Lankeswar, Heavy Water Plant – Baroda
vii) Dr. P.P. Shrivastava, Heavy Water Plant – Baroda

Chairman, AERB granted approval to Competent Persons under various Sections of the Factories Act, 1948 as detailed below:

i) Eight persons of Indian Rare Earths Ltd. – Chavara.
ii) One person of Indian Rare Earths Ltd.- OSCOM.
iii) Six persons of Indian Rare Earths Ltd.- Manavalakurichi
iv) One person of Heavy Water Plant – Thal.
v) Six persons of Heavy Water Plant – Kota.

2.4 OTHER FACILITIES

2.4.1 Variable Energy Cyclotron Centre (VECC)

Chairman, AERB has constituted the VECC-CAT Unit Safety Committee to review the radiological, industrial and environmental safety status at Variable Energy Cyclotron Centre at Kolkata and Centre for Advanced Technology, Indore. The Committee would also review from the safety angle, new projects and expansion proposals at these two DAE units.

Chairman, SARCOP issued the authorisation for operation of the high performance 14.4 GHz Electron Cyclotron Resonance (ECR-2) ion source installed at high bay area of VECC, Kolkatta on May 28, 2002. This ion source is an augmentation to the existing facility to facilitate higher charge state ions of heavier mass. The Super Conducting Cyclotron is under construction.

2.4.2 Centre for Advanced Technology (CAT)

The Advisory Committee on Fire Safety visited CAT for reviewing the fire safety aspects of CAT. The Committee reviewed the detailed design of INDUS II fire safety arrangement. Suggestions made are in the process of implementation. The committee also suggested necessary changes in other areas of CAT.

2.4.3 Board of Radiation and Isotope Technology (BRIT)

AERB staff carried out a regulatory inspection on industrial safety aspects, under the Factories Act, 1948 and Atomic Energy (Factories) Rules, 1996 in BRIT:

A detailed inspection report was sent. The report covered items such as storage of combustible material, periodic inspection of rubber tube connected to welding torch and availability of written safety procedures for activities like accessing the chemical store, handling the hazardous chemicals and operating the overhead crane.

2.4.4 Indira Gandhi Centre for Atomic Research

Since AERB enforces industrial safety provisions in all DAE units, it follows similar procudures in the research institutions under its jurisdiction as a matter of good

practice. On this basis, Chairman, AERB granted approval to 15 persons of Indira Gandhi Centre for Atomic Research (IGCAR) - Kalpakkam as Competent Persons

2.5 Significant Events

Fatalities due to Industrial Accidents

There were six work-related fatalities due to industrial accidents during 2002-2003 in various DAE units during the year. The unit-wise break up is given in Table-6.

Fatal Accident Assessment Committee of AERB reviewed the investigation reports of these fatal accidents and conveyed its observations to the unit concerned and all other DAE units for implementation.

In view of the large number of fatal accidents at construction sites, Chairman AERB issued a notification on July 08, 2002 specifying the minimum number of safety officers required at construction sites. Based on the above notification, NPCIL had sought some exemptions. An appraisal of departmental and contractors Safety Officers and Safety Supervisors at the construction sites at RAPP 5&6, Tarapur Atomic Power Projects 3&4, Kaiga 3&4 and Kudankulam Atomic Power Project were carried out. Exemptions were given with respect to the qualifications of some safety officers / supervisors who have adequate field experience.

2.6 SAFETY UPGRADATIONS IN DAE INSTALLATIONS

During 1995, the Atomic Energy Regulatory Board (AERB) reviewed the status of safety systems and prepared a comprehensive report titled' Safety issues in (DAE) installations'. The report detailed the evaluation and upgradations, which were required in the nuclear installations of the Department of Atomic Energy. The report was an outcome of stock taking of safety status and aimed at establishing an agreed action plan which detailed the corrective action and time frame to implement them.

Action plans with their completion schedule for each safety issue were drawn up with agreement of the DAE units and AERB. The progress of implementation of these action plans have been regularly monitored by AERB.

Based upon the action plans, the utilities have been submitting the progress reports on the implementation of the action plans in AERB. These are reviewed with the help of different safety committees. After satisfactory acceptance of the report and verification during regulatory inspection of the facilities the issues are recommended for closure to the Atomic Energy Regulatory Board.

For effective follow up, based on safety significance, AERB had classified the safety issues into 4 categories, As on March 31, 2003, of the 110 issues related to the institutions coming under the jurisdiction of AERB 104 has been resolved. The pending issues are being followed up by AERB. The pending issues in different categories are shown in brackets.

Category 1:Hardware related issues leading to replacement of defectivecomponents; (2)

Category 2: Ageing relating issues;(1)

Category 3: Confidence building exercises involving some analytical studies; (0)

Category 4: Upgradation of safety standards in plants that have been built to earlier safety standards (3).

The monitoring of the safety status of units coming under the jurisdiction of AERB is a continuing process. Besides the initial assessment, the staff of AERB verifies whether the resolution of each issue is satisfactory or not during regulatory inspections and reviews.

Table - 6 Fatalities during 2002 – 2003

UNIT	Category of worker	Cause
TAPP3&4(8-6-2002)	Contractors worker(unskilled)	Fall from height
HWP-Baroda(11-06-2002)	Contractors worker(helper)	Fall from height
TAPP3&4(18-6-2002)	Contractors worker(helper)	Fall from height
RAPP5&6(3-8-2002)	Contractors worker(helper)	Struck by object
Kaiga 3&4(15-11-2002)	Contractors worker	Fall from height
UCIL -Jaduguda Mine (11-01-03)	Loader operator	Fall of Object

SECTION 3

RADIOLOGICAL SAFETY SURVEILLANCE OF RADIATION FACILITIES

3.1 SAFETY REVIEW OF RADIATION EQUIPMENT AND APPROVAL OF SAFETY PERSONNEL

3.1.1 Type Approval of Radiation Equipment and Issuance of No Objection Certificates to Import Radioactive Material/Radiation Generating Equipment

The Safety Review Committee for Applications of Radiation (SARCAR) held five meetings from April 2002 to March 2003. Based on the recommendations of SARCAR, AERB issued type approval certificates to the manufacturers/suppliers of devices incorporating radioactive materials and radiation generating equipment. AERB issued type approvals for 178 devices and equipment during the year. The following is the break-up:

Medical diagnostic X-ray units	:	72
Mammography units	:	3
Bone densitometers	:	2
Radiation therapy simulators	:	8
Computed tomography (CT) units	:	3
Combined CT and Gamma camera	:	1
Telegamma therapy units	:	2
Gamma knife	:	1
Medical linear accelerators	:	2
Remote controlled brachytherapy units	:	8
Gamma chambers	:	7
Encapsulation for sealed sources for transport	:	3
Nucleonic gauging devices	:	63
Ionisation chamber smoke detectors	:	1
Baggage inspection systems	:	2

AERB accorded site clearance to M/s. Jhunsons Chemicals Private Ltd., Agra, M/s. Organic Green Foods Ltd., Kolkata and M/s. Gamma Agro-Medical Processings Private Ltd., Hyderabad. AERB accorded design approvals for beam lines shielding calculation for the superconducting booster and modification of the beam hall-II at Nuclear Science Centre, New Delhi, and for the radiation cell of the high capacity gamma radiation processing plant at M/s. Agrosurg Irradiators (India) Private Ltd., Mumbai.

3.1.2 Approval of Radiological Safety Officers

During the year, approval certificates were issued in respect of 217 Radiological Safety Officers. The break-up is as follows:

RSO Level-III (Radiation therapy)	:	85
RSO Level-II (Nuclear medicine diagnosis)	:	12
RSO Level-III (Industry)	:	10
RSO Level-II (Industrial Radiography)	:	40
RSO Level-I (Industry and research)	:	70

(Radiological Safety Officers are categorised in three levels depending on the type of sources handled and their hazard potential.)

SARCAR reviewed the draft revision of the Radiation Protection Rules and recommended the draft rules to the Board for its consideration. The committee approved a common syllabus for conducting B.Sc./diploma in nuclear medicine technology to enable successful candidates of the course for approval as Radiological Safety Officer.

3.2 AUTHORISATIONS AND REGULATORY INSPECTIONS

On the basis of the regulatory requirements, authorisations were issued for handling radioactive materials for medical, industrial and research purposes. Pre-authorisation inspections were conducted in many institutions all over the country. The details are given in the Table-7.

Table-7 Number of Authorisations Issued for Radiation Facilities

Radiation facilities	No. of authorizations issued
Teletherapy	27
Brachytherapy	51
Blood irradiator	1
Nuclear medicine	333
Unsealed sources in research	324
Industrial radiography	695
Nucleonic gauging	105
Manufacture of consumer products	92
Total	1628

3.3 RADIOLOGICAL SAFETY SURVEILLANCE

3.3.1 High Intensity Gamma Irradiation Facilities

AERB staff carried out inspections of the following six gamma irradiation facilities. (These were routine inspections.)

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 Plant for Spices, BRIT, Vashi, Navi Mumbai
6. Isotope in Medicine (ISOMED), BRIT, Mumbai.

AERB gave general directions to improve the status of radiological safety at these facilities. These include proper functioning of Uninterrupted Power Supply (UPS) system and closed circuit TV system, provision of battery backup to Programmable Logic Controller (PLC), rectification in leakage of control valve of pool water make up system, re-adjustment of preset level of audio/visual alarm to radiation area monitor, record keeping of periodic maintenance schedule and updating of emergency contact phone numbers.

AERB received the mandatory quarterly safety status report for all the four quarters in the year 2002 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. AERB reviewed four proposals for the replenishment of Cobalt-60 sources from gamma irradiation facilities and issued clearances for the same for augmenting the source strength. The staff from the Board of Radiation and Isotope Technology carried out the source loading operations safely and smoothly in three gamma irradiation facilities.

AERB revised the Safety Standard entitled," Radiological Safety for the Design and Installation of Land-Based Stationary Gamma Irradiators" from the view point of technological update and cumulative operational experience. AERB will shortly publish the revised version.

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

Augmentation of Cobalt Handling Facility (ACHF) at RAPPCOF:

RAPPCOF is a cobalt handling facility located at RAPS site. It processes Cobalt-60 isotope generated from the reactors. The Cobalt-60 radiation sources are used for various applications in medicine and industry.

The present hot cells at RAPPCOF are designed to handle one million Curies of Cobalt-60. In order to meet the increased demand of Cobalt-60, the Board of Radiation and Isotope Technology (BRIT) have proposed to augment the capacity to 2.5 Million Curies by constructing additional hot cells adjacent to the existing facility. The Project Safety Review Committee (PSRC) constituted by AERB carried out a detailed review of design and safety aspects for the proposed augmentation project. Based on this review, SARCOP granted authorization for construction of this facility with stipulations that include implementation of proper safety interlocks, integrated control and display system, radiation zoning and action plan on qualifying the operating staff.

3.3.2 Radiation Diagnostic and Therapy Facilities

AERB staff inspected 23 teletherapy and brachytherapy installations all over the country. On the basis of pre-commissioning safety analysis, AERB also 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. AERB accorded permissions for re-starting four telecobalt and two accelerator facilities, and three new radiotherapy centres. The AERB staff inspected 21 nuclear medicine facilities where unsealed radioactive materials are used for diagnostic and therapy purposes. The Board issued Regulatory Consent in the form of a licence to 8 nuclear medicine laboratories. AERB received annual safety status reports from each user. 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. AERB observed certain deviations and violations of regulatory requirements and asked the users to comply with the requirements.

3.3.3 Industrial Radiography

There are 442 industrial radiography institutions in India. Nine new institutions were authorised to handle radiography sources during the year. The total number of industrial gamma radiography exposure devices which are in use in India is 1182. Since radiography work shall 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, 395 source movements were approved by AERB for carrying out radiography activities at various sites. 101 industrial radiography sites and installations were inspected for confirming compliance with the regulatory requirements. A total of 8 radiography enclosures were inspected and approved for radiography purposes. Each user is required to send monthly safety status reports. These help AERB to monitor the radiological safety status continuously. AERB staff reviewed the reports for verifying compliance with the regulatory requirements.

3.3.4 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 246 installations in 12 institutions. Each user is required to submit six-monthly safety status reports. AERB reviewed these reports 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. On suspicion that a user had locally disposed off gauges supplied, AERB staff visited the institution, conducted a radiation survey and located the gauges which were buried at the site. The sources were disposed off safely.

3.3.5 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. AERB inspected seven such installations. Generally, the practices followed were in conformity with the regulatory requirements.

3.3.6 Transport of Radioactive Materials

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

AERB issued twenty-four authorizations for transport of radioactive material and conducted four regulatory inspections of packages 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.

3.3.7 Disposal of Radioactive Material

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 were as follows:

Export to original supplier	:	24
For transfer to domestic supplier	:	34
Number of consignments transported for disposal at authorised sites	:	16

3.4 UNUSUAL OCCURRENCES

3.4.1 Loss of Well Logging Sources

Seven well logging sources belonging to various institutions got stuck in wells while in operation. As per international practice, the wells were sealed with about 50 m of concrete so that the sources would not pose any hazard.

3.4.2 Loss of Industrial Gamma Radiography Exposure Device(IGRED)

On 17/07/02 an industrial radiography institution reported that a radiography camera with source (Iridium 192 of strength 19.7 Ci) kept in a locked brief case was lost during its transport by the radiography personnel to the radiography site by a public transport bus. AERB sent a team of scientists immediately to the place for investigation and search for the lost exposure device by using sensitive instruments. The team thoroughly searched the whole stretch of the high way with the police. It was observed that the exposure device was either stolen or had slipped out of the rear luggage hold of the bus due to improper locking of the lid of the compartment which was later noticed. It was a case of negligence and violation of the provisions of the regulations for safe transport of radioactive material which prohibit such transport of radioactive material by public transport buses or vehicles by the institution. In spite of wide publicity and intense search for the lost radiography exposure device, it could not be traced. The potential for hazard due to radiation exposure decreased rapidly because of the short half-life (74 days) of the radioactive material (iridium 192) which was in the device.

The authorisation issued to the radiography institution to carry out radiography work was suspended for 6 months and the certificate of the person who was in charge of radiation safety was cancelled.

3.5 REVIEW OF NON-COMPLIANCE OF REGULATORY PROVISIONS BY RADIATION INSTALLATIONS AND ENFORCEMENT ACTIONS

3.5.1 Industrial Radiography

During inspections, AERB staff observed that six institutions doing industrial radiography violated the regulatory provisions stipulated for industrial radiography. These include loaning of radiography exposures devices containing radiography source without prior approval of AERB, insufficient shielding to the enclosed type radiography installation, unauthorized radiography source movements from one radiography site to another site, conduct of radiography work at unauthorized site by trainee radiographer, non-use of personnel monitoring badge while carrying out radiography work, improper maintenance of log book records and non-submission of relevant documents to AERB.

Three incidents involving loss of radiography exposure device, malfunction of source drive system of exposure device and overexposure incurred by uncertified radiography person due to detachment of source assembly from the exposure device were investigated by AERB. AERB enforced regulatory actions against such institutions which included 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, withdrawal of the certificates of radiography personnel.

3.5.2 Radiotherapy Centres

AERB staff observed that a radiation therapy centre in a hospital had constructed a room with totally inadequate shielding to house a medical linear accelerator. The constructed facility deviated significantly from that approved for construction. The major deviation was that they used very low density cement to construct parts of the wall. As a result of this the radiation levels in some parts of the occupiable areas were unacceptably high.

AERB refused operating consent for the facility till the room was redesigned and constructed to offer adequate shielding. The hospital has now used nearly 300 tons of steel to ensure adequate shielding. AERB staff inspected the modified installation and issued permission for commissioning the accelerator unit.

AERB conducted a regular radiation protection surveillance in all the cancer hospitals in north-east which had not been inspected for some years. Various types of violations of regulatory safety requirements were observed during the survey. The violation observed in a hospital in Dibrugarh was serious and had the potential to cause a serious exposure to the patients. This compelled the immediate stoppage of patient treatment using the teletherapy unit installed in that hospital. The patient treatment was suspended for

about three weeks and restored only after compliance with the recommendations given by AERB to rectify the defects of the unit. The operation of a high energy linear accelerator in another hospital had to be suspended due to the non availability of proper dosimetric equipment in the hospital which led to the failure of regular measurement of the beam energy. Permission to operate was given only after arrangements had been made to make the requisite measurements regularly.

3.5.3 Nuclear Medicine Laboratories

During the routine inspections carried out by AERB, it was observed that one of the nuclear medicine centers violated various provisions of radiation safety applicable to nuclear medicine practice. These include

- alteration in the approved plan of laboratory without obtaining prior approval from BARC;
- non availability of approved Radiological Safety Officer (RSO) and technologist;
- non submission of annual safety status report to AERB;
- not obtaining AERB authorization for waste disposal and non availability of QA records.

AERB reviewed the violations. All these violations were observed in facilities handling very low activity sources and did not involve significant radiation doses to patient or members of the public. AERB issued directives emphasizing the need for initiating immediate steps to obtain approval from BARC for the modified layout as existing and for immediate appointment of RSO to provide surveillance in handling nuclear medicine radioisotopes.

3.5.4 Medical Diagnostic X-ray Installations

Personnel Dose Monitoring Services (PMS) were not available to the staff members working in the Department of Radiodiagnosis of four Medical Colleges & Hospitals in Kerala. AERB issued a directive to these hospitals asking them to resume PM services immediately. Accordingly, the above hospitals resumed the PM services. One of the medical X-ray manufacturer agencies in Pune was engaged in supplying medical X-ray machines not type approved by AERB to various users. AERB issued a directive to this agency to suspend immediately the marketing of such machines till AERB type approval was obtained and demonstrations given by this agency to various users to which such units had been supplied on the compliance of the X-ray units with the regulatory requirements specified by AERB. The compliance with these enforcement actions is being monitored by AERB.

One manufacturer of diagnostic X-ray unit was found to be manufacturing and supplying the units to medical institutions without obtaining regulatory approval of the unit from the AERB. Appropriate action is being initiated against the manufacturer.

3.6 TRAINING PROGRAMMES

In order to ensure that safe practices are followed for use and handling of radioisotopes, appropriate training of the personnel involved is necessary and mandatory. A number of long term and short term training courses are conducted by various Divisions of BARC and other organisations. AERB staff participate in these training programs as faculty and examiners.

3.7 AERB RADIOLOGICAL SAFETY BULLETIN

During this year AERB published a quarterly radiological safety bulletin to highlight information on common violations of regulatory provisions in various radiation installations as well as measures to avoid recurrence of these violations. The newsletter includes latest information on regulations, safety publications by AERB such as safety codes, standards and guides from time to time. The first issue of this bulletin highlighted information on safety aspects of medical X-ray installations. The bulletin was circulated among relevant radiation installations in the country.

SECTION 4
ENVIRONMENTAL AND OCCUPATIONAL SAFETY

4.1 ENVIRONMENTAL SAFETY

The Environmental Survey Laboratories of the Health, Safety and Environment Group, BARC carry out environmental surveillance of all operating plants under DAE. The radiological impact 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 2002 from the operating units was only a small fraction of the prescribed safe Technical Specification limits.

Figures 2a-2e show the liquid and gaseous discharges from the plants. Data for previous years is also included for comparison. Figure 3a and 3b shows the committed dose to the members of public due to release of radioactive effluents from the plants. Radiation dose to members of the public near the operating NPPs is estimated based on measurements of radio-nuclide 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 dose limit of 1000 microSv. (Sv is a unit of biologically significant dose. In a typical chest X-ray examination the patient may be exposed to a skin dose of 100 to 1000 micro sievert)

4.2 OCCUPATIONAL EXPOSURES

The number of workers who received radiation doses greater than 30mSv (annual limit) and 20mSv(Investigation limit) during the year 2002 in NPPs is given in Table 8a The percentage of workers who received doses above the limits is given in Table 8b. Data from earlier years is also given for comparison. Only two cases of exposures greater than 30 mSv have occurred during the year one at MAPS and other at NAPS.

At MAPS, one departmental radiographer received a dose of 151.3 mSv while conducting a radiography job. A special committee appointed by SARCOP investigated the incident. The radiographer got inadvertently exposed while removing and re-fixing the radiography film, as he had forgotten to retract the radiography source in to the shielded device. It was estimated that the radiographer spent almost 5-6minutes in close proximity with the source, at a distance of 20 cm or less. The person was medically examined and no abnormalities attributable to the exposure were noticed. The investigation committee concluded that the exposure occurred due to human error, non-compliance with safety precautions and inadequate supervision. Apparently the radiographer did not use the radiation survey meter to check the status of the source. Also the site-in-charge of radiography was not supervising the work. Based on the observations made by the investigation committee, SARCOP asked MAPS and other NPCIL stations to periodically carry out refresher training on safe radiography work procedures for all their radiographers. SARCOP directed that the management of the power stations should strengthen supervision and ensure that the workers adhere strictly to safe work practices.

At NAPS a worker received a dose of 30.97mSv during the annual shut down of NAPS Unit-1 while carrying out ISI related jobs. (Refer section 2.2.4.)

The respective station exposure investigation committees investigated the exposures, which were again reviewed by AERB. The two persons have been kept away from radiation work for an appropriate period of time.

Data on the occupational exposure in medical, industrial and research institutions (non-DAE institutions) during the year 2002-2003 is given in Table-8c. It is seen that the average annual dose in each category of institutions is very small and that the number of individuals who have received doses in excess of the prescribed limit is also very small.

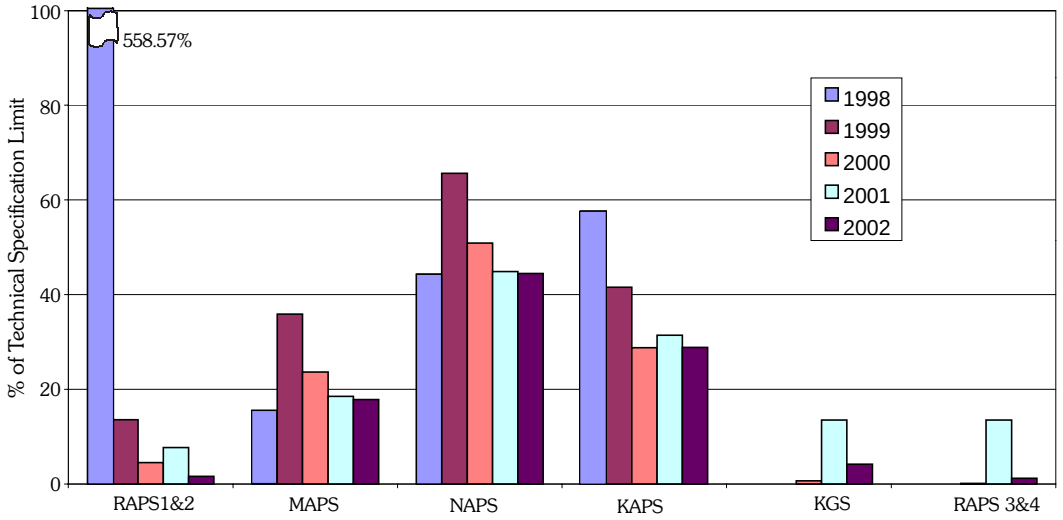
4.3 OCCUPATIONAL HEALTH

4.3.1 Advisory Committee on Occupational Health

The Advisory Committee on Occupational Health met four times during the period. The major deliberations were :

- Appointment of more than one Certifying Surgeon in the plant.
- The "Pre-employment Medical Examination" portion of the "Manual on Occupational Health" has been prepared by a sub-committee of ACOH.
- The yearly Status Reports of all the DAE units were studied by the committee and major findings were discussed in the 19th DAE Safety and Health Professionals Meet at Kaiga, Karnataka.
- The Format for the yearly Status Report needed some clarification. This was debated and necessary changes were incorporated by ACOH.

Fig. 2a : LIQUID DISCHARGES FROM NPPs
Tritium



There is no Tritium discharge at TAPS.

Fig. 2b : LIQUID DISCHARGES FROM NPPs
Gross Beta

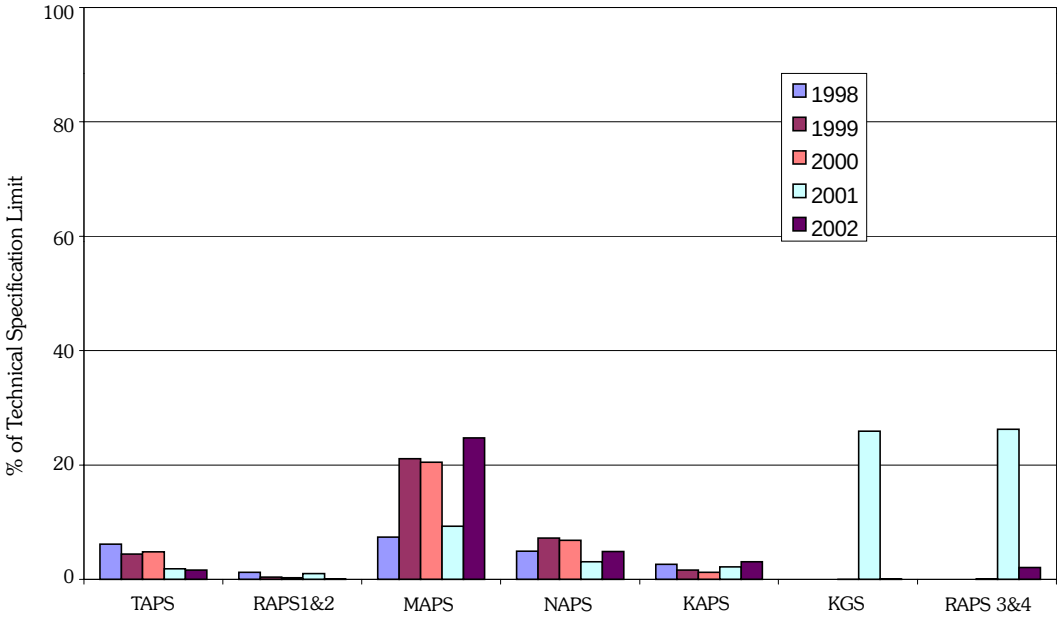
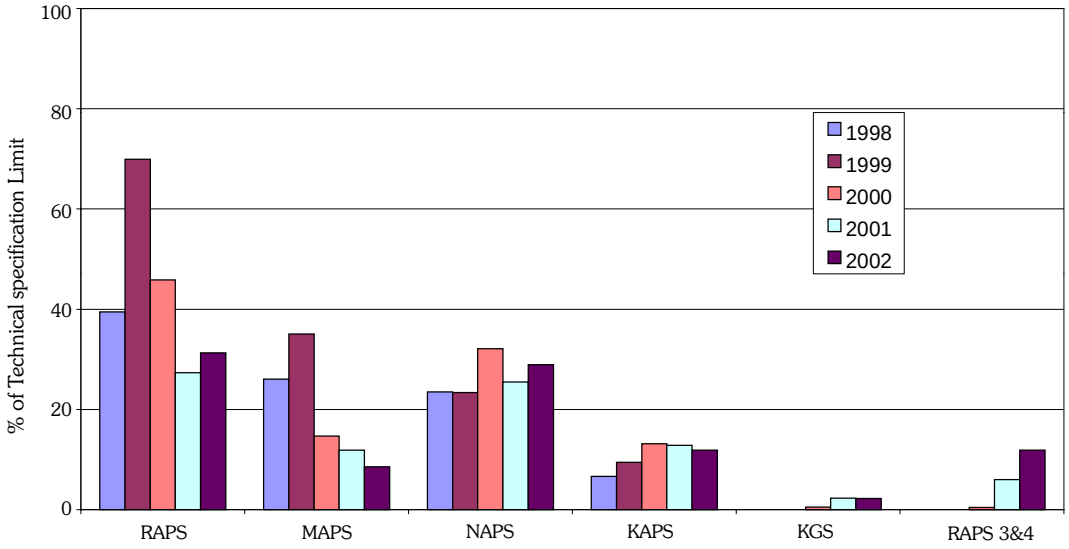
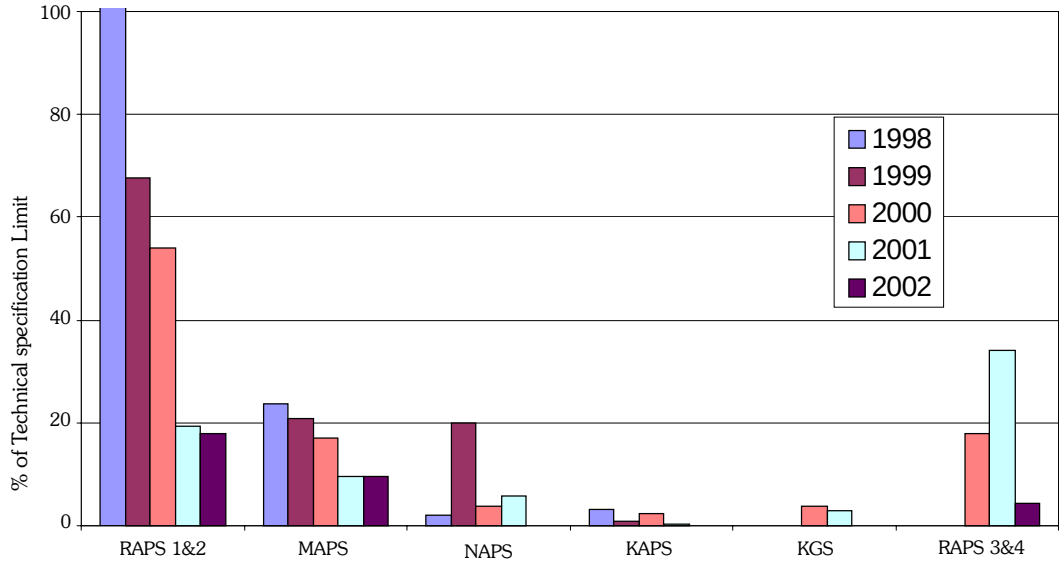


Fig. 2c : GASEOUS DISCHARGES FROM NPPs
Tritium



There is no Tritium discharge at TAPS

Fig. 2d : GASEOUS DISCHARGES FROM NPPs
Argon-41



There is no Ar-41 discharge at TAPS

Fig-2e : GASEOUS DISCHARGES FROM NPPs
Fission Product Noble Gases

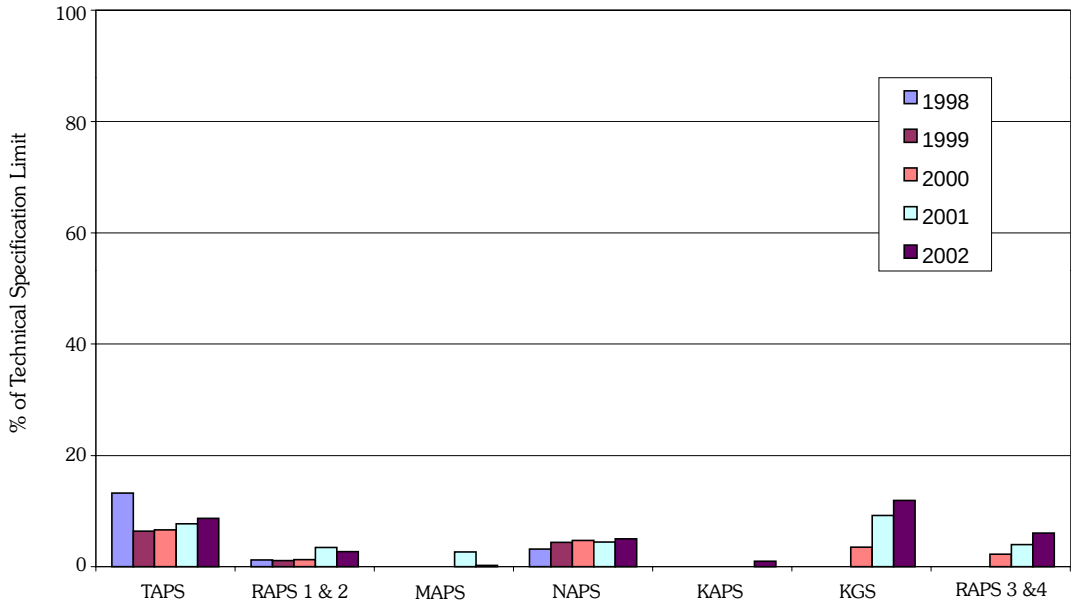


Table-8a. Number of Workers in NPPs Exposed to > 20 mSv (Investigation Limit) and > 30 mSv (Annual Limit)

Year	1998		1999		2000		2001		2002	
Unit	20-30 mSv	> 30 mSv	20-30 mSv	> 30 mSv	20-30 mSv	> 30 mSv	20-30 mSv	> 30 mSv	20-30 mSv	> 30 mSv
TAPS	0	0	0	0	0	0	0	0	2	0
RAPS1&2	0	0	29	1	1	0	37	1	0	0
MAPS	3	1	10	4	1	0	0	0	2	1
NAPS	6	2	41	0	10	1	16	1	10	1
KAPS	0	0	0	0	0	0	1	0	1	0
KGS					0	0	0	0	0	0
RAPS3&4					0	0	0	0	0	0

Table-8b. 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	%
1997	10008	30	0.30	3	0.03
1998	10145	9	0.09	3	0.03
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

Table-8c. Occupational Exposure in Medical, Industrial and Research Institutions

Category	No. of Institutions	No. of Persons	Average Annual Dose mSv	No. of Persons Receiving Annual Dose (mSv)	
				>20	>30
Industry	509	5120	1.05	25	10
Medical	2220	19807	0.71	37	22
Research	198	2763	0.16	0	0

Fig 3a: PUBLIC DOSE AT 1.6km DISTANCE FROM NPPs

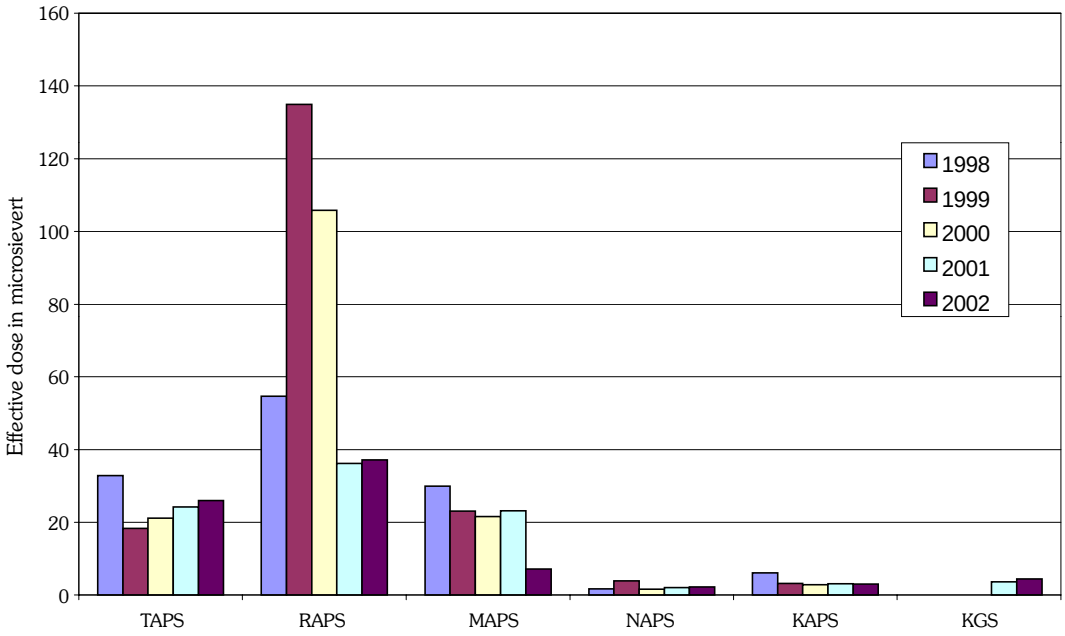
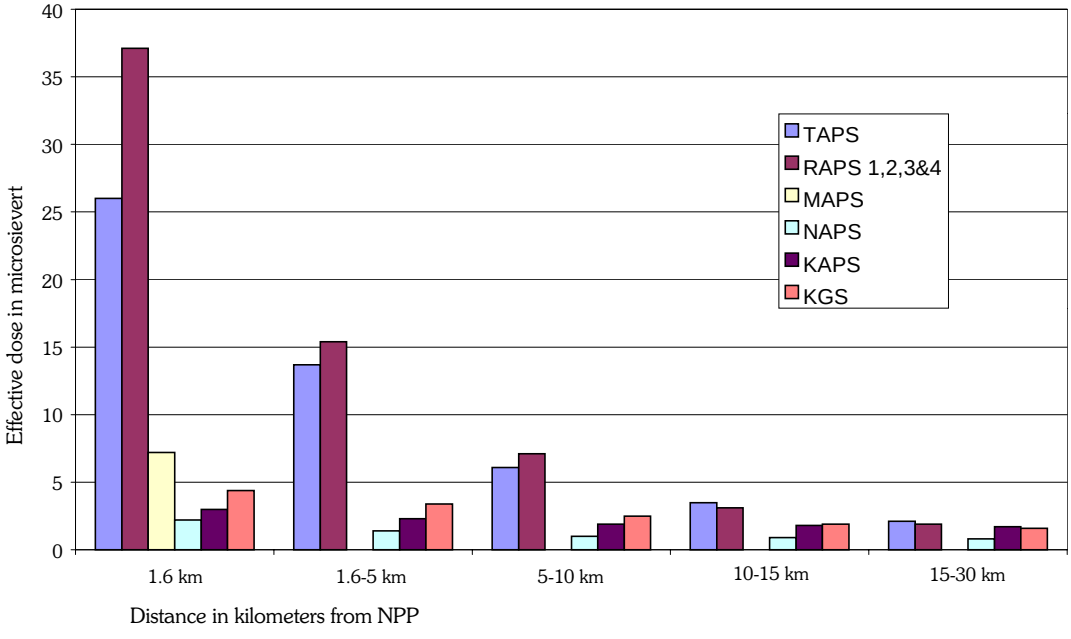


Fig 3b: TOTAL EFFECTIVE DOSE IN DIFFERENT ZONES DURING THE YEAR 2002



SECTION 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. These involve the station authorities, the district administration and the members of public.

The exercises help in evaluating the readiness of plant and district agencies involved and also increase awareness amongst the public. Special observers are posted by AERB to witness these exercises.

During the year 2002, emergency exercises were carried out as under:

Table-9 Emergency Exercises

PLANT	PEE (Once in a quarter)	SEE (Once in a year)	OSEE (Once in 2 years)
TAPS	4	1	–
RAPS	2	2	–
MAPS	4	-	–
NAPS	3	1	–
KAPS	4	1	1
KGS	4	1	–
RAPS 3&4	3	1	–
HWP (Kota)	–	–	–
HWP (Manuguru)	–	–	–

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

The response of the plant personnel, officials and public involved in the exercises was generally good. The general level of awareness of the members of public was also found to be satisfactory.

SECTION – 6

DEVELOPMENT OF REGULATORY DOCUMENTS

One of the important functions of AERB is to issue safety codes, standards, guides and manuals for nuclear and radiation facilities and other related activities. The following safety documents were published during the year:

Safety Classification and Seismic Categorisation for Structures, Systems and Components of Pressurised Heavy Water Reactors (AERB/NPP-PHWR/SG/D-1)

This guide provides guidance for safety classification and seismic categorisation of structures, systems and components of PHWRs. It provides necessary information to assist personnel and organisations participating in the design of Pressurised Heavy Water reactors in assigning the required levels of importance to various structures, systems and components.

Fuel Design for Pressurised Heavy Water Reactors (AERB/NPP-PHWR/SG/D-6)

This guide provides the requirements of fuel design so as to conform to the specified limits for normal and off-normal reactor operating conditions as well as operations on fresh fuel and spent fuel at the reactor site. It is applicable to Pressurised Heavy Water Reactor fuel elements and bundles consisting of natural and depleted uranium dioxide fuel and covers the fuel design aspects for different conditions such as fresh fuel handling, normal operation, spent fuel handling and storage. It also covers the criteria for determining fuel cladding integrity during accident conditions.

Primary Heat Transport System for Pressurised Heavy Water Reactors (AERB/NPP-PHWR/SG/D-8)

Guidelines for designing the primary heat transport system of Pressurised Heavy Water Reactors (PHWR) are prescribed based on the current designs of 220 MWe and 500 MWe PHWRs. The guide covers safety requirements on primary heat transport system, associated systems, support systems and major components of these systems. The guidelines include major requirements like layout, maintenance and inspection, seismic considerations, over-pressure protection and decommissioning. Design bases for some systems like shutdown cooling system, feed and bleed system and emergency core cooling system are also included.

Liquid and Solid Radwaste Management in Pressurised Heavy Water Reactor Based Nuclear Power Plants (AERB/NPP-PHWR/SG/D-13)

This guide addresses various regulatory aspects in the design and construction of awaste management facility. It reflects upon the practical methodologies adopted in the management of liquid and solid radwaste generated during the operation of a NPP and emphasizes the strategy to be adopted in the design of waste management facilities, pertaining to PHWR based NPPs.

Hydrogen Release and Mitigation Measures under Accident Conditions in Pressurised Heavy Water Reactors (AERB/NPP-PHWR/SG/D-19)

Guidelines for estimating hydrogen generation due to metal-water reaction and radiolysis during accident conditions in pressurised heavy water reactors and hydrogen mitigation measures in the containment are given.

Safety Related Instrumentation and Control Based Nuclear Power Plants for Pressurised Heavy Water Reactor (AERB/NPP-PHWR/SG/D-20)

Safety related I&C includes the control systems and information systems, which are necessary to operate the plant within the limiting conditions of operations and thus not necessitating the actuation of the safety critical system. The systems and features specifically engineered to mitigate the consequences of an accident situation which

has been brought under control by the actuation of one or more of the safety critical systems, also fall under this category. This guide deals mainly with the generic design requirements for the safety related instrumentation and control systems. The necessary actuation devices to perform control actions and the associated system support features are also included within the boundaries of safety related I&C.

Design of Fuel Handling and Storage Systems for Pressurised Heavy Water Reactors (AERB/NPP-PHWR/SG/D-24)

Fuel handling and storage involves activities related to the receipt of new fuel in a nuclear power plant, storage and inspection before use, transfer of new fuel into the reactor, removal of irradiated fuel from the reactor and its reinsertion when required, transfer to the spent fuel storage bay, underwater storage and inspection, loading into a shipping cask and handling of the shipping cask.

This guide includes safety requirements in the design of equipment for handling and storage of new fuel, spent fuel and other irradiated core components, which are related to handling of fuel including handling and storage of failed or damaged fuel bundles. It also addresses the safety aspects in fuel handling control and instrumentation and auxiliary equipment related to the fuel handling system. Design provisions to facilitate inspection and testing of fuel handling and storage systems are also covered in this guide.

Design, Fabrication and Erection of Embedded Parts and Penetrations Important to Safety of Nuclear Facilities (AERB/NF/SS/CSE-4)

Civil engineering structures in nuclear installations form an important feature having implications to safety performance of these installations. The functional and safety requirements of the embedded parts and penetrations important to safety of a nuclear power plant call for special design requirements. This standard describes methods for implementing the requirements of design, fabrication, inspection, testing and installation of such embedded parts, penetrations and attachments.

Regulatory Inspection and Enforcement in Nuclear and Radiation Facilities (AERB/SG/G-4)

This guide provides guidance to the Regulatory Body on its role during regulatory inspection of nuclear and radiation facilities and with regard to enforcement. It is also intended to assist the concerned facilities and their participating/collaborating agencies in fulfilling the stipulated requirements.

SECTION 7

SAFETY RESEARCH AND DEVELOPMENT : WORKSHOPS, CONFERENCES, SCIENTIFIC PUBLICATIONS.

7.1 SAFETY ANALYSIS

Safety analysis consists of two approaches: Deterministic Analysis, which is also known as Accident Analysis and Probabilistic Analysis which is a defense-in-depth concept for safety assessment of a nuclear plant. Probabilistic approach complements the deterministic approach for design basis accidents and provides further insights in case of beyond design basis accidents including very low probability accidents.

Probabilistic Safety Assessment (PSA) is performed in three levels: Level 1 PSA determines Core Damage Frequency (CDF) postulating occurrences of various Initiating Events (IEs). A Level 1 PSA provides insights into the design weaknesses and ways of preventing core damage.

A Level 2 PSA assesses frequency of radioactivity release outside containment under accident conditions taking inputs from Level 1 PSA. A Level 2 PSA provides insights into the relative importances 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 public risks. A Level 3 PSA provides insights into the relative importances 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.

PROBABILISTIC SAFETY ANALYSIS

AERB has adopted a "Risk-informed" approach for PSA, considering the present state-of-art and international trends in the PSA. A draft paper on 'AERB Policy on PSA' has been prepared, which describes the regulatory approach on PSA, requirements of PSA studies for different stages/activities for new as well as operating nuclear plants, priority areas for PSA applications, probabilistic safety goals, which the utility should try to achieve, quality assurance in PSA studies and review processes, documentation, etc. These aspects were discussed in a discussion meet attended by NPCIL and experts from BARC, IGCAR and AERB.

The finalisation of AERB policy based on the approach paper is under progress. A committee constituted by Chairman, AERB is preparing a safety document on 'Guidelines on PSA', which will help the utility as well as reviewers to perform and review, PSA related studies. The R-0 draft of this safety document prepared in June 2002 is under review by the Advisory Committee on Codes and Guides and Associated Manuals for Safety in Operations of Nuclear Power Plants (ACCGASO).

In August 2002, Chairman, AERB constituted the 'Committee on PSA for Nuclear Facilities' to review and monitor progress of PSA related activities in DAE units. NPCIL submitted Level 1 PSAs for internal events for Kakrapar Atomic Power Station (KAPS) and Tarapur Atomic Power Station (TAPS) (Part-II considering PIEs other than LOCAs). Part-I covering LOCA events submitted earlier by NPCIL was reviewed by a AERB Working Group. AERB Committee on PSA completed the review of TAPS PSA (Part-II) and the review report is being issued shortly. The review of KAPS PSA is in progress.

Task force updation of MAPS PSA for internal events has completed plant-specific failure data collection for components including human actions. The processing of these data for inputting and quantification of Fault Trees/ Event Trees (FTs/ETs) is in progress. ETs have been already drawn. FTs are being updated to reflect latest plant status as on this date.

IGCAR has performed a Reliability Analysis on Safety Grade Decay Heat Removal System for Prototype Fast Breeder Reactor (PFBR) and submitted it to AERB. The Committee on PSA for Nuclear Facilities has reviewed and accepted this report with certain recommendations.

ACCIDENT (DETERMINISTIC SAFETY) ANALYSIS

The review of the Preliminary Safety Analysis Report (PSAR) on accident analysis of KK Project submitted by NPCIL was taken up in AERB. There were 13 packages covering analyses with regard to 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 the SG on 5 packages were reviewed by the AERB Co-ordination Group and four of these were also reviewed by the Advisory Committee on Project Safety Review-Light Water reactors (ACPSR-LWRs).

As a part of an ongoing AERB project at IIT Bombay on development of a coupled neutronics & thermal hydraulics code for loosely coupled reactors, modules have been developed/modified for inclusion of parallel coolant channels and coupling of neutronics feed back.

7.2 SAFETY RESEARCH & DEVELOPMENT

The safety research programme of AERB registered good progress during the year. Several officers from AERB interacted with institutions which are carrying out the projects. AERB gave grants for the following new research projects during the year.

1. Quality assurance & patient exposure in CT imaging, Medical College, Calicut
2. Measurement of X-ray exposure received by children during CT examination in comparison with adults, Medical College, Calicut
3. Geometrical analysis of plates and shells, IIT Bombay
4. Validation on the measurement of translocation frequency for cumulative dose estimation, Sri Ram Chandra Medical College and Research Institute, Porur-Chennai*
5. Micronuclei and comet assay as a tool for radiation bio-dosimetry, Kasturba Medical College, Manipal*
6. Radiation induced chromosome aberrations and their use in bio-dosimetry, AIIMS, New Delhi*
7. Study of telemeric damage patterns in cancer patients before and after radiotherapy, Manipal Hospital, Bangalore *

** AERB has plans to develop these institutions into laboratories which can carry out bio-dosimetric work.*

Besides these, AERB renewed fifteen on-going research projects. AERB has also extended grants to twenty-two organisations for conducting various seminars/symposia/conferences during the year.

7.3 AERB – SAFETY RESEARCH INSTITUTE

Safety Research Institute (SRI), since its formal inauguration on February 20, 1999, has been making steady progress towards establishing the basic infrastructure required for organizing the research activities in the following areas:

- Nuclear Plant Safety Studies
- Radiation Safety Studies
- Environmental Safety Studies

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 Data Bases and Safety Related Computer Codes

The progress made in the above activities during the year 2002-2003 is described below.

Prof. S.P. Sukhatme, Chairman, AERB with SRI staff.

7.3.1 Nuclear Plant Safety Studies

Reliability Analysis of Shut Down System of PFBR

Reliability Analysis of PFBR Shut Down System (SDS) was performed by evaluating the minimal cut sets of fault trees. The fault trees were developed using immediate cause approach. The fine impulse test feature used in SDS was also included in the fault tree analysis. Probabilistic safety analysis of Core Temperature Monitoring System (CTMS) of PFBR was performed for

safe and unsafe failure probability for different configurations of real time computers to be used in PFBR Shutdown System.

Investigations on Station Black Out (SBO) frequency were performed for Fast Breeder Test Reactor (FBTR) to compare the reliability of power supply with a single feeder between MAPS and FBTR and that with two feeders. The results were compared with that of MAPS to find how the reliability is affected by the intermediate components such as transformers, feeders and other electrical equipment from MAPS to FBTR. A study on the comparison of the fault tree model and integral model was made for the estimation of nuclear power station blackout frequencies.

7.3.2 Radiation Safety Studies

Radiation Shielding Computations

PFBR top shield components design

PFBR top shield contains Roof Slab (concrete), Large Rotating Plug (steel), Small Rotating Plug (steel) and Control Plug (steel). To enable movement of these components with respect to the other, an annular gap of width around 20 mm is provided through which radiation leaks to the working platform. In addition, Transfer arm meant for movement of sub-assemblies penetrates through the small rotating plug also contains 40 mm of gap allowing streaming of radiation. Therefore, calculations have been done for both reactor operating and shut down conditions to estimate the additional shielding required around and on the top of annular gaps.

Monte Carlo Simulation of Medical LINAC for Dose Distribution inside Water Phantom

Monte Carlo method is widely employed in the treatment planning system of medical Linear Accelerators for arriving at precise dose distribution inside the body (water phantom). In the usual approach electrons and photons histories are simulated starting from the incident electron impinging the target till cascade of particles produced as a result of multitude of collisions either escapes or gets absorbed in the system. This approach would need a large amount of CPU time (days) for each case due to tracking of particles over a long distance of the order of 1m. The amount of CPU time can be reduced by a factor four if one follows an alternate new method called the virtual source method developed at SRI. Here, the simulation distance is split into two steps: a) the first step (case independent) involving the target, primary collimator and the flattening filter and b) the second step (case dependent) involving secondary collimator jaws and the body. The virtual source generated in the first step at the end of flattening filter can be employed for subsequent simulations of varying field dimensions. The dose distributions simulated with this new method are with in the 1% deviation of the usual approach. Typical sample cases analyzed for 6 MeV incident electron showed the reduction of a factor of 4 in CPU time with the new approach.

7.3.3 Environmental Safety Studies

Environmental Impact Assessment for Nuclear Power Plants (NPPs) using Remote Sensing and Geographic Information System (RS-GIS) data

The preliminary studies have been made on EIA of Kalpakkam site after setting up of RS-GIS facility at SRI in collaboration with Space Application Center, Ahmedabad. The studies utilized IRS-1C/1D satellite data for creating spatial data base on various natural characteristics such as land use/cover, hydrogeomorphology, ground water prospects, surface water bodies, transportation network, natural hazards such as flood, erosion etc. on 1:12,500 scale. A land use change matrix has been prepared to find out the land transformations. The preliminary change report suggests that the land use transformation has been due to the developmental and other natural activities but not due to setting up of NPP.

PFBR Geohydrological Investigations

As a part of the project "Aquifer parameter estimation, flow velocities and impact analysis around Kalpakkam coastal area", a detailed reconnoitery field survey has been carried out for obtaining the sub-surface cross-section data with a team from National Geophysical Research Institute (NGRI). The area in which the resistivity soundings were recorded is bounded by sea in the east, Buckingham canal in the west, Kokkilamedu backwaters in the north and Sadras backwaters in the south. The locations of the bore wells were recommended based on the above studies for the subsequent determination of the aquifer parameter estimation and flow velocities. About 14 wells were drilled in the designated locations and

pumping tests were undertaken to evaluate aquifer parameters. Further studies are in progress. It is proposed to carry out detailed hydrogeological investigations at the site in collaboration with Anna University, Chennai. These studies are complementary to the EIA studies and provide the essential inputs in database preparation.

Projects Awarded by Safety Research Institute

Projects on some studies in the chosen areas of work were 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.

1. Characterization of Thermal Internal Boundary Layer (TIBL) along the eastern coast of India, Dept. of Meteorology and Oceanography, Andhra University

AIR-USA Inc., tether balloon system has been procured and made operational. Data have been collected for three different seasons at Kalpakkam jointly with other research institutes and IGCAR for model validations. These data have been used to validate sea breeze model MAM-1 developed at IGCAR for coastal dispersion analysis. A generic dispersion model for regulatory applications during accidental release for all nuclear stations have been developed and the data from Kalpakkam is used for validation of the same.

2. Development of tracer release, sampling and analysis, Central Leather Research Institute, Chennai

Gas Chromatograph (GC) with Electron Capture detector for SF6 tracer gas has been commissioned. The GC has been calibrated and very low level detection of tracer gas has been achieved (5 ppt of SF6 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.

7.3.4 Discussion Meeting/Conference

One of the objectives of the Safety Research Institute 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 a Discussion Meeting on Inter – Institutional Collaborative Research was organized by SRI during January 30, 2003 at Kalpakkam. About 50 delegates from the various units in DAE participated. The meet provided an opportunity to review the status of sponsored research programmes by BRNS, AERB and SRI. Detailed proceedings of the Meet were documented and distributed to the delegates.

SRI and IARP of Kalpakkam Chapter (Indian Association for Radiation Protection) jointly organized the 26th IARP conference successfully during 5-7 March 2003 at Kalpakkam. The theme of conference is on

Discussion Meeting on Inter-institutional Collaborative Research
(From right) Professor M.S. Ananth, Director, IIT, Madras;
Prof. S.P. Sukhatme, Chairman, AERB, Shri S.B. Bhoje, Director, IGCAR; Dr. S.M. Lee, Director, SHINE Group, IGCAR and
Shri A.R. Sundarajan, Director, SRI.

Prof. S.P. Sukhatme, Inaugurates the SRI Guest House Building by lighting a lamp.

Radiation Exposure Control at Nuclear Fuel Cycle Facilities and Radiation Installations. About 150

professionals attended the conference shared the rich experience gained over more than 3 decades operating nuclear fuel cycle facilities.

7.3.5 Establishment of Computer Code Depository at SRI

The following codes are available in the computer code depository of SRI.

1. **MCNP** (General Purpose Monte Carlo Program for Radiation Transport)
2. **KENO** (Monte Carlo Program for Estimation of Neutron Multiplication Factor of System Containing Fissile Materials)
3. **ASFIT** (Gamma Ray Transport Code for 1-D Systems)
4. **ORIGEN** (Fission Product Inventory Calculation Code)
5. **QAD-CGGP** (A Point Kernel code for Shielding Calculations)
6. **SAND-II** (A code for Neutron Spectrum Analysis of Activation Detectors)
7. **GUI2QAD-3D** (A Graphical User Interface in Tandem with QAD-CGGP Program)
8. **VIEW-CXS** (Neutron and Gamma Cross Section Plotting Program)

Training on MCNP on request for a week or two provided to several personnel of DAE by SRI officers of Radiation Safety group.

7.3.6 Publications in Journals / Conference Proceedings

1. "Monte Carlo Modeling of beam flattening filters of Medical Accelerators", C. Sunil Sunny and K.V. Subbaiah, Contributed to the Symposium on Measurement and Computational Techniques in Radiation Physics and Safety, Dept. of Physics, Visva-Bharati University, Santiniketan organised by ISRP, Kolkata Chapter during February 10-12, 2002.
2. "Mobile Shield Design for the West Beam Port of the KAMINI Reactor", K.V. Subbaiah & C. Sunil Sunny, First Asian and Oceanic Congress for Radiation Protection (AOCRP-1) on Radiation Protection Toward the New Horizon, Seoul, Korea, October 20-24, 2002.
3. "Simulation of Electron Linear Accelerator Head for 6MV Photon Beam Dose Calculations in Water Phantom Using Monte Carlo Methods", C. Sunil Sunny, L.V. Narayana and K.V.Subbaiah; Synopsis for 23rd Annual Conference on Medical Physics & Radiation Safety, AMPICON-2K2, SMS Medical College & Hospital, Jaipur, Rajasthan, India, 15-17, November, 2002. Journal of Medical Physics, Vol. 27, No.3 July – September, 2002.
4. "GUI2QAD-3D A Graphical User Interface for QAD-CGPIC Program", K.V. Subbaiah and R.Sarangapani, First Asian and Oceanic Congress for Radiation Protection (AOCRP-1) on Radiation Protection Toward the New Horizon, Seoul, Korea, October 20-24, 2002.
5. "Environmental Impact Assessment of a Nuclear Power Plant – A case study of Kalpakkam Site," P.Sasidhar, A.R. Sundararajan, S.K. Pathan and Ajai, Proceedings of International Symposium on Resource and Environmental Monitoring, Hyderabad, pp. 22-26, December 3-7, 2002.
6. "Ion-exchange behaviour of Uranium Antimonate", Sivaiah, Sivakumar, Sasidhar, et. al. in the Proceedings of National Symposium on Nuclear and Radiation Chemistry (NUCAR 2003), Mumbai, India, pp. 279-280 (2003).
7. "Sorption of Strontium on Zirconium Molybdate Tungstate", Sivaiah, Sivakumar, Sasidhar, et. al. in the National Symposium on Nuclear and Radiation Chemistry (NUCAR 2003), Mumbai, India, pp. 289-290 (2003).
8. "Sub-Surface Investigations on Deep Saline Groundwater of Charnockite Rock Formation", C. Gurumoorthy, P. Sasidhar, V. Arumugham and R.K. Mathur, Kalpakkam, India. Accepted for publication in March 2003 in Environmental Monitoring and Assessment, Kluwer Academic Publishers, Netherlands.
9. "Experimental methodology to assess contaminant diffusion in rock mass", C.Gurumoorthy and D.N. Singh. Accepted for publication in

International Journal of Environmental Monitoring and Assessment, 2003.

10. "The power law character of offsite power failures", A. John Arul, C. Senthil Kumar, S. Marimuthu and Om Pal Singh, Accepted for publication in Annals of Nuclear Energy.

7.4 SAFETY PROFESSIONALS MEET

7.4.1 Annual DAE Safety & Occupational Health Professionals Meet

AERB, Kaiga Generating station and Kaiga Project 3&4 jointly held the 19th DAE Safety & Occupational Health Professionals Meet at Kaiga on November 27 - 29, 2002. The theme of the Meet was 'Construction and Contract Safety' and 'Chronic absenteeism'. Technical sessions on the second day of the meet covered industrial safety statistics, occupational health statistics, fatal accident case studies, job hazard analysis, etc.

Around 120 participants from various DAE units attended the meet. Chairman, AEC presented the AERB Fire Safety Award for the year 2001 to Madras Atomic Power Station 1&2 and the AERB Green Site Award for the year 2001 to Indian Rare Earths Ltd., OSCOM.

7.4.2 Fire Safety Professionals Meet

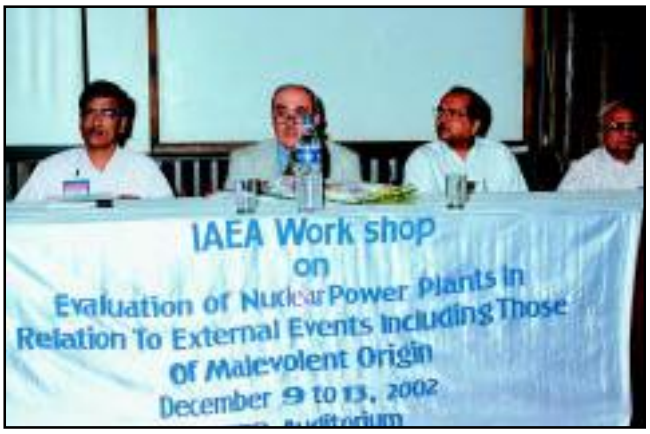
Fire Safety Professionals Meet at AERB

The Advisory Committee on Fire Safety organised a fire safety professionals meet for DAE units on December 23 - 24, 2002 in the AERB auditorium. Eighty four officials from various DAE units attended. Topics such as availability and utilisation of existing fire fighting facility, shortcomings in implementation of regulatory requirements and availability of new technology were discussed in this meet.AERB staff brought out the proceedings of the Meet.

7.5 WORKSHOPS

7.5.1 IAEA Workshop on "Evaluation of Nuclear Power Plants in Relation to External Events Including those of Malevolent Origin",

AERB organised an IAEA workshop on "Evaluation of Nuclear Power Plants in Relation to External Events Including those of Malevolent Origin", in Mumbai from December 9-13 2002 at AERB Auditorium. Delegates from AERB, BARC, NPCIL, IGCAR, NFC and HWB participated in the workshop.



IAEA Workshop on 'Evaluation of Nuclear Power Plants in Relation to External Events including those of Malevolent Origin' during December9-13, 2002 at AERB Auditorium

Dr. John D. Stevenson, USA, Dr. Thomas J. Katona, Hungary, and Dr. Aybars Guerpinar and Dr. Sok Chul Kim of IAEA delivered lectures. Dr. Ashok K. Ghosh, BARC, Dr. Prabir C. Basu, AERB and Shri Arun G. Chhatre, NPC were also in the faculty.

Lectures covered topics such as IAEA Safety Standard on External Events, evaluation of NPPs against extreme wind loads and floods, evaluation of NPPs against human induced events, US practice on protection of NPPs against malevolent acts, assessment of safety/security of NPPs, and seismic re-evaluation/upgrading of NPPs, etc. Indian experts delivered lectures on evaluation of NPPs in India against external events and seismic re-evaluation and upgrading of Indian NPPs.

7.5.2 Workshop on AERB Safety Code and Guides on Quality Assurance for Nuclear Power Plants

AERB organized a two day Workshop on the Safety Code and Guides on Quality Assurance for Nuclear Power

Plants at Niyamak Bhavan, Mumbai on July 25 and 26, 2002. The workshop was inaugurated by Professor S.P. Sukhatme, Chairman, AERB. Talks were delivered by senior officers from AERB, IGCAR, NPCIL and Consultants who have been actively involved in the preparation of these documents. This was followed by a panel discussion session. Officers from operating stations, projects, NPCIL headquarters and IGCAR participated in the workshop. Officers from Nuclear Training Centres/ Station Training Centres were specially invited to attend.

The workshop was well appreciated. It provided a forum for dissemination of the vast information contained in the documents. It also served as a means to emphasize the need for proper implementation. One complete set of published documents was given to each participant.

Workshop on AERB Code and Guides on Quality Assurance for Safety in Nuclear Power Plants. (From right – Shri R.S. Kumar, formerly Director (QA), NPCIL; Shri V.K. Sharma, Senior Executive Director, NPCIL; Prof. S.P. Sukhatme, Chairman, AERB; Shri G.R. Srinivasan, Vice Chairman, AERB; Shri S.K. Agarwal, Director, Safety Analysis and Documentation Division, AERB).

As a follow-up to the above Workshop, a similar workshop was conducted at Kaiga Generating Station. Officers from AERB delivered lectures in this workshop.

7.6 PARTICIPATION IN CONFERENCES/ WORKSHOPS/SEMINARS/TRAINING COURSES

1. Shri R. Bhattacharya attended a training programme on 'Management of Hazardous Chemicals' at Vadodara on March 5 - 6, 2003.

2. Shri G. Natrajan & Shri V.P. Gholap attended the 26th IARP Conference on Radiation Exposure Control at Nuclear Fuel Cycle Facilities and Radiation Installations' at Kalpakkam during March 5-7, 2003.

3. Smt. S. Bhattacharya the attended '10th National Conference on Health and Safety Challenges in the Era of Globalisation' organised by National Safety Council , New Delhi on April 9 -11, 2002.

4. Smt.S. Bhattacharya attended the training programme on 'Industrial Heat Stress and Heat Disorders, Its Evaluation and Management for Safety, Health and Productivity at Work' organised by Central Labour Institute, Mumbai on September 24-27, 2002

5. Shri A. Ramakrishna participated in the conference INSAC-2002 organized by the Indian Nuclear Society during October 9-11, 2002 at Mumbai.

6. Shri Ramakrishna A., Srivasista K., Hajra P., Agarwal S.K., Rao R.S., Solanki R.B. participated in the 1st National Conference on Nuclear Reactor Technology, held at Bhabha Atomic Research Centre, Trombay, during November 25-27, 2002.

7. Shri S.K. Dubey participated in the 47th Congress of the Indian Society of Theoretical and Applied Mechanics (ISTAM-2002) at IIT, Guwahati during December 23-26, 2002.

8. Shri R. P. Garg attended the 12th Symposium on Earthquake Engineering held at Indian Institute of Technology, Roorkee during December 16-18, 2002.

9. Shri A. D. Roshan attended the workshop on "*DAE Vision of Information Exchange (DAEVIE 2003)*" conducted by Computer & Informatics group, Variable Energy Cyclotron Center, Kolkata and Computer Division, BARC, at Variable Energy Cyclotron Centre, Kolkata during January 30-31, 2003.

7.7 PAPERS PUBLISHED / PRESENTED / INVITED TALKS

7.7.1 Papers Published

1. Ghosh P. K., "An approach to Intrinsically Safe Chemical Plants" in proceedings of seminar on "Safety, Health & Environment in Indian Chemical Industry" organised by Indian Institute of Chemical Engineers, Mumbai Regional Centre on January 1, 2003.

2. Bhattacharya R., "Job Hazard Analysis" in 19th Annual DAE Safety & Occupational Health Professionals Meet held at Kaiga on November 28, 2002.

3. R. B. Solanki, U. K. Paul, P. Hajra, S. K. Agarwal, 'Realistic Approach for Reliability Assessment of Computer Based Systems: An Overview', Proceedings of the 1st National Conference on Nuclear Reactor Technology, 25-27 November 2002, Bhabha Atomic Research Centre, Trombay.

4. R. B. Solanki, U. K. Paul, P. Hajra, S. K. Agarwal, 'Probabilistic Safety Assessment: Regulatory Perspective', Proceedings of the 1st National Conference on Nuclear Reactor Technology, 25-27 November 2002, Bhabha Atomic Research Centre, Trombay.

5. U. K. Paul, P. Hajra, S. K. Agarwal, 'Review of Accident Analysis of NPPs-Indian Regulatory Perspective', Proceedings of the 1st National Conference on Nuclear Reactor Technology, 25-27 November 2002, Bhabha Atomic Research Centre, Trombay.

6. R. Srinivasa Rao, B. Chatterjee, A. Srivastava, A. J. Gaikwad, H. G. Lele, P. Hajra, S. K. Gupta and V. Venkat Raj, 'Steamline Break Analysis for 1000 MWe Kudankulam Nuclear Power Plant', Proceedings of the 1st National Conference on Nuclear Reactor Technology, 25-27 November 2002, Bhabha Atomic Research Centre, Trombay.

7. B. Chatterjee, R. Srinivasa Rao, A. Srivastava, S. Kavimandan, A. J. Gaikwad, H. G. Lele, S. K. Gupta and V. Venkat Raj, 'Large Break Loss of Coolant Accident Analysis for Kudankulam NPPs', Proceedings of the 1st National Conference on Nuclear Reactor Technology, 25-27 November 2002, Bhabha Atomic Research Centre, Trombay.

8. Deepak De, 'Consenting Process of the Kudankulam Nuclear Power Project', Proceedings of the 1st National Conference on Reactor Technology, November 25-27, 2002, Mumbai.

9. Basu Prabir C., "Seismic Upgradation of Buildings: an Overview", Special Issue on Seismic Retrofitting, The Indian Concrete Journal, Vol.76, August 2002, No. 8

10. Basu Prabir C., "In-service Inspection of Concrete Structures of Nuclear Reactors", IAEA TCM, India

11. Basu Prabir C., "High Performance Concrete", National Seminar on Engineering Building Materials and their Performance, January 17-18, 2003, Indian National Academy of Engineering, Indian Institute of Technology Bombay, Mumbai, pp. 426-450

12. Gupchup Vijay N., Basu Prabir C., "Aseismic Design of Buildings and Structures of Nuclear Power Plants", National Seminar on Seismic Design of Nuclear Power Plants, 21-22 February 2003, pp. 475-490

7.7.2 Invited Talks

1. Parthasarathy K.S. " Enforcement of Provisions of Radiological Safety in the Medical Applications of Radiation", 23rd Annual Conference of the Association of Medical Physicists of India at Jaipur August 15-17, 2002.

2. Agarwal S. K. "AERB Guides for Safety in Operation of Nuclear Power Plants", Kaiga Generating Station-1&2 on August 28 and August 29,2002

3. Shah Y. K., "AERB Code and Guides for Safety in Operation of Nuclear Power Plants" Kaiga Generating Station-1&2 on August 28 and August 29,2002

4. Ghosh P.K " The Factories Act, 1948 and Atomic Energy (Factories) Rules -1996" at Kaiga on September 12, 2002.

5. Bhattacharya R., "Factories Act, 1948" at TAPS on September 5,2002 and "Safety Management" at KGS on September 12,2002.

6. Prasad J., "Competent Persons" at Tarapur Atomic Power Station (TAPS) 1 - 2 on 5th September 2002 and at Indira Gandhi Centre for Atomic Research (IGCAR) on September 17, 2002.

7. Ramprasad K., "The Factories Act, 1948 & Hazard Identification Techniques" at KAPS on October 22, 2002.

8. Ghosh P.K "Quantitative Risk Analysis" at NAPS

on November 30 & December 1, 2002.

9. Pande V.V "The Factories Act, 1948 at NAPS on November 30 & December 1, 2002.

10. Bhattacharya R., "Atomic Energy (Factories) Rules - 1996", "Role of Competent Persons on Pressure Plant" and "Handling of Hazardous Chemicals" at KAPS arranged for Competent Persons of all NPPs on January 15 –16, 2003.

11. Parthasarathy K.S. "Evolution and Implementation of Radiological and Nuclear Safety Provisions in India" Seminar on "Radioactivity and Ionizing Radiation" organised by the Centre for Human Resource Development Bangalore on February 23, 2003.

12. Ramakrishna A. "Regulatory Safety Aspects of Nuclear Power Programme" at a Public Awareness Seminar organised by DAE and Indian Institute of Chemical Engineers on 27th February,2003 at Cochin.

7.8 AERB COLLOQUIA:

AERB conducted two colloquia during 2002-2003. These covered various issues related to regulatory/scientific aspects in nuclear engineering. The details are as follows:

1. Selecting Target Reliabilities in Probability Based Design Dr. Baidurya Bhattacharya, University of Delaware, Newark, USA.

2. Proposed Seismic Design Provisions of 2004 National Building Code of Canada Prof. Jag Mohan Humar, Chancellor's Professor, Department of Civil & Environmental Engineering, Carleton University, Canada.

SECTION 8

PUBLIC INFORMATION / AWARENESS PROGRAMMES

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

8.1 PRESS RELEASES

The following press releases were issued:

1. Leakage at Tarapur Atomic Power Station (May 16, 2002)
2. AERB Issues Excavation Clearance for Prototype Fast Breeder Reactor (July 17, 2002)
3. Radioactive Source Missing in Transit (July 19, 2002)
4. AERB Rates Radiation Exposure Event at Level-2 (August 22, 2002)
5. Buy Only AERB Approved Medical X-ray Unit (September 20, 2002)
6. Safety Status of Indian Nuclear Power Plants (October 25, 2002)
7. Incident of Chemical Explosion at NFC (November 21, 2002)
8. Shri S.K. Sharma Appointed Vice Chairman, AERB (January 9, 2003)
9. AERB and Federal Nuclear and Radiation Safety Authority of Russia Sign Agreement (January 16, 2003)
10. Visit of USNRC Team to AERB (February 24, 2003)
11. AERB Industrial Safety Awards (March 20, 2003)

8.1.1 Leakage at Tarapur Atomic Power Station

A section of the press reported an incident of leakage of water from Unit-2 of Tarapur Atomic Power Station. This incident has no safety significance. There was no radioactive release into the environment. Three workers engaged in the repair and recovery work received radiation dose which exceeded the monthly limit by about 10%. But this is well within the annual dose limit.

AERB has provisionally rated the incident at Level 0 in the International Nuclear Events Scale. The International Nuclear Events Scale rates nuclear events on a scale of 1 to 7. Events with no safety significance are rated at Level-0.

The reactor was under re-fuelling shutdown. The leakage occurred on April 20, 2002. AERB had received and reviewed a detailed report on the incident. The leaked water was contained in the dry well and pumped back into the reactor.

8.1.2 AERB Issues Excavation Clearance for Prototype Fast Breeder Reactor

The Atomic Energy Regulatory Board has issued on July 13, 2002 excavation clearance for the 500 MWe Prototype Fast Breeder Reactor (PFBR) to be constructed at Indira Gandhi Centre for Atomic Research, Kalpakkam.

A nine-member Project Design Safety Committee and the Civil Engineering Safety Committee are assisting the Board in the safety review of the project. The Board had granted clearance to locate the PFBR at Kalpakkam on October 9, 2000.

8.1.3 Radioactive Source Missing in Transit

Radiographic Inspection Services, Kolkata has informed Atomic Energy Regulatory Board (AERB) that a gamma radiography camera (Amertest-660 Serial Number 5857) housing a radioactive source (Iridium-192 of strength19.7 Curies) was lost on July 17, 2002 while being transported from Lakhimpur to Digboi in Assam. A report has been lodged by the Company with the police and they have been requested to help in the search for the lost device on a priority basis.

The camera is a shielded container made of depleted uranium and weighs around 24 kg. It is a very sturdy equipment which cannot be easily tampered with and would not cause any significant hazard to persons so long as the source is inside the container. Depleted uranium is commonly used as a shielding material in radiography cameras. It also does not pose any radiological hazard.

A "Danger" warning sign along with radiation symbol is displayed on the device. AERB is coordinating with local authorities to locate the device containing the source.

8.1.4 AERB Rates Radiation Exposure Event at Level-2

The Atomic Energy Regulatory Board has rated an event in which a radiation worker was exposed above the regulatory limit at Level-2 in the International Nuclear Event Scale (INES) of the International Atomic Energy Agency. Levels at 1 to 3 are termed "incidents" and Levels at 4 to 7 are called "accidents".

The worker belonging to Quality Control and Inspection Section was performing radiography in the turbine auxiliary systems outside the reactor building of the Madras Atomic Power Station. He received a radiation exposure of 151 mSv when he was removing an exposed film and installing the new film. The annual dose limit for radiation workers prescribed by AERB is 30 mSv. Though the radiation exposure is unlikely to cause any significant harm to the individual, the worker has been taken out of radiation work as per the administrative procedure. AERB is viewing the incident seriously and investigations are under way.

A preliminary investigation has indicated that the exposure took place as the worker did not retract the source into the shielded remotely operable camera prior to replacing the film. The exposure occurred on July 24, 2002. It was noted later only after the processing of his personal dosimeter. The worker failed to use a direct reading survey meter which would have indicated the presence of radiation.

8.1.5 Buy Only AERB Approved Medical X-ray Unit

Among the man-made sources of ionizing radiation, diagnostic X-ray units are probably the most beneficial. An important step to improve radiological safety in X-ray installations is to use X-ray units, which have been type approved by the Atomic Energy Regulatory Board (AERB). Such units will have all the essential built-in-safety features.

Recently, AERB teams of scientists carrying out surprise inspections found that four companies located in four locations in the country are "manufacturing" X-ray units and selling them without getting their equipment type approved by AERB. AERB has already issued show cause notices to them. In one instance, AERB has suspended the marketing of its medical X-ray machines in the country.

Hospitals or individuals should buy only X-ray units which are "type approved" by AERB. The user should look for the type approval certificate in his own interest. Buying non-approved equipment may prove to be very expensive.

AERB has certified nearly 520 combinations of X-ray tubes, generators and couches made by 19 companies. The buyer should ensure that the equipment satisfies all the safety requirements prescribed by AERB. Displaying AERB type approval numbers on the X-ray unit is also a mandatory requirement.

Suppliers of imported X-ray equipment shall obtain a No Objection Certificate from AERB before marketing their equipment.

AERB may issue type approval / NOC only if the X-ray unit satisfies the safety specifications prescribed by AERB. Applications for these procedures are available at AERB web site (www.aerb.gov.in)

The manufacturers shall make available to the user detailed procedures for quality assurance tests, exposure charts, operating manuals and copies of AERB safety documents issued from time to time. According to the AERB Code the manufacturer/supplier should provide appropriate servicing and maintenance facilities during the useful lifetime of the X-ray machine.

Any person who employs radiation workers or who is self-employed as a radiation worker is ultimately responsible for ensuring radiation safety and availability of qualified personnel for operating X-ray equipment. The employer must provide personnel monitoring devices to the workers. The employer shall ensure that persons handling medical X-ray equipment abide by the provisions of AERB Safety Code.

The employer shall implement all safety measures stipulated by the Atomic Energy Regulatory Board. Texts of AERB Safety Code on Medical Diagnostic X-ray Equipment and Installations, Radiation Protection Rules and Radiation Surveillance Procedures for Medical Application of Radiation are available from AERB web site www.aerb.gov.in

8.1.6 Safety status of Indian Nuclear Power Plants

Recently, a section of the media quoted a report titled "Leaks at India's nuclear power plants: cause for concern" published in the Christian Science Monitor (October 11, 2002.). This report doesnot reflect the correct

safety status of nuclear power plants in India. It is biased and one sided and has used uncritically, a series of unsubstantiated statements of known and unnamed anti nuclear critics in India.

Over twenty months ago on February 20, 2001, while presiding over the inaugural session of the International Conference on Radiation Protection Dosimetry in Mumbai, Dr. S.P. Sukhatme, Chairman Atomic Energy Regulatory Board stated that the collective dose per GWe-Year to workers at the Kakrapar Atomic Power Station was over three times the best values in the world. Though the exposures are within the limits prescribed by AERB, he said that there is a clear need for reducing the exposures to workers.

Based on the reports on the conference, on July 6, 2002, the reporter of the Christian Science Monitor wanted to know the exact meaning of Dr. Sukhatme's statement. His other questions were whether there are some inherent design flaws in the Indian nuclear reactors and about the possible design improvements. Dr. Sukhatme sent the following response which is partly a running extract of the talk he gave at the Conference.

"Radiation exposures at nuclear power plants are subject to close scrutiny. Though the exposures are within the limits prescribed by Atomic Energy Regulatory Board, there is a clear need for reducing the exposure to workers. The collective dose in our power stations continues to be high. Rightly or wrongly, the collective dose per GWe-year produced is used as a bench mark parameter for international comparison. This parameter does have certain inherent limitations, which work against us because our reactors are of small size, all around 200 MW. Our best station in this respect is Kakrapar which has an average rate of about 7 Person-Sv per GWe-year. We will probably get better values at Kaiga. In contrast, the best values in the world are around 2 Person-Sv/GWe-year.

It is heartening to note that NPCIL has incorporated many design changes in the recent family of reactors to reduce radiation doses to workers and members of the public. Reducing the generation of Argon-41 is one of the important factors. Reducing the number of pumps in the primary heat transport system, improving the design of seals, and elimination of valves help to reduce leakage of heavy water which is the major source of airborne tritium which in turn leads to internal exposure of workers and also increased releases into the environment.

As you can see there are no design flaws in the PHWR design. However design improvements are possible and as mentioned, some have been implemented successfully."

Surprisingly, the reporter concluded that this "is a shocking admission that puts the rest of the country's nuclear power plants in grave perspective". We regret to note that he has been unduly influenced by anti nuclear critics in India and abroad.

The collective dose per unit electrical energy produced is one of the concepts used to compare reactors. It depends on the reactor size, age and type. If we examine the data over the past two decades, out of seven type of nuclear power reactors, a High Temperature Gas Cooled Reactor (HTGR) offered the lowest collective dose, whereas some Light Water-cooled Graphite moderated Reactors have clocked collective doses 80 times higher.

Even among the same type of reactors, significant variations in collective doses are found. For instance, even in Europe, the highest collective dose from a Boiling Water Reactor (BWR) in Netherland was 90 times higher than that in Finland.

The report incorrectly states that most of the fourteen Indian nuclear power reactors are modelled after Shippingfort reactor. Shippingport reactor was a Pressurised Water Reactor (PWR). Actually there is not even a single PWR in India. We have 12 Pressurized Heavy Water Reactors (PHWR) and two Boiling Water Reactors (BWR).

Apparently, the reporter is confused about safeguards and safety standards. His statement that three of the 14 reactors fall under International Atomic Energy Agency(IAEA) standards is incorrect. All reactors follow AERB safety standards which are on par with international safety standards.

Two reactors at Rajasthan (RAPS 1 & 2) and two reactors at Tarapur (TAPS 1 & 2) are under IAEA safeguards. That means the nuclear materials from these reactors are separately accounted for and verified regularly by IAEA inspectors. Safety and safeguards are different.

The reporter writes about the leaks in Indian nuclear power plants are of concern. There were instances of leaks in the nuclear power reactors. There are standard procedures to handle them. AERB analyses such incidents

and publishes their safety related details in the annual reports.

Radiation dose to workers in all nuclear power stations are well within the limits specified by AERB. Actually AERB stipulations on dose limits are in a way more conservative than those prescibed internationally. There is near total compliance with AERB stipulations by all nuclear power stations. For instance, during the year 2001, only 2 out of 13059 workers received doses above the limits.

The radioactive releases from nuclear power stations are closely monitored. They are also within the AERB limits.

AERB enforces international safety standards in all phases of the nuclear fuel cycle in India. Nuclear Power Corporation of India Limited (NPCIL) operates 14 reactors. Some of them, as in other countries, were built to earlier standards. The Board enforces the prescriptions of the International Atomic Energy Agency and ensures that appropriate safety upgradations are carried out by NPCIL.The Unit 1 of the Rajasthan Atomic Power Station is currently under shut down for upgradation as per the directive issued by AERB.

8.1.7 Incident of Chemical Explosion at NFC

On Sunday, the 17.11.2002 early morning around 0415 hrs, there was an incident of explosion in the thermo-syphon evaporator unit of Natural Uranium Oxide Fuel Plant (NUOFP) at Nuclear Fuel Complex (NFC) Hyderabad. There were no fatalities and no spread of radioactivity outside the plant premises, due to this incident.

Immediately following the notification of the incident by NFC authorities, Atomic Energy Regulatory Board sent a team of experts to NFC to make an on-the-spot assessment. A high level meeting convened in Mumbai on 20.11.2002, reviewed the situation with the expert team. Following detailed discussions, AERB has suspended the authorization for operation to the wet section of NUOFP, until further orders. AERB has also initiated a detailed inquiry into the incident.

8.1.8 Shri S.K. Sharma Appointed Vice Chairman, AERB

Shri S.K. Sharma has been appointed Vice Chairman and Member of the Atomic Energy Regulatory Board in place of Shri G.R. Srinivasan who superannuated on December 31, 2002. Prior to this he was the Director of the Reactor Group in BARC.

A graduate in chemical engineering from the Banaras Hindu University, Sharma has served BARC in different capacities from 1965 onwards. As Director, Reactor Group, he has been responsible for the overall supervision of the three research reactors Apsara, Cirus and Dhruva, at Trombay. He was also responsible for implementing three important plan projects. They are "Refurbishing of Cirus", "Critical facility for Advanced Heavy Water Reactor and 500 MWe Pressurised Heavy Water Reactors" and "Design modification and refurbishing of Apsara".

Shri Sharma has participated in the regulatory activities of AERB as Vice Chairman of the Safety Review Committee for Operating Plants and the Advisory Committee for Project Safety Review of Light Water Reactors. He has been a member of AERB Advisory Committee on Nuclear Safety. He has served IAEA as an expert in Tunisia, Korea and Egypt.

8.1.9 AERB and Federal Nuclear and Radiation Safety Authority of Russia Sign Agreement

Dr. S.P. Sukhatme, Chairman, Atomic Energy Regulatory Board and Dr. Yuri Vishnevskiy, Chairman, Federal Nuclear and Radiation Safety Authority of Russia have signed an agreement on January 15, 2003 for cooperation in the field of safety regulation in the peaceful uses of nuclear energy. The regulatory agencies have agreed to familiarize themselves with the practices followed by them to ensure the safety of nuclear power plant personnel and the public and protection of the environment against any possible harmful effects of radiation.

The agreement proceeded from the understanding reached between the erstwhile Union of Soviet Socialist Republics and the Republic of India on November 20, 1988 and the Supplement to the Inter-Governmental Agreement dated June 21, 1998 to set up two 1000 MWe Russian nuclear power reactors at Kudankulam in Tamil Nadu.

Mutual exchange of information and experience will cover regulatory documents used for the design and for all subsequent phases of the nuclear power project, methodology adopted to validate computer codes and comparison of results against international verification programmes and requirements for qualifications, training and licensing of power plant personnel. Method of

acceptance of design and its analysis with regard to seismic stability and environmental qualification, methodology of selection of materials for critical components, regulatory positions on other matters related to the safety of nuclear power plants are some of the other issues where AERB and the Russian regulatory authority will exchange information and experience.

The present agreement came into force from January 15, 2003 and is valid up to the beginning of regular operation of the nuclear power plant at Kudankulam.

8.1.10 Visit of USNRC Team to AERB

On invitation from Prof. S.P. Sukhatme, Chairman, Atomic Energy Regulatory Board (AERB), Dr Richard A. Meserve, Chairman, United States Nuclear Regulatory Commission (USNRC) visited AERB today. He was accompanied by a 15 member team. The officials from AERB and NRC discussed several safety-related topics of mutual interest. These included fire safety, emergency operating procedures, design issues, risk informed performance based regulatory procedures, licence renewal and periodic safety review.

8.1.11 AERB Industrial Safety Awards

Prof. A.K. De, former Chairman, Atomic Energy Regulatory Board (AERB) presented the AERB Industrial Safety Awards for 2002 to Narora Atomic Power Station and Heavy Water Plant Tuticorin in the category of nuclear power plants and heavy water plants and to Indian Rare Earths Ltd., Manavalakurichi in the category of other production units at a simple function held at AERB Auditorium on March 20, 2003.

On this occasion, Prof. S.P. Sukhatme, Chairman, AERB released a booklet entitled "Industrial Safety Statistics of the Department of Atomic Energy (DAE) Units for the year 2002". The booklet contains data to analyse and compare the injury statistics amongst different units of DAE and also those (collected from Labour Statistics Publications) among similar units outside DAE.

Safety status of DAE Units is found to be higher than that in comparable units outside DAE.

Lost time injuries (injury causing death or disablement for 48 hours or more) in all DAE Units under the jurisdiction of AERB were 143 in 2002 and have shown a decreasing trend over the years (243 in 1999, 211 in 2000 and 172 in 2001). Fall from height, fall of object and struck by object are the major reasons for the injuries. The Atomic Power Stations at Tarapur, Narora and Kaiga and Heavy Water Plants at Hazira and Tuticorin achieved the distinction of no injuries in 2002. Heavy Water Plant at Tuticorin clocked another distinction; it has the longest accident free period of 3681 days.

8.2 INTERVIEWS WITH PRESS

Dr. K.S. Parthasarathy, Secretary, AERB and Director, Information and Technical Services Division was interviewed by Newspapers and News Agencies. The interviews covered various safety related activities of AERB.

1. N-medicine units are violating safety norms, The Times of India April 25, 2002.
2. Leakage at Tarapur Atomic Power Station insignificant, PTI on May 16, 2002.
3. AERB warns against indiscriminate CT scan – The Deccan Herald on June 5, 2002.
4. Radioactive camera was found in a bus, The Indian Express, July 20, 2002.
5. Radioactive camera lost in transit, The Telegraph, July 18, 2002.
6. Radioactive camera missing in Assam, United News of India, July 17, 2002.
7. MAPS worker exposed to radiation is kept out of work site, Press Trust of India, August 22, 2002.
8. AERB to probe radiation exposure at Kalpakkam, The Hindu, August 20, 2002.
9. Atomic Board refutes media reports, The Hindu, October 26, 2002.
10. Safety standards high in nuclear plants – AERB, The Deccan Herald, October 26, 2002.
11. AERB denies reports terming India's n-reactors as unsafe, Press Trust of India, October 26, 2002.
12. Radiation dose to employees within limits – AERB, October 24, 2002.
13. AERB train customs officials to handle radioactive material, The Indian Express, November 16, 2002.

8.3 AERB NEWSLETTER

AERB published two newsletters:

i) Vol.14, Nos. 1-4 on October, 2002.

ii) Vol.15, Nos. 1-4 on January, 2003.

The publications covered the activities of the Board including authorisations issued and regulatory restrictions imposed on various installations. The newsletters also included articles on Probability Safety Analysis and Safety in the Transport of Radioactive Materials.

8.4 LECTURES ON ALL INDIA RADIO

Dr. K.S. Parthasarathy delivered a series of nine lectures on the activities of AERB on All India Radio Samvadita Channel Mumbai A .

The following topics were covered:

1. Nuclear and radiological safety in India (December 1, 2002 and December 8, 2002)
2. Medical X-rays : A note of caution (February 7, 2003)
3. Radiation processing of food (February 14, 2003)
4. Nuclear radiation, myths and the reality (February 21, 2003)
5. Medical physics in cancer treatment (February 28, 2003)
6. Why radiological safety? (March 7, 2003)
7. Safe uses of radiation in research applications (March 14, 2003)
8. Radiological safety in the medical applications of radiation (March 21, 2003)
9. Safe uses of radiation in industry (March 28, 2003)

8.5 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.

SECTION 9

INTERACTION WITH OTHER INSTITUTIONS

9.1 BUREAU OF INDIAN STANDARDS (BIS)

The Bureau of Indian Standards assigned Shri P.K. Ghosh, Director, Industrial Plants Safety Division, AERB the task of drafting a document on "Hazard Identification and Risk Assessment". The draft prepared by him is being reviewed by a Committee set up by BIS with Shri Ghosh as Convener and Smt. S. Bhattacharya from AERB as member along with members from the National Safety Council, Central Leather Research Institute, Indian Space Research Organization and Indian Institute of Technology.

9.2 IAEA COORDINATED RESEARCH PROJECT

Safety Significance of Near Field Earthquakes

The CRP aims at applying 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. The objectives are as follows:

a) Bench mark studies on near field effects

   i) To interpret the existing experimental data

   ii) To carry out computations of models of the objects used in the experimental background

   iii) To test the applicability of displacement based to assess nuclear facilities.

b) Concur on engineering practice

The purpose is to arrive at an appropriate and acceptable methodology to realistically account for the effects of near field earthquakes and their safety significance, on the basis of the results from the above benchmark studies.

The CRP is based on the specimens of CAMUS - I. The CAMUS experiment consists of shake table testing of lightly reinforced concrete walls. This three year project, started in 1996, was supported by Comissarit al Energic Atomique (CEA), Federation Nationale de Batiment (FNB), Plan Genie Civil, and Electricite de France (EDF). The test project was to ascertain that the reinforced concrete shear walls with limited reinforcement possess capacity to sustain seismic loading as per French seismic design code, which in turn would validate the design code. The project consisted of performing a series of seismic tests on two test specimens, which are models of reinforced concrete shear walls. The two specimens, each having a total mass of 35 tons are named as CAMUS I & II.

To achieve the objectives listed above, the scope of the CRP has been outlined in two steps. The first step carries out an interpretation of existing experimental data of CAMUS experiments so that the participants share the safety significance of the results of these experiments and also arrive at a common approach to the necessary evaluation of the engineering practice. For this purpose, the participants of CRP will be carrying out numerical experimentation of the CAMUS model using appropriate approach. In the second step, the participants are invited to carry out numerical simulation of the response of the CAMUS models to a set of seismic input motion representative of near field earthquakes and to examine the outputs of engineering methods on this examples.

SECTION 10

INTERNATIONAL ACTIVITIES

10.1 DEPUTATIONS ABROAD

Name of officer	Period of deputation	Venue	Purpose
Prof. S.P. Sukhatme	03.06.2002 to 05.06.2002	Austria	IAEA/Eleventh meeting of the Commission on Safety Standards
	14.09.2002 to 21.09.2002	Austria	IAEA General Conference and Special Programme on Safety for Senior Regulators
Shri S.K. Sharma	29.01.2003 to 31.01.2003	Paris	4th Session of Indo-French dialogue on Nuclear Safety
	03.02.2003 to 07.02.2003	Bangkok	IAEA/Regional Co-ordination seminar for Decision Makers for the Implementation of Radiation Protection & Regional Seminar for Senior Staff of Regulatory Agencies on Approaches for the Effective Regulation of Radiation Protection & Safety of Radiation Sources.
Dr. A. N. Nandakumar	09.07.2002 to 12.07.2002	Austria	Consultant meeting to Revise the Draft of the Safety Report on the Security of Radioactive Sources.
	01.10.2002 to 03.10.200	Austria	IAEA consultant to review a safety report on recommended measures to improve the security of radioactive sources
	03.02.2003 to 07.02.2003	Bangkok	IAEA/Regional Co-ordination seminar for Decision Makers for the Implementation of Radiation Protection & Regional Seminar for Senior Staff of Regulatory Agencies on Approaches for the effective Regulation of Radiation Protection & Safety of Radiation Sources.
	17.02.2003 to 21.02.2003	Austria	IAEA/Extra Ordinary meeting of Transport Safety Standards Committee (TRANSSC).
Shri S.K. Chande	15.04.2002 to 19.04.2002	Korea	IAEA/Management Workshop on Operational & Safety Issues with special focus on "Measures to Achieve Sustained Excellence in Safety & Overall Performance."
	01.07.2002 to 05.07.2002	Vietnam	IAEA Advisory Review Mission (Pilot) on Education and Training.
	28.10.2002 to 01.11.2002	Korea	IAEA Technical Meeting of the Senior Regulators of Countries Operating CANDU Type reactors
	11.03.2003 to 14.03.2003	Austria	IAEA/Technical Meeting on "Evaluation Effectiveness of Operational Safety Services (OSART, PROSPER and Safety Culture) and their Future Evolution".

Name of officer	Period of deputation	Venue	Purpose
Shri Ajay Pisharady	12.05.2002 to 26.05.2002	Russia	Visit of AERB team to Russian Federation in relation with issues raised during Kudankulam Project Review & Visit to VVER Plant.
	17.03.2003 to 22.03.2003	Hungary	IAEA Training Programme for Indian Engineers on Seismic Re-evaluation of Existing Nuclear Power Plants.
Dr. P. C. Basu	12.05.2002 to 26.05.2002	Russia	Visit of AERB team to Russian Federation in relation with issues raised during Kudankullam Project Review & Visit to VVER Plant.
	13.10. 2002 to 18.10.2002	Turkey	First Research Co-ordination Meeting (RCM) of IAEA & visit to the Kandilli Observatory Earthquake Research Institute.
	16.03.2003 to 26.03.2003	Hungary	IAEA training programme for Indian Engineers on "Seismic Re-evaluation of existing Nuclear Power Plants"
Shri A.D. Roshan	12.05.2002 to 26.05.2002	Russia	Visit of AERB team to Russian Federation in relation with issues raised during Kudankullam Project Review & Visit to VVER Plant.
	17.03.2003 to 22.03.2003	Hungary	IAEA Training Programme for Indian Engineers on Seismic Re-evaluation of Existing Nuclear Power Plants.
Shri G.R. Srinivasan	14.05.2002 to 17.05.2002	France	IAES/NEA meeting to Exchange information of reactor events in Nuclear Power Plants & Technical Committee Annual Meeting of Incident Report System National Co-ordinators.
	03.07.2002 to 05.07.2002	Hungary	Co-ordination forum for WWER Regulators.
	28.10.2002 to 01.11.2002	Korea	IAEA Technical Meeting of Senior Regulators of Countries Operating CANDU Type Reactors.
Shri L.R. Bishnoi	12.05.2002 to 26.05.2002	Russia	Visit of AERB team to Russian Federation in relation with issues raised during Kudankulam Project Review & Visit to VVER Plant.
	17.03.2003 to 22.03.2003	Hungary	IAEA training programme for Indian Engineers on " Seismic Re-evaluation of existing Nuclear Power Plants
Smt. P. Shylamoni	12.05.2002 to 26.05.2002	Russia	Visit of AERB team to Russian Federation in relation with issues raised during Kudankulam Project Review & Visit to VVER Plant.
Shri S.A.H. Ashraf	24.06.2002 to 26.06.2002	Austria	IAEA Technical Meeting on "Enhancing NPP Safety Performance & Life extension through Effective Ageing Management

Name of officer	Period of deputation	Venue	Purpose
Shri K.D. Pushpangadan	24.06.2002 to 05.07.2002	Indonesia	IAEA Regional Training Course for Regulatory Organization and Implementation of National Regulatory Programme for the Control of Radiation Sources.
Shri George Thomas	05.08.2002 to 16.08.2002	Indonesia	Regional Training Course on Radiation Protection of Aspects of radioactive Waste Management
Shri Arun Kumar	08.09.2002 to 13.09.2002	Austria	International Conference on Physical Protection on "Strengthening Global Practices for Protecting Nuclear Materials"
Dr.K.V. Subbaiah	20.10.,2002 to 24.10.2002	Korea	First Asian Oceanic Conference for Radiation Protection
Shri K.K. Chandrakar	20.11.2002 to 22.11.2002	Austria	IAEA TM to Assess the Safety Implications to External Storage of Radioactive Waste
Shri R. Venkataraman	28.10.2002 to 01.11.2002	China	IAEA Technical Meeting on "Exchange of Operational Safety Experience to Pressurised Heavy Water Reactors"
Shri Deepak De	22.09.2002 to 02.10.2002	Iran	IAEA Mission projcet on No.IRA/9/015
Shri S.N. Rao	14.10.2002 to 18.10.2002	China	IAEA Workshop on Strengthening Management of Plant Operational Safety through Self Assessment of Operational Performance
Shri A.R. Sundararajan	25.11.2002 to 29.11.2002	Austria	IAEA 1st Steering Committee to Advise on the Development & Maintenance of its Educational and Training Programme in Radiation Protection & Waste Safety.
Shri Utkarsh Chikkanagoudar	01.09.2002 to 31.08.2003	Sweden	Undergoing Graduate Study at Royal Institute of Technology
Dr.P. Sasidhar	11.11.2002 to 15.11.2002	Austria	1st Research Co-ordination Meeting of IAEA CRP on Applications of Safety Assessment Methodologies for Radiation Waste Disposal Facilities (ASAM)
Shri Fredric Lall	04.12.2002 to 18.12.2002	China	IAEA Regional Training Course on Physical Protection of Nuclear Facilities & Materials
Shri S.P. Agarwal	22.07.2002 to 26.07.2002	Austria	IAEA TCM on National Strategies for Detecting and Locating Orphan Sources.
	11.11.2002 to 15.11.2002	Japan	IAEA Regional Workshop on the Safety of Radiation Sources and Security of Radioactive Materials.
Shri Sachin Tripathi	17.03.2003 to 22.03.2003	Hungary	IAEA training programme for Indian Engineers on "Seismic Re-evaluation of Existing Nuclear Power Plants"
Shri Jaganath Mishra	17.03.2003 to 22.03.2003	Hungary	IAEA training programme for Indian Engineers on Seismic Re-evaluation of Existing Nuclear Power Plants

10.2 VISIT OF OFFICIALS FROM THE REGULATORY AUTHORITY OF THE RUSSIAN FEDERATION

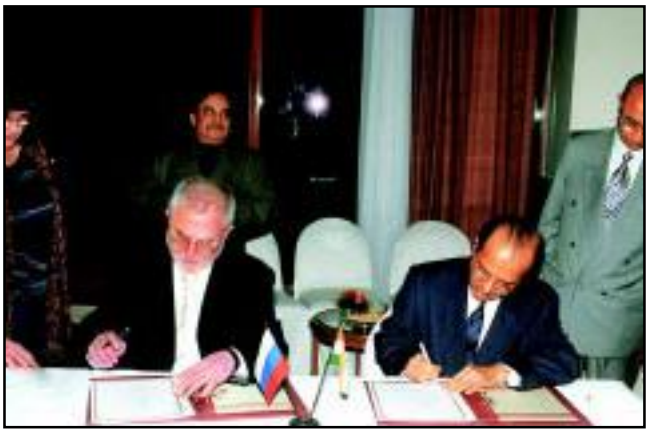
A team led by Dr. Yuri G. Vishnevskiy, Chairman, GAN visited India during January 13-19, 2003. During the visit, an Agreement on "Co-operation in the Field of Safety Regulation of Nuclear Energy Use for Peaceful Purposes" was signed between the Russian Regulatory Authority (GAN) and Atomic Energy Regulatory Board. The Agreement was necessary to understand the Russian Regulatory Authority's approach towards licensing as the design is based on the Russian documents approved by the Russian Regulatory Authority (GAN).

Further technical exchange and co-operation will also be carried out through the Foreign Trade Organisation Safety Ltd., which is a sister concern and the Nuclear Projects Safety Division of AERB.

Mutual exchange of information and experience will cover regulatory documents used for the design and for all subsequent phases of the nuclear power project, methodology adopted to validate computer codes and comparison of the results against international verification programme and requirements for qualifications, training and licensing of the power plant personnel. Method of acceptance of design and its analysis with regard to seismic stability and environmental qualification, methodology of selection of materials for critical components, regulatory positions on other matters related to the safety of nuclear power plants eg. Validation of computer codes, training, qualification and licensing of plant personnel, etc. are some of the other issues where AERB and the Russian Regulatory Authority will exchange information and experience.

10.3 VISIT OF A TEAM FROM THE UNITED STATES NUCLEAR REGULATORY COMMISSION

On invitation from the Chairman, AERB, Dr Richard Meserve, Chairman, United States Nuclear Regulatory Commission accompanied by a team of 15 officials visited AERB on February 24 and 25 2003. The officials from AERB and US NRC carried out discussions on various safety related topics of mutual interest, which had been identified in advance. These included fire safety, emergency operating procedures, design issues, risk-informed performance based regulatory procedures, licence renewal and periodic safety review. Further discussions and meetings are planned.



Dr. Yuri Vishnevskiy, Chairman, GAN and Prof. S.P. Sukhatme, Chairman, AERB signing the agreement on co-operation in the field of safety regulation of nuclear energy use for peaceful purposes in respect of Kudankulam reactors.

Prof. S.P. Sukhatme, Chairman, AERB receives Dr. Richard Meserve , Chairman, United States Nuclear Regulatory Commission.

SECTION 11

HUMAN RESOURCE DEVELOPMENT

11.1 AERB TRAINING PROGRAMME

The Training programme for AERB staff which was started in October, 2001, continued satisfactorily during the year 2002-2003. The programme is held on every Monday. The faculty is drawn from experts available on specific topics from AERB, BARC, NPCIL and Consultants. An examination is conducted at the conclusion of each module.

The cumulative number of training modules completed, during the year 2002-2003 and cumulative as on 31st March, 2003, in the areas of Basic Safety, Radiological Safety, Industrial Safety and Civil & Structural Engineering Safety are as follows:

Table-10
Number of Training Modules Completed during 2002-2003

S.N.	Modules	Nos. Completed during 2002-2003	Cumulative
1	Basic Safety	11	16
2	Radiological Safety	07	12
3	Industrial Safety	07	12
4	Civil & Structural Engineering Safety	05	10
	TOTAL	**30**	**50**

The training programme continued to generate enthusiasm and interest among officers and staff of AERB, at the same time, contributing to the enhancement of their knowledge, skills and functional competencies. This is a part of Quality Management System and leads to increased regulatory effectiveness.

11.2 TRAINING WORKSHOP

Seismic re-evaluation of existing NPPs, March 17 – 22, 2003. PAKS, Hungary

AERB arranged an advanced workshop on "Seismic Re-evaluation of Existing Nuclear Power Plants" with the help of IAEA. This was held at PAKS NPP, Hungary during March 17 – 22, 2003. Sixteen participants from Atomic Energy Regulatory Board, Bhabha Atomic Research Centre, Nuclear Power Corporation of India Ltd., Heavy Water Board and Indira Gandhi Centre for Atomic Research participated in the workshop. The programme was coordinated by Dr. Prabir C. Basu of Civil & Structural Engineering Division of AERB.

The training workshop consisted of lectures on overall seismic evaluation progrmme for existing NPPs, methodologies and practical approaches to seismic evaluation, preparation of list of structures, systems and equipment for seismic evaluation, seismic walk down procedures, use of caveats in mechanical and electrical equipment qualification, seismic PSA, seismic evaluation of buried structures and practical walk down exercises through PAKS NPP which has undergone extensive seismic re-evaluation and up-gradation.

The faculty included Mr. J.D. Stevenson, R. Masopust, O. Coman, V.V. Kostarev and A. Berkovski of Stevenson and Associates, A. Guerpinar and P. Contri of IAEA, T.J. Katona of NPP, PAKS, Hungary and L. Toth of Georisk Earthquake Research Institute, Hungary.

11.3 PARTICIPATION IN TRAINING PROGRAMME

Prof. S.P. Sukhatme delivered a set of 8 lectures to trainees of the BARC Training School in the subject, 'Heat Transfer and Fluid Mechanics' in April 2002. The topics covered were Heat transfer during Boiling and Condensation. Hazard Identification & Risk Assessment module for trainees at NFC-HWP training school for trainees was conducted by IPSD. Fifteen lectures were delivered by Shri P.K. Ghosh, Shri J. Prasad, Shri R. Bhattacharya and Smt S. Bhattacharya. Shri P.K. Ghosh was the course co-ordinator for this programme.

SECTION 12
SAFETY PROMOTIONAL ACTIVITIES IN DAE

12.1 INDUSTRIAL SAFETY AWARDS

The Industrial Safety Awards Presentation function was held on March 20, 2003 in AERB auditorium. Narora Atomic Power Station & Heavy Water Plant, Tuticorin won the award amongst operating units while Indian Rare Earths Ltd., Manavalakurichi Plant won the award amongst production units for the year 2002. Prof A. K. De, former Chairman, AERB was the Chief Guest and presented the safety shields to the winners.

12.2 INDUSTRIAL SAFETY STATISTICS OF DAE UNITS FOR THE YEAR 2002

The data related to injuries sent by various DAE units to AERB were compiled and a document entitled "Industrial Safety Statistics of DAE Units for the year 2002" was released on 20th March, 2003 during the Industrial Safety Awards presentation function.

This document contains safety statistics of DAE 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 2002 are also included. Comparison of injuries and man-days lost were made with respect to agency involved in injury, type of accident causing the injury, unsafe act causing injury, unsafe condition leading to injury, nature of injury and the location of the part of the body injured. Frequency rates (number of lost time injuries per million man hours wasted) and incidence rates (number of lost time injuries per thousand persons employed) in DAE units in comparison with those in industries outside DAE units are given in Fig. 4 & 5.

12.3 OTHER ACTIVITIES

12.3.1 Advisory Committee on Fire Safety

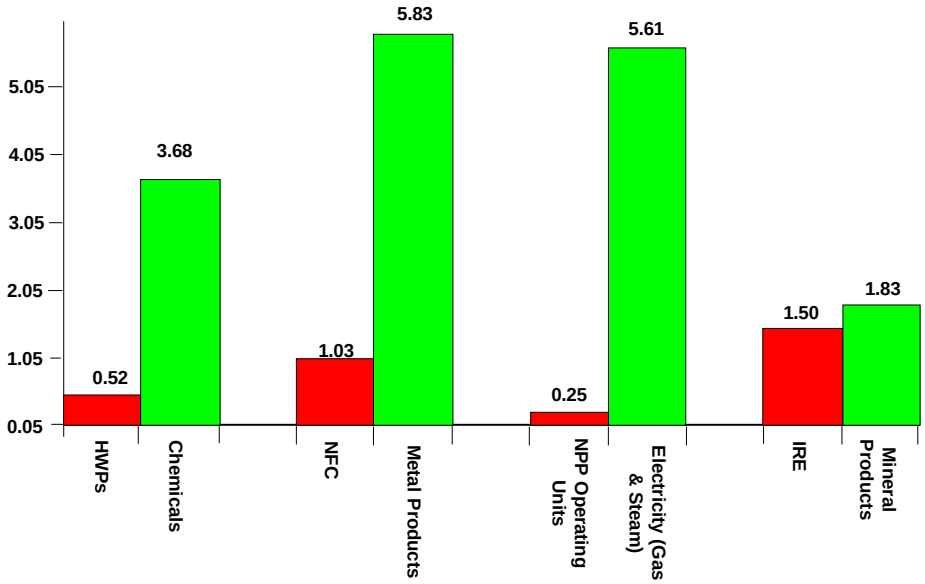
The following were some of the activities of the Advisory Committee on Fire Safety during the year :

- The Committee reviewed and cleared the proposal to upgrade the fire protection system at Madras Atomic Power Station with some stipulations.
- The Committee provided the necessary input to prepare a conceptual report to upgrade the fire protection system at the Centre for Advanced Technology at Indore.

Prof. S.P. Sukhatme, Chairman, AERB releases Industrial Safety Statistics of DAE Units for the year 2002.

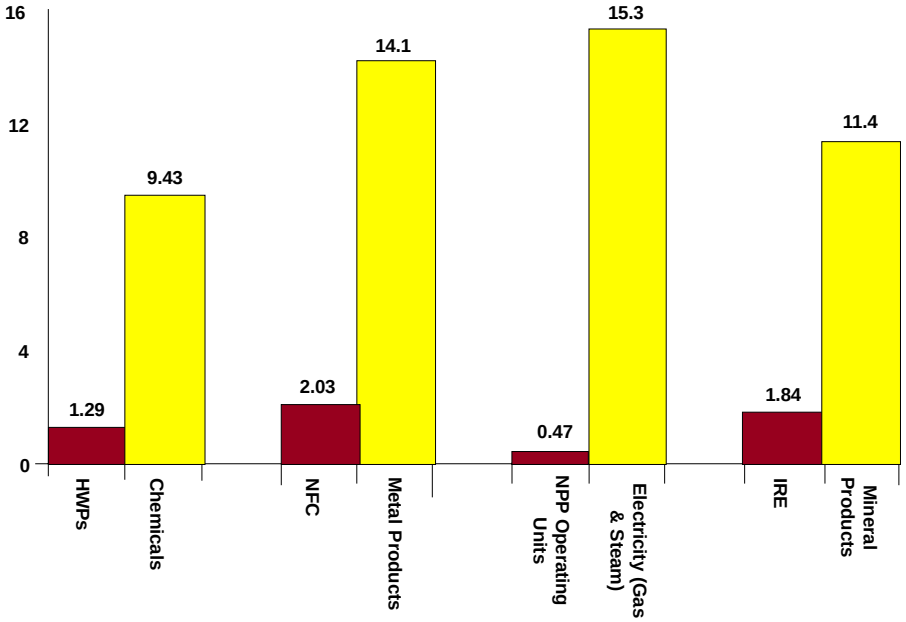
Prof. A.K. De, Former Chairman, AERB addressing the gathering at the Industrial Safety Awards Function.

Fig. 4 Comparison of Frequency rate of DAE Units with those of other Industries



Note : The data of DAE units for the year 2002 is compared with other Non –DAE Industries for the year 1996 based on data from Pocket Book of Labour Statistics 1999, published by Ministry of Labour, Government of India. The data for Non –DAE Industries for the year 1996 was the only data available when this figure was prepared.

Fig. 5 Comparison of incidence rate of DAE Units with those of other industries



Note: The data of DAE units for the year 2002 is compared with other Non – DAE Industries for the Year 1996 based on data from Pocket Book of Labour Statistics 1999, published by Ministry of Labour, Government of India. The data for Non –DAE Industries for the year 1996 was the only data available when this figure was prepared.

SECTION 13

OFFICIAL LANGUAGE IMPLEMENTATION

AERB staff celebrated Hindi Week from September 13 to September 19, 2002. During Hindi Week, various Hindi competitions were organized. These included Hindi Typing, Essay Writing, Elocution, Debate, To-day's Words, Noting & Drafting and Quiz competitions. On September 17, 2002, an Official Language Talk (Rajbhasha Varta) was arranged at AERB auditorium, jointly by AERB, DCSEM, DPS, and HWB located at Anushaktinagar, Mumbai. About 150 persons attended the programme.

Staff from AERB also participated and won prizes in the Hindi competitions organized on September 23 and 24, 2002, jointly by AERB, HWB, DPS, DCSEM, BRIT located at Anushaktinagar, Mumbai.

A Workshop in Hindi on "Scientific Writing" was organized from June 12 to June 14, 2002 at AERB auditorium, with assistance from Commission for Scientific and Technical Terminology, Ministry of Human Resource Development, Government of India, New Delhi. The workshop was organized jointly by the five DAE Units located at Anushaktinagar, Mumbai. On this occasion, the Commission for Scientific and Technical Terminology had also put up an exhibition at AERB, displaying Hindi books and periodicals. The workshop was well appreciated.

Three Hindi Workshops were organized by the Official Language Implementation Joint Co-ordination Committee of Anushaktinagar based five DAE Units. Officers and employees from AERB participated in these workshops. One employee participated in Hindi Computer Workshop organized at National Information Centre, Bhopal.

The Incentive Schemes of DAE for promoting the use of Hindi in official work are implemented in AERB and one employee was awarded cash prize under these schemes.

Concluding session of the workshop in Hindi on 'Scientific Writing' during June12-14, 2002 at AERB Auditorium.

AERB celebrates Hindi Week.

Official Language Talk (Rajbhasha Warta) at AERB Auditorium on September 17, 2002.

SECTION 14
AERB PERSONNEL

Sl.No	Name	Designation/Grade
1	Sukhatme S.P. (Prof.)	Chairman
2	Sharma S.K.	Vice Chairman
3	Parthasarathy K.S (Dr.)	Scientific Officer (H)
4	Agarwal S.K.	"
5	Chande S.K.	"
6	Basu P.C. (Dr.)	"
7	Deepak De	"
8	Ghosh P.K.	"
9	Dave D.K.	"
10	Warrier S.K.	"
11	Hajra P.	"
12	Venkataraman R.	"
13	Chandrakar K.K.	Scientific Officer (G)
14	Sukeshwala S.A.	"
15	Nandakumar A.N. (Dr.)	"
16	Chugha R.K.	"
17	Pande V.V.	"
18	Prasad J.	"
19	Ramakrishna A.	"
20	Rao S.N.	"
21	Agarwal S.P.	"
22	Bhattacharya R.	"
23	Fedric Lall	"
24	Krishnamurthy P.R.	"
25	Chauhan B.S.	"
26	Shah Y.K.	"
27	Srivasista K.	"
28	Singh R.P.	Scientific Officer (F)
29	Subbiah K.V.	"
30	Bhattacharya S. (Smt.)	"
31	Kanta Chokra (Smt.)	"
32	Ashraf S.A.H.	"
33	Bishnoi L.R.	"
34	Khan S.A.	"
35	Shirva V.K.	"
36	Swamy S.T.	"
37	Raghavendran C.P.	"
38	Ramprasad K.	"
39	Sasidhar P. (Dr.)	"
40	Paul U.K.	"
41	Janakiraman G.	Scientific Officer (E)
42	George Thomas	"
43	Arun Kumar	"
44	Nagalakshmi B (Smt.)	"
45	Harikumar S.	"
46	Nehru R.M.	"
47	Sonawane A.U.	"
48	Deepak Ojha	"
49	Koley J.	"
50	Pushpangadan K.D.	"
51	Gupta R.P.	"
52	Upadhyay K.C.	"
53	Natarajan G.	"
54	Dash Sharma P.K.	"
55	Senthil Kumar	"
56	Asokan Pillai N.G.	"
57	Parmar R.U.	"
58	Mahale L.B.	"
59	Raut V.V.	"
60	Kulkarni H.K.	"
61	Bhave S.R.	Scientific Officer (D)
62	Titto E.R.	"
63	Shylamoni P. (Smt.)	"
64	Iyer V.S.	"
65	Jena J.P.	"
66	Roshan A.D.	"
67	Singh R.K.	"
68	Vijayan P.(Dr.)	"
69	Valivetti L.N.	"
70	Rao R.S.	"

Sl.No	Name	Designation/Grade
71	Solanki R.B.	"
72	Chikkanagaudar S.C.	"
73	Bhattacharya D.	"
74	Suneet K.	"
75	Vivek	"
76	Virdhi P.S.	"
77	Pisharady A.S.	"
78	Gurumurthy	Scientific Officer (C)
79	Anuradha Vangala (Smt.)	"
80	Dubey S.K.	"
81	Pradhan S.K.	"
82	Tripathi S.K.	"
83	Mahendra Prasad	"
84	Inamdar M.V. (Smt.)	"
85	Sunil Sunny C.	"
86	Mishra J.	"
87	Amit Sen	"
88	Pimple D.V.	"
89	Gholap V.P.	Scientific Officer (SB)
90	Singh B.K.	"
91	Ingavale B (Smt.)	"
92	Vadivala R.N. (Smt.)	Scientific Assistant (E)
93	Kodolkar S.M.	Scientific Assistant (D)
94	Sivaraman G.	"
95	Chodankar N.M.	"
96	Rane D.M.	"
97	Dhotre V.R.	"
98	Kavi Upreti	Scientific Assistant (C)
99	Soumya George (Kum.)	Scientific Assistant(B)
100	Bapat A.P.	Tradesman (F)
101	Bhoite S.S.	Chargehand
102	Salgaonkar R.D.	Tradesman (D)
103	Kajania B.D.	Tradesman (B)
104	Puran Singh	"
105	Nair N.S.	Administrative Officer
106	Sarojini L. (Smt.)	Principal Pvt. Secretary.
107	Elsie T.M.(Smt.)	Dy. Controller of A/c
108	Samuel P.(Smt.)	Accounts Officer
109	Palamattam R.J.	Senior Pvt. Secretary
110	Vijayan C.K.	Asstt. Personnel Officer
111	Kuriakose V.P.	"
112	Nair S.M.(Smt.)	Asstt. Accounts Officer
113	Narsingh Ram	Assistant Director(OL)
114	Sumambika Panicker(Smt.)	Assistant
115	P. Chandrasekhar (Smt.)	Stenographer I
116	Sheela K. Menon (Smt.)	"
117	Mallika Nair (Smt.)	Stenographer II
118	Narayanan P.	"
119	Radha Raghavan (Smt.)	"
120	Latha Mohandas (Smt.)	"
121	Javed Jafri	Assistant Accountant
122	Shukla M.K.	Jr. Hindi Translator
123	Neena J. (Smt.)	Stenographer III
124	Shelar P.A. (Smt.)	Upper Division Clerk
125	Prakash K.V.	"
126	P. Harinarayanan(Smt.)	"
127	Koli R.R.	Lower Division Clerk
128	More J.K.	"
129	Shettigar S.M. (Smt.)	"
130	Vaibhavi A. Naik	"
131	Naktode J.S.	Hindi Typist
132	Randhe V.R.	Driver(OG)

ABBREVIATIONS USED

ACCGORN	:	Advisory Committee on Preparation of Code and Guides on Governmental Organization for Regulation of Nuclear and Radiation Facilities
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
AMD	:	Atomic Minerals Division
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 Reactor 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 (of International Atomic Energy Agency)
ISI	:	In-Service Inspection
KAMINI	:	Kalpakkam Mini Reactor
KAPS	:	Kakrapar Atomic Power Station
KGS	:	Kaiga Generating Station
KK-NPP	:	Kudankulam Nuclear Power Project
MAPS	:	Madras Atomic Power Station
MOU	:	Memorandum of Understanding
LMC	:	Lead Mini Cell
NAPS	:	Narora Atomic Power Station
NFC	:	Nuclear Fuel Complex
NOC	:	No-Objection Certificate
NPCIL	:	Nuclear Power Corporation of India Limited
NPP	:	Nuclear Power Plant
NUOFP	:	New Uranium Oxide Fabrication Plant
OPSD	:	Operating Plants Safety Division
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	:	Rajastan Atomic Power Project Cobalt Facility
RAPS	:	Rajasthan Atomic Power Station
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
SER	:	Significant Event Reports
SFSB	:	Spent Fuel Storage Bay
SGTF	:	Steam Generator Test Facility
SRI	:	Safety Research Institute
SSSF	:	Solid Storage Surveillance Facility
TAPP	:	Tarapur Atomic Power Project
TAPS	:	Tarapur Atomic Power Station
Type B(U)	:	Type B (Unilateral)
UCIL	:	Uranium Corporation of India Limited
VECC	:	Variable Energy Cyclotron Centre
VVER	:	Water Water Energy Reactor
USNRC	:	United States Nuclear Regulatory Commission
WIP	:	Waste Immobilisation Plant
ZSP	:	Zirconium Sponge Plant

Edited and published by Dr. K.S. Parthasarathy, Secretary, Atomic Energy Regulatory Board, Government of India, Niyamak Bhavan, Mumbai-400 094 website: www.aerb.gov.in
Printed at New Jack Printing Works Pvt. Ltd.