Annual Report
2001-2002

ATOMIC ENERGY
REGULATORY BOARD
MUMBAI

GOVERNMENT OF INDIA

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 nine 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

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NIYAMAK BHAVAN

MUMBAI 400 094

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 and radiation facilities under design, construction and operation;
- Issuing authorisations for construction, commissioning and operation of nuclear 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, 2001 to September 25, 2001)

1. Prof. S. P. Sukhatme … Chairman

2. Shri. G.R. Srinivasan … Ex-officio Member
Vice Chairman, AERB
Chairman, Safety Review Committee for
Operating Plants (SARCOP).

3. Dr. R.D. Lele … Member
Consultant Physician and Formerly Director of Nuclear Medicine,
Jaslok Hospital & Research Centre, Mumbai.

4. Dr. S. S. Ramaswamy … Member
Formerly Director General,
Factory Advice Service & Labour Institutes, Mumbai.

5. Prof. J.B. Joshi, … Member
Professor and Director,
University Institute of Chemical Technology (UICT)
University of Mumbai, Mumbai.

6. Dr. K.S. Parthasarathy … Secretary
Head, Information and Technical Services Division, AERB

COMPOSITION OF THE BOARD
(From September 25, 2001)

1. Prof. S. P. Sukhatme … Chairman

2. Shri. G.R. Srinivasan … Ex-officio Member
Vice Chairman, AERB
Chairman, Safety Review Committee for Operating Plants (SARCOP).

3. Dr. M.V.S. Valiathan, … Member
Honorary Advisor,
Manipal Academy of Higher Education,
Madhav Nagar, Manipal.

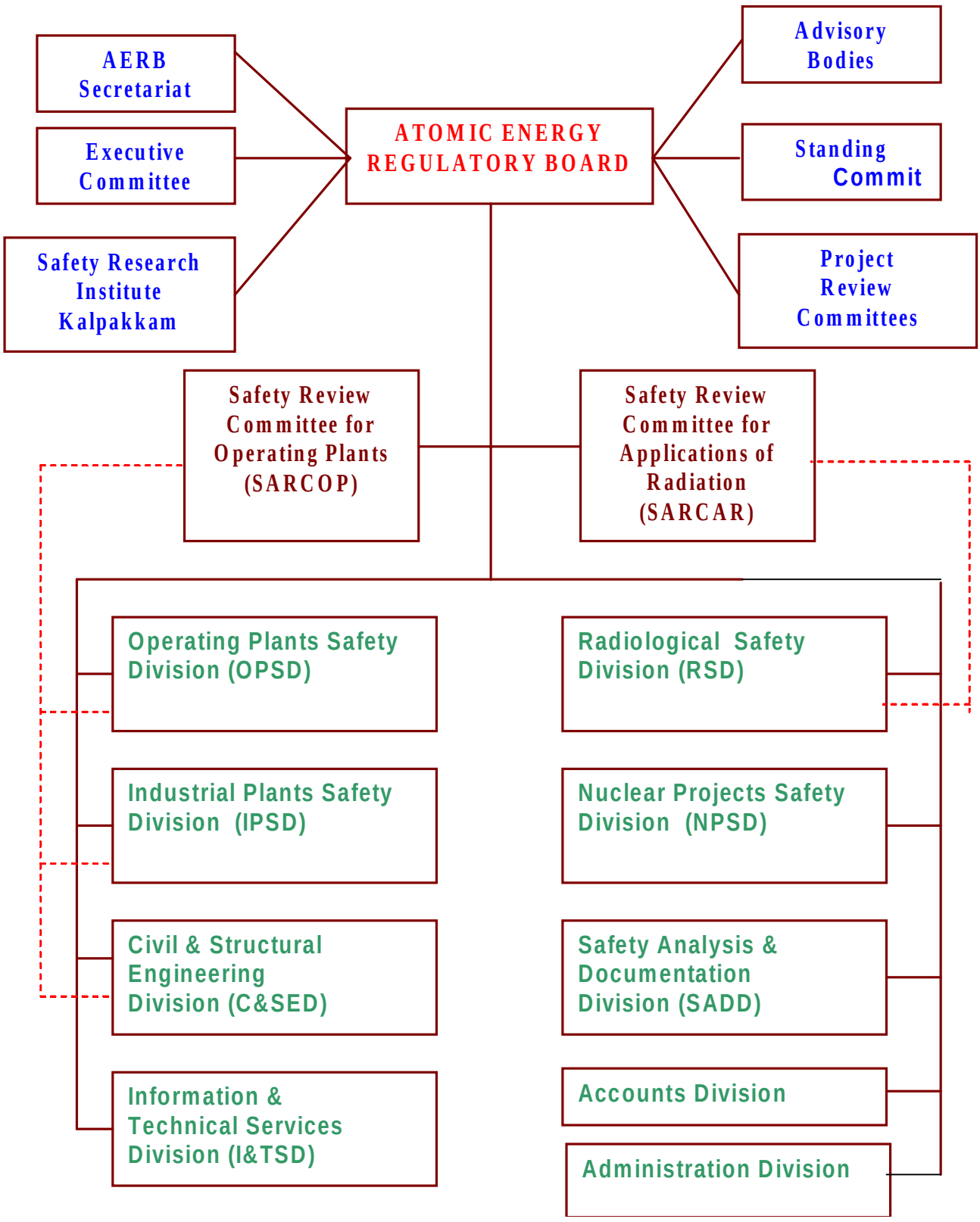
4. Dr. K.V. Raghavan, … Member
Director, Indian Institute of Chemical Technology,
Uppal Road, Hyderabad.

5. Prof. J.B. Joshi, … Member
Professor and Director,
University Institute of Chemical Technology (UICT)
University of Mumbai, Mumbai.

6. Dr. K.S. Parthasarathy … Secretary
Head, Information and Technical Services Division, AERB

1.2 ORGANISATION CHART

ATOMIC ENERGY REGULATORY BOARD



1.3 SUMMARY

During the year 2001-2002, the activities of the Atomic Energy Regulatory Board, the Board's Secretariat and its specialists' technical committees covered all the chartered functions of the Board. The Board met four times during the year.

The Board was reconstituted on September 25, 2001. Dr. S.S. Ramaswamy and Dr. R.D. Lele retired as members after rendering distinguished service as members of the Board for over 11 years. The new members are Dr. M.V.S. Valiathan, Honorary Advisor, Manipal Academy of Higher Education, Manipal and Dr. K.V. Raghavan, Director, Indian Institute of Chemical Technology, Hyderabad.

Safety Review: Nuclear Power Projects

AERB continuously reviews each of its regulatory processes and activities to update and improve them based on national and international experience. Such meetings of experts from licensee, licensor and other relevant organisations help to consolidate the valuable experience gained through the consenting process adopted for the new pressurised heavy water reactors. AERB organised such a review meeting on the consenting process. One of the important decisions of the meeting was to consider three clearance stages for the construction authorisation, namely, excavation, first pour of concrete and installation of major equipment.

The Board granted authorisation for continuous operation of Unit-1 of Kaiga Generating Station and Unit-4 of Rajasthan Atomic Power Project for a period of three years. AERB also issued clearance to NPCIL for the first pour of concrete for Units-3&4 of Kaiga Generating Station and Units-1&2 of Kudankulam Nuclear Power Project. The units at Kaiga will be of the pressurized heavy water type each of 220 MWe, while those at Kudankulam will be Russian make water moderated water cooled reactor (VVER) of 1000 MWe each.

The Board is being assisted by Project Design Safety Committees and Advisory Committees for Project Safety Review in carrying out the safety review of Tarapur Atomic Power Project Units-3&4, Kaiga Units-3&4 and Rajasthan Atomic Power Project Units-5&6. An in-house co-ordination group along with specialists groups and an Advisory Committee for Project Safety Review of Light Water Reactors are assisting AERB in the safety review of the Kudankulam Project. A Project Design Safety Committee is assisting in the safety review of the Prototype Fast Breeder Reactor. The Civil Engineering Safety Committee reviews the civil engineering aspects related to the projects. In general, the safety review process progressed satisfactorily throughout the year.

Teams of AERB Officers inspected different project sites and covered quality assurance and other site-related issues, aspects related to civil engineering safety and industrial safety. AERB suspended the clearance for excavation for Kaiga Units-3&4 on January 17, 2002 due to two fatal industrial accidents in the month of November 2001 and January 2002. AERB insisted that NPCIL set up a full-fledged safety organisation for the project. AERB withdrew the suspension on January 29, 2002 after NPCIL complied with AERB's requirements.

In all AERB issued 12 authorisations to various nuclear power projects during the year.

Safety Review: Operating Nuclear Power Plants

AERB carried out the safety review of operating plants of DAE through its Safety Review Committee for Operating Plants. The Board renewed the operating authorisation of RAPS-2 and KAPS-1&2 for a further period of three years. The operating authorisation of NAPS was renewed up to June 30, 2003 as the more comprehensive periodic safety review which is carried out once in nine years is due for NAPS in December 2002.

All nuclear power reactors operated safely. The radioactive releases from the power stations to the environment were well within the limits prescribed by AERB. The radiation dose to workers also indicated near total compliance with the limit prescribed by AERB. However, the radiation exposures to nuclear power plant personnel due to tritium intake showed an increasing trend. One of the reasons is the inadequate care taken by workers in using appropriate protective equipment. The Safety Review Committee for Operating Plants expressed concern over these factors and directed all nuclear power plants to take concrete steps to reduce the exposure.

The radiation dose to a small but significant number of contract workers employed in nuclear power plants exceeded the annual regulatory limit of 15 mSv. The maximum dose received by one contract worker was 38.3 mSv. (The annual dose limit for contract workers is restricted at 15 mSv as against 30 mSv for normal workers). The reasons for the workers receiving higher doses were identified. AERB directed all nuclear power plants to take appropriate action to ensure that the doses do not exceed the limit.

NPCIL had fabricated a certain number of dry storage casks to store spent fuel from Units-1&2 of the Rajasthan Atomic Power Station. These casks were found to be inadequately designed for very long term storage. In view of this, AERB authorised NPCIL to use these casks with several stipulations for a period of 10 years only. The stipulations covered monitoring of the integrity of the casks, periodic monitoring of leak tightness, and procedures for lifting and handling the casks.

The Tarapur Atomic Power Station has now completed over 30 years of operation, and NPCIL has applied for authorisation for continued long term operation. As directed by AERB, NPCIL took up a comprehensive assessment of safety of the two units for continued long term operation. The review will cover actual condition of the plant as against current safety requirements, design basis, safety analysis, feedback of operating experience, ageing and residual life assessment. NPCIL has submitted some related reports. AERB extended the present interim authorisation for operating TAPS up to May 2003 pending review of various assessment reports to be submitted by NPCIL.

During the year, the Atomic Energy Regulatory Board reviewed the operational safety status of RAPS Unit-1. It noted that, being the first of its kind,

the Unit had to face many problems associated with the adoption of a new technology. Turbine blade failures, formation of cracks in the end shields, leak in the calandria over pressure relief device and tube leaks from the moderator heat exchangers were some of the problems. Since the restart on July 24, 2001 the reactor operation has been irregular. Taking a holistic view of the issues related to RAPS-1 and as a matter of abundant caution, AERB has decided that, in its present condition, operation of RAPS-1 can be permitted only up to 7 Effective Full Power Years or April 30, 2002, whichever is earlier.

AERB participated in the licensing of 153 officers for positions like Shift Charge Engineer, Assistant Shift Charge Engineer and Control Engineers in nuclear power plants.

In an overall sense, the status of industrial and civil engineering safety of operating plants were satisfactory. AERB is empowered to issue licences under the Factories Act, 1948 to the units of DAE and to administer the provisions under the Act. During the year, AERB renewed for a period of five years the licences under the Factories Act issued to TAPS-1&2, MAPS-1&2 and RAPS-1&2. KGS-1&2 received the first licence under the Factories Act.

Enforcement of Radiological Safety Provisions

AERB enforced provisions of radiological safety in medical, industrial and research institutions using radioisotopes and radiation generating equipment.

The Board reviewed the applications for siting, design and design modifications of an electron beam generator at Hyderabad and two gamma irradiation plants. AERB issued siting clearance to two stationary gamma irradiators at New Delhi and Ahmednagar after reviewing their application and inspecting the sites.

AERB approved 194 Radiological Safety Officers (RSO) employed in medical, industrial and research institutions. Of these, 109 belonged to Level-III, 19 Level-II and 66 Level-I (RSOs are categorised as Level-I, II & III depending on the type of sources they handle and the hazard potential). AERB issued over 2600 authorisations to users of radiation in medical, industrial and research institutions.

AERB inspected 139 institutions, which handle radiation sources for medical and industrial purposes. Of these, thirty-six were medical users of radiation and twenty-five were nuclear medicine facilities. The Board withdrew the authorisation of one hospital indefinitely as it was carrying out high dose therapy in violation of safety provisions. AERB also suspended authorisation of three institutions for periods up to three months till they complied with safety provisions.

AERB withdrew the certificate of approval issued to the Demonstration Plant for Radiation Processing of Spices at Vashi operated by the Board of Radiation and Isotope Technology, based on the report of an inspection team from AERB, which found certain procedural lapses needing urgent correction. The lapses had not compromised public safety. The directive was withdrawn when the organisation implemented the regulatory requirements.

AERB initiated action against seven industrial radiography institutions, which violated regulatory provisions. The action included suspension of radiography work for various periods, issuing warning letters and making adverse entries in the certificates of safety personnel.

The cobalt facility at Rajasthan Atomic Power Project resumed operation from June 2001 after complying with all mandatory safety requirements. AERB had suspended the operation of the facility in October 1999 following an incident of excessive radiation exposure.

AERB issued a public notice through leading newspapers informing the users of medical X-ray units about the regulatory requirements. The notice and related documents were published on AERB web site (www.aerb.gov.in).

AERB sent Safety Information Notices in the field of radiotherapy and radio diagnosis to several institutions. These indicated the safety significance of certain practices and incidents.

AERB Safety Documents

During the year, AERB published 18 documents including Safety Codes, Standards and Guides in various areas coming under its purview.

Safety Research

The Safety Research Institute set up at Kalpakkam made steady progress towards establishing the infrastructure required to carry out studies related to nuclear power plant safety, environmental safety, fire safety and industrial safety.

The Board funded nine new safety research projects and renewed ten ongoing projects. The Safety Research Institute granted four new projects.

International Activities

Twenty-two officers from AERB participated in the activities of the International Atomic Energy Agency. These include attending the General Conference, workshops and technical committee meetings and serving in expert missions. ■

SECTION 2

SAFETY SURVEILLANCE OF NUCLEAR FACILITIES

2.1 NUCLEAR POWER PROJECTS

2.1.1 Project Safety Review

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. This Committee consists of specialists. The recommendations of the PDSC are reviewed by the Advisory Committee for Project Safety Review (ACPSR), which acts as the second tier. 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.

Tarapur Atomic Power Project Units-3&4

The Project Design Safety Committee (PDSC) for TAPP-3&4 has held 169 meetings so far, 26 of these being during the year 2001-2002. 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 the following documents related to the design of TAPP-3&4:

(i) Design Basis Reports (DBRs) on
- Reactor Regulating System
- Reactor Building Cooling System
- Primary Containment Ventilation System
- Primary Containment Controlled Discharge
- Reactor Building Heavy Water Vapour Recovery System
- Fuel Handling Systems and associated equipment
- Calandria Vault Cooling System
- End Shield Cooling System
- Service Water System

(ii) Preliminary Safety Analysis Reports (PSAR) on
- Reactor Building Cooling System
- Primary Containment Controlled Discharge
- Secondary Containment Ventilation Clean up and Purge System

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

- Proposal for Simplified Small Leak Handling System (SLHS)
- Calibration of Strong Motion Seismic Sensors
- Proposal for Deletion of Fast Acting Main Steam Isolation Valve (MSIV)
- Specifications for Integrated Leakage Rate Test of Primary Containment and Secondary Containment
- Use of Seamless Calandria Tubes
- Approach Plan for Training of TAPP-3&4 Operating Personnel on the Full Scope Simulator
- Comparison of End Shields
- Estimation of Man-rem for Fuel Handling Activities
- Up rating of Electrical Power Output for TAPP-3&4 to 540 MWe

After a detailed review, PDSC accepted design modifications related to the small leak handling system, boiler pressure programme and main steam isolation valves and deletion of fast acting steam isolation valves proposed by NPCIL.

KGS-1 & 2 and RAPP- 3 & 4

During the year, the Project Design Safety Committee (PDSC) for KGS-1&2 and RAPP-3&4

Members of the Board visit TAPP 3 & 4

continued the review of Unit-4 of RAPP. The PDSC held four meetings. The 395th Meeting was the last meeting of the Committee, and with this, the Committee completed its task of design safety review of KGS-1&2 and RAPP-3&4.

Some major issues identified during the final design review of KGS-1&2 and RAPP-3&4 are highlighted below.

Cooling Capability of Shut-down Cooling System

As a part of the design modifications arising from feedback of operational experience, several pieces of equipment such as valves were removed. The main Primary Heat Transport (PHT) System has been made a valveless system in KGS-1&2 and RAPP-3&4. This has been done to eliminate maintenance requirements on valves. This design change helps to reduce the collective dose of plant personnel, as no leakage is possible in the absence of valves. (Leakages through valves cause an increase in the concentration of airborne tritiated water vapour which contributes to the internal dose to workers).

AERB studies all the suggested modifications from the stand point of safety. Following this practice, AERB examined the safety aspects of the above change. Due to this change, the shut down cooling flow through the core maintained by the shut down cooling system will get bypassed to some extent. AERB asked NPCIL to calculate the amount of such bypassing and to ensure that the bypassing does not affect the core cooling under all circumstances. It was also suggested that it would be prudent to verify these calculations by an actual experiment.

Hence at KGS-2, NPCIL carried out the shut down cooling capability test after 140 Full Power Days (FPDs) of reactor operation, when sufficient fission products contributing to decay heat are built up in the core. The objective was to test the capability of the system to cool down PHT to 55oC. Review of the test results indicated that the objective was fulfilled satisfactorily. KGS-1&2 and RAPP-3&4 operated beyond 100 FPDs. During their operation beyond 100 FPDs, it has been observed that these units could be cooled down to below 55oC with the help of the shut down cooling system.

Annulus Gas Monitoring System (AGMS)

The Annulus Gas Monitoring System (AGMS) is a new system added in pressurized heavy water reactors all over the world. In India, this system has also been provided to detect any leak from the pressure tube into the annular gap between the pressure tube (PT) and the calandria tube (CT). The system re-circulates carbon dioxide through the annulus and monitors the change in its dew point temperature, thereby detecting any leak. The provision of CO_2 also eliminates the possibility of Argon-41 build-up in the annulus. (If air is present instead of carbon dioxide, the traces of argon in air become Ar-41, a radioactive gas.) NPCIL rectified the deficiencies observed in the performance of the Annulus Gas Monitoring System. The system is working satisfactorily in KGS-1&2 and RAPP-3&4 and Ar-41 build-up in the annuli has been reduced considerably.

Programmable Logic Controllers

Programmable Logic Controllers (PLCs) have been used for the controls of major equipment in the latest family of Indian pressurized heavy water reactors. In RAPP-4, certain programmable logic controllers failed because their power supply failed. Consequent to this, the turbogenerator lubricating oil and generator seal oil pumps tripped. This led to the damage of the bearing of a turbine generator and uncontrolled release of hydrogen. Though the incident did not affect nuclear safety, AERB stipulated that such failures should be studied for their impact on safety.

Following the incident, PDSC and NPCIL constituted separate task teams to review the incident. The teams came out with certain remedial measures to avoid recurrence of the incident. It was suggested that standby power be provided in case the normal power supply fails, and that controls for major equipment including core-cooling equipment be segregated. The modifications which required immediate attention have been implemented at all the four units. The other modifications recommended by the task teams are being implemented in a phased manner.

KGS Units - 3&4 and RAPP Units - 5&6

As a part of the safety review structure, a new PDSC was constituted for review of KGS Units-3&4. Later the responsibility of the Committee was extended to include review of RAPP Units-5&6. The mandate of the Committee is to review the safety in design, various stages of construction and commissioning up to full power operation of these reactors.

KGS Units - 3&4

In line with the recent provisions introduced for the consenting process, the Construction Clearance is now being subdivided into three stages: (i) Excavation (ii) First Pour of Concrete and (iii) Erection of Major Equipment. AERB issued the excavation clearance in June 2001.

NPCIL submitted the required documents and the application for First Pour of Concrete in March 2002.

KGS-3&4 is essentially a repeat design of KGS-1&2. The differences between KGS-3&4 and KGS-1&2 have been brought out by NPCIL. These were reviewed by PDSC and Civil Engineering Safety Committee (CESC) with the support of other specialists. PDSC also completed review of the design description, the plant layout drawings and the site Quality Assurance (QA) manual for construction for KGS-3&4.

The major observation/recommendations are as follows:

- **Plant Lay-out** - KGS-3&4 Plant Layout has undergone major changes primarily due to necessity of having a sound rock-bed for the reactor building. PDSC considered the changes in layout and accepted the same.

- **Industrial and Fire Safety** - An adequate organisation for Industrial and Fire Safety has been established to ensure adherence to safety requirements.

- **Fire Protection during Construction** - During construction, fire protection measures have to be provided by the major civil contractors. Site Fire Safety Section will supervise the adequacy of the fire fighting measures provided by the contractor.

- **Emergency Preparedness** - NPCIL should review the existing Emergency Preparedness Plan document of KGS-1&2 taking into the presence of construction workers of KGS-3&4 at the site.

- **Labour Camp** - Adequate fencing must be put around the labour camp which houses construction workers to prevent camp residents from approaching the security fence for KGS-1&2 within the exclusion zone.

- **Design Provision for Decommissioning** - NPCIL should follow the AERB code on design for the purpose of decommissioning and indicate the design provisions made thereof.

Based on the review of relevant chapters of the Preliminary Safety Analysis Reports of KGS-3 and 4 and other documents, PDSC recommended that AERB may grant Clearance for First Pour of Concrete as second stage of Constructional Authorization for KGS-3&4. Accordingly, on March 22, 2002, AERB gave clearance for the first pour of concrete.

RAPP Units - 5&6

AERB revalidated the site clearance for locating 2 x 220 MWe units (as against two 500 MWe units proposed earlier) at RAPP-5&6 sites. Subsequently NPCIL applied for excavation clearance from AERB.

For recommending excavation clearance, PDSC reviewed Preliminary Safety Analysis Report PSAR Chapter 1 (General Description and Safety Classification Philosophy), Chapter 2 (Siting & Environmental Data) & Chapter 3 (Plant Layout, Buildings and Structures). PDSC and CESC jointly reviewed the comments of AERB along with the item-wise response to these comments submitted by NPCIL.

The major observations / recommendations are as follows:

Plant Lay-out

The Plant Layout has been found to be generally in order except that the Induced Draft Cooling Tower (IDCT) will have to be relocated as it falls under Turbine Disintegrated Missile Zone. (Turbine blades which may be ejected from the turbine generator assembly may cause considerable damage to structures and components in their path. Although such events are rare, the lay out of various structures are examined to avoid such a possibility). NPCIL has to bring out this change in layout with respect to IDCT of RAPP-5&6 along with other design changes before the clearance of First Pour of Concrete.

Emergency Preparedness Plan

NPCIL should submit within six months a comprehensive emergency preparedness plan for the

construction phase of RAPP 5&6. The plan should cover requirements / procedures to tackle radiation emergencies arising from RAPS-1&2/ RAPP-3&4 and also any emergency situation which may be caused by the accidental release of H2S from the near by Heavy Water Plant.

Industrial Safety

NPCIL should take all steps to enforce Industrial Safety before commencement of site excavation. It should set up a safety organization specifically for RAPP 5&6 before starting excavation.

Documentation

NPC should strengthen its in-house QA on documentation.

Based on the review of the relevant documents related to RAPP-5&6, AERB issued clearance for excavation in January 2002.

Kudankulam Project (KK Project)

The Kudankulam project consists of two nuclear power reactors of 1000MWe of the Russian VVER-1000 type. As is the international practice (which India also follows) the Units are to be licensable as per Russian regulatory practice as well as in India by AERB. The regulatory review of Kudankulam reactors by AERB is in progress.

AERB Co-ordination Group along with the Specialist Groups at the first level and ACPSR at the second level reviewed the comments along with responses from NPCIL and categorized them for proper follow up. AERB considered the Russian Normative Technical Documents (NTDs) for design review. Applicable clauses of relevant AERB codes/guides and relevant IAEA documents were used during the review process.

Based on the recommendations of ACPSR, AERB considered the application for site excavation and issued clearance for site excavation in October 2001.

Some observations / recommendations are as follows:

(i) Although NPCIL has made a fence at a distance of 2.0 km all the dose calculations should be carried out at 1.6 km as per AERB requirements.

(ii) In order to cater to the requirements spelt out by AERB with reference to the maximum flood level and considering a return period of 1000 years, a safe grade elevation of +7.50m above Mean Sea Level should be provided for the plant structures.

(iii) A collective dose to workers of 2 person-Sievert per unit per year should be ensured as a design target number as against 5 person-Sievert per unit per year limit specified by the Russians. (Collective dose expresses the total radiation dose incurred by a group of people. It is defined as the product of the number of individuals exposed to a source and the average radiation dose. For instance, if 1000 persons are exposed to an average dose of 0.001 Sv, the collective dose is one person-Sv).

(iv) In order to develop a better understanding of the Russian design codes used in civil and structural analysis, an inter-comparison between the values obtained to check the elemental design by the Russian and the ASME Code was suggested. For this purpose, the areas, which will be checked, the methodology and the inputs needed including the target schedule for completion of this activity have been worked out. NPCIL-KK has agreed to complete the inter comparison exercise before June 2002. NPCIL should report on the progress of this job to AERB every two months. This job should be completed and results satisfactorily reviewed by AERB before construction of the hermetic portion of the containment is taken up.

(v) The possibility of aircraft impact has been eliminated by locating the KK-NPP at a distance greater than the screening value distance from airports as given in the AERB Code on Siting. The effect of mechanical impacts on important structures due to small aircrafts on important structures has been considered as per IAEA-Safety Guide 50-SG-S-5.

Prototype Fast Breeder Reactor (PFBR)

As part of the programme for utilizing abundant thorium deposits in India, Department of Atomic Energy has taken up several projects. The 500 MWe Prototype Fast Breeder Reactor (PFBR) to be installed at Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam, Tamil Nadu is one such project. AERB has been conducting Safety Review in greater detail for this project, which is first of its type. This detailed review is in

progress for last few years by the Project Design Safety Committee (PDSC) of AERB. During 2001-2002, PDSC-PFBR conducted 7 meetings. Preliminary Safety Analysis Report (PSAR) chapters on Initial Test Program, Plant Layout, Radioactive Waste Management and Plant Services were reviewed. With this, review of 17 chapters out of 18 has been completed.

PDSC-PFBR felt that prior to issuing authorization for construction of PFBR, an independent review of reactor systems important to safety should be carried out to ensure that decisions taken on such items are sound and will not call for any major changes, which are difficult to implement after placement of orders for procurement and commencement of construction. For this purpose, PDSC constituted 6 Specialist Groups to review design specifications and conceptual design documents of following systems:

- Shut Down System
- Core Design
- Reactor Assembly
- Decay Heat Removal System
- Reactor Containment
- Design bases for Systems, Structures, Components and Equipment.

Reports of first 5 of these Specialist Groups were reviewed by PDSC and there recommendations are implemented. Review by 6th Specialist Group is in advance state and its report is expected shortly. Earlier, PDSC constituted 5 subcommittees to validate the computer codes used in the design and safety analysis of PFBR. The recommendations of these subcommittees are under review of PDSC.

In general, the review has resulted in some important design changes in Safety Systems of PFBR.

Based upon the satisfactory review of systems important to safety, IGCAR is in process of ordering manufacture of certain long delivery mechanical components of the Nuclear Steam Supply System. IGCAR has also put up an application for permission for excavation from AERB, which is the first stage of Construction Authorization.

2.1.2 Civil Engineering Safety

Civil Engineering Safety Committee (CESC) met 16 times to review civil engineering aspects related to KGS 3&4, RAPP 5&6, TAPP 3&4, and Prototype Fast Breeder Reactor (PFBR). Documents related to siting of the plants, design basis ground motion parameters, foundation excavation, analysis and design; constructability aspects of reactor buildings of KGS 3&4, RAPP 5&6 were reviewed. After satisfactory completion of review work, CESC recommended granting permission for commencement of excavation activities of KGS 3&4 and RAPP 5&6. CESC completed the review work of all safety related structures of TAPP 3&4. Site characteristics and plant layout of PFBR are under review.

Specialist Groups constituted for the review of the Preliminary Safety Analysis Report of Kudankulam, met twenty nine times to review various Preliminary Safety Analysis Packages and the internal layout of buildings of Kudankulam Atomic Power Project. The observations of Specialist Groups were discussed in the combined meetings of AERB Co-ordination Group and Specialised Groups. The finalised comments and NPCIL's responses were discussed by the Advisory Committee for Plant Safety Review for Kudankulam project.

The working groups of CESC met twelve times to review documents related to design basis ground motion parameters, geological and geotechnical investigation reports, blasting activities and various design reports of safety related civil engineering structures of RAPP 5&6, KGS 3&4, TAPP 3&4 and PFBR and submitted their reports to CESC.

AERB conducted seven site inspections of excavation activities of KGS 3&4, RAPP 5&6 and Kudankulam and various stages of construction at TAPP 3&4. During the regulatory inspection of the founding strata of reactor building 3 of KGS 3&4, the inspection team observed a highly fractured rock patch of triangular shape having a base of about 10m at the periphery with apex near the centre of the reactor building. In view of this, the inspection team suggested that NPCIL should complete the geological mapping of the excavated surface and evaluate the safety of reactor building foundation.

NPCIL submitted relevant reports with suitable engineering analysis and measures to ascertain the safety of the foundation. Civil Engineering Safety Committee reviewed these reports. The results of the analysis and proposed engineering measures suggested in the report were found to be satisfactory. Personnel from AERB inspected RAPP-4 to verify the Construction Completion Certificates (CCC) of RAPP-4.

Workshoop on Consenting / Authorisation Process, (From right) Shri G. R. Srinivasan, Vice Chairman, AERB, Shri Deepak De, Head Nuclear Projects Safety Division, AERB, Shri Ch. Surendar formerly Chairman & Managing Director, NPCIL addressing the workshop.

2.1.3 Authorisations Issued to Nuclear Installations

1. Extension of Validity of Authorisation for RAPP-4 to operate at 100% FP (May 17, 2001).

2. Authorisation for Storage of Spent Fuel in the 28 no. of Concrete Casks of Old Design at RAPS (July 3, 2001).

3. Authorisation for RAPP-4 Continuous Operation at 100% FP. - Extension of Validity Period (August 24, 2001).

4. Authorisation for Continuous Operation at 100% F.P. of RAPP-4 (October 8, 2001).

5. Clearance for Site Excavation of Kudankulam Nuclear Power Project (KK NPP) (October 9, 2001).

6. Revalidation of site clearance for locating two additional units of 220 MWe at Rawatbhata (RAPP-5&6) (November 26, 2001).

7. Suspension of Excavation Activities at KGS-3&4 (January 17, 2002).

8. Excavation Clearance for RAPP Units 5&6 (January 25, 2002).

9. Lifting of Suspension on Excavation Activities at KGS-3&4 Site (January 29, 2002).

10. Extension of Provisional Authorisation for Operation of New Uranium Oxide Fuel Plant, NFC (February 22, 2002).

11. Clearance for First Pour of Concrete for Reactor Auxiliary Building of Kudankulam Nuclear Power Project Units-1&2 (March 22, 2002).

12. Clearance for First Pour of Kaiga Generating Station Units-3&4 (March 22, 2002).

2.1.4 Regulatory Inspection of Projects

Regulatory inspections of the nuclear power projects were carried out to ensure compliance with the AERB stipulations during construction and design implementation and compliance with the industrial safety requirements.

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	2
Kudankulam Atomic Power Project- Units 1&2	3
Kaiga Generating Station - Units 3&4	2

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 and Kaiga Project Units 3&4 for giving clearances for excavation and concrete pouring.

The inspections at TAPP-3&4 covered mainly organisational aspects of safety section, QA section and project management. The inspectors noted that NPCIL has put in efforts to inculcate the 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, several design related issues like design concessions given during procurement and erection of

major equipment were also identified and put up to PDSC- TAPP 3&4 for specific attention/review.

AERB teams inspected the KK Project mainly with regard to the excavation work and related industrial safety requirements. AERB insisted that NPCIL should follow proper procedures for all civil works including blasting, maintaining of proper slopes and related safety requirements. These were subsequently implemented by NPCIL. In view of the risk involved during excavation, setting up of a dedicated safety organisation during civil work was insisted upon by AERB. NPCIL has complied with the requirement. The inspection team also discussed/ verified other site related aspects such as water supply, project organisation and establishment of a regular micrometeorological laboratory at the project site.

An AERB team carried out a special inspection at Kaiga Project Units 3&4 in Dec. 2001 to check civil engineering safety aspects, safety organisation and industrial safety measures. The clearance for excavation for Kaiga Project Units-3&4 was suspended on January 17, 2002 due to two fatal industrial accidents in the month of Nov. 2001 and Jan. 2002. AERB insisted that NPCIL should establish a separate safety organisation for the project.

AERB revoked the suspension of excavation clearance on January 29, 2002 after NPCIL established the safety organisation and satisfied other requirements as stipulated by AERB. AERB verified the compliance with its stipulations by NPCIL during another special regulatory inspection carried out in February 2002.

2.1.5 Industrial Safety

Regulatory inspections on industrial safety aspects were carried out during 2001-2002 in the following Nuclear Power Projects:

Tarapur Atomic Power Project -3&4
Rajasthan Atomic Power Project -3&4

Recommendations to NPCIL included improving safety work permit system procedures / practices, applying for and obtaining licence under the Factories Act, 1948 / Atomic Energy (Factories) Rules, 1996, periodic load testing of lifting machines and periodic medical examination of employees.

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.

SARCOP held 26 meetings during the year. The Committee continuously receives inputs on safety performance of operating plants and reviews issues In the following, some of the important issues/events are described.

As per the existing requirements of AERB, the Authorization for operation of nuclear power plants needs to be renewed once in three years. For this, the power plants are required to submit an application in a format prescribed by AERB, namely Application for Renewal of Authorization (ARA) for review. The review covers among other aspects plant performance, in-service inspections, collective radiation exposures, radiation protection measures and reliability analysis of safety systems.

AERB received applications for renewal of authorization from NAPS, KAPS and RAPS Unit-2 during the year 2001. In view of the overall satisfactory safety performance of these plants, the authorizations for these plants were renewed as follows:

RAPS-2: From June 1 2001 to May 31, 2004
KAPS: From July 15, 2001 to July 14, 2004
NAPS: From March 1, 2002 to June 30, 2003.

The authorization for NAPS was renewed only up to June 2003 as the more comprehensive Periodic Safety Review (PSR), which is carried out once in nine years, is due for NAPS in December 2002.

2.2.1 Tarapur Atomic Power Station (TAPS)

TAPS Units-1&2 were operational up to 160MW(e). Unit-1 had its 16th refuelling outage from June 8, 2001 to July 19, 2001.

Continued Long-term Operation of TAPS Units 1&2

TAPS Units1 & 2 have completed more than 30 years of operation. NPCIL has now applied for

Senior Officials of NPCIL making a presentation at 72nd meeting of Atomic Energy Regulatory Board.

Board meeting in progress - October 5, 2001. (From left) Prof. J. B. Joshi, Dr. M. V. S. Valiathan, Prof. S. P. Sukhatme, Chairman, Shri G. R. Srinivasan, Vice Chairman, Dr. K. V. Raghavan, Dr. K. S. Parthasarathy, Secretary, AERB.

Meeting of the Safety Review Committe for Operting Plants.

Members of the Board visiting Radiometallurgy Laboratory Lab, IGCAR, Kalpakkam - March 22, 2002. Dr. Baldervaj, Director (Materials, Chemical and Reprocessing Group) (extreme right facing the camera) briefs the Board.

authorization for continued long-term operation of these Units. As directed by AERB, NPCIL/TAPS took up a comprehensive assessment of the 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 design basis, safety analysis, operating experience feed back, ageing and residual life assessment. A Probability Safety Assessment at Level 1 is also necessary.

In this connection, NPCIL/TAPS has already submitted the reports on operational performance and ageing management and these are being reviewed by AERB. The reassessment of design basis and safety analysis is expected to be completed by May 2002.

NPCIL has also been asked to submit a Probabilistic Safety Analysis (See Section 2.2.10) study on TAPS along with life assessment. The study is partially complete and is currently under review.

In order to enable review of these reports by AERB and to arrive at decisions regarding modification/up-gradations needed and a time schedule for their implementation, AERB has decided to extend the present interim authorization for operation of TAPS up to May 2003.

Health of Core Shrouds in TAPS

In the early 1990s, the United States Nuclear Regulatory Commission (US NRC) and General Electric (GE) had reported occurrence of cracks in the core shrouds of some Boiling Water Reactors (BWR). The core shroud in a BWR is an integral structure of the reactor that ensures alignment of the fuel bundles and separates the incoming cooling water from the hot water at reactor outlet. The cracks were reported to be in the Heat Affected Zone (HAZ) of the horizontal welds in the core shroud. As per the preliminary evaluation done by US NRC at that time it was found that a cracked core shroud could affect alignment of fuel assemblies and could pose difficulties in shutting down the reactor and maintaining core cooling under accident situations.

Taking note of these concerns and the fact that TAPS Units 1&2 reactors were BWRs supplied by GE, NPCIL started an action plan to inspect accessible welds of the core shrouds and to analyse their structural integrity on the advice of AERB.

In pursuance of this, visual and ultrasonic inspection of the accessible horizontal welds is being carried out regularly during refuelling outages of TAPS units, since 1995. As part of this program NPCIL inspected some of the core shroud welds during the 16th refuelling outage of TAPS Unit-1 from 8th June 2001 to 19th July 2001. No abnormalities have so far been reported on any of the inspected welds.

Due to inaccessibility, inspection of some of the welds in core shrouds of TAPS reactors is not feasible. In view of this, an analytical approach was considered more appropriate for identifying the areas of concern. The analysis carried out covered (a) structural analysis of behaviour of the shroud with postulated cracks under normal operation and accident conditions, (b) consequences of any movement of the shroud (c) fracture mechanics studies, and (d) assessment of acoustic loads.

Based on the above analysis, it was concluded that under postulated accident conditions even with a 360 degree crack at any weld location in the shroud, there is no possibility of disruption of any safety functions, namely control rod movement, liquid poison injection or emergency coolant injection.

High Temperature in Biological Shields of TAPS Units.

During a regulatory inspection of TAPS in May 2001, the inspection team observed that the temperatures in the biological shields in both units of TAPS are higher than the specified design temperatures.

The biological shield is a concrete structure surrounding the reactor, which provides shielding against the high radiation coming from the reactors. The shield is cooled by circulating water through the cooling coils, which are embedded in it.

Investigation indicated that the concrete shield is getting heated externally due to the high ambient temperature and not due to any deficiencies in the biological shield or its cooling system. TAPS took measures to reduce the ambient temperatures by cleaning the choked ventilation filters and grills and rebalancing the ventilation flows. After this while the temperatures have significantly reduced, they are still higher than the specified temperature limits in some areas.

SARCOP has asked TAPS to bring down the temperatures by appropriate measures and also examine the health of the concrete shield which has been subjected to the higher temperatures.

Upgradation of Fire Protection System at TAPS

In view of the proposed long term operation, NPCIL is carrying out an extensive up-gradation on the fire protection system at TAPS. An expert group of AERB reviewed the adequacy of measures taken by TAPS vis-à-vis the requirements/intent of AERB fire safety standards. The review indicated that with the recent upgradations, TAPS meets most of the requirements of the fire safety standards. NPCIL will complete actions on remaining requirements by December 2003.

2.2.2 Rajasthan Atomic Power Station (RAPS)

RAPS Unit-1 remained shut down from September 2000-July 2001 to repair the light water leak from its north end shield and for replacement of a few coolant channels on a trial basis. The Unit was restarted on July 24, 2001. The Unit was again shut down in August 2001 due to failure of the exciter reduction gear of the Turbine Generator. NPCIL rectified the problem and restarted the Unit on 27th January 2002. Subsequently, the unit was operating at about 160 MWe.

RAPS Unit-2 operated normally up to 200 MWe during the period April 2001-March 2002. The Unit had taken a shut down in August 2001, to replace a moderator heat exchanger and for other maintenance and surveillance activities.

RAPS Units 3&4, the new units which became operational during 1999-2000, operated normally during the year up to a power level of about 220 MWe.

Operation of RAPS-1

Unit-1 of RAPS, India's oldest Pressurized Heavy Water Reactor (PHWR) became operational in 1972-73. Being the first of its kind RAPS-1 had to face many problems associated with the adoption of new technology. Turbine blade failures, formation of cracks in the south end shield, leak in the calandria over pressure relief device and tube leaks from moderator heat exchangers were some of the problems that were resolved from time to time. Resolution of these problems required engineering solutions and considerable time and effort for their development and implementation.

From March 1997 to September 2000, this unit operated steadily up to a power level of 75% full power, with an average capacity factor of 60%. On September 26, 2000, NPCIL shut down RAPS Unit-1 after a tube leak developed in one of the moderator heat exchangers. Shortly afterwards, on October 4, 2000, when the Unit was under shutdown, the north end shield of the reactor developed two cracks. The Unit had operated for about 6.77 Effective Full Power Years by this time.

After the cracks on the north end shield were sealed successfully, and after safety review and clearance by AERB, the Unit was restarted on July 24, 2001. During the shut down of the Unit from October 2000 to July 2001, a few coolant channels were also replaced on a trial basis.

Since restart on July 24, 2001, operation of RAPS Unit-1 has been very irregular and the unit remained shut down for a significant period due to failure of the exciter reduction gear in the Turbine Generator. After rectification of this problem, the Unit was restarted on January 27, 2002.

Being built more than 30 years ago, RAPS Unit-1 requires upgradation in some of its safety related systems. Some of the equipment of the plant such as moderator heat exchangers have shown signs of ageing.

After careful deliberation, SARCOP decided that operation of RAPS Unit-1 shall be limited to 7 effective full power years or till April 30, 2002, whichever is earlier. The Board endorsed the SARCOP decision. The Board also took a holistic view of the problems encountered at RAPS Unit-1and the upgradation needed to meet current international safety standards. The Board concluded that in its present condition, operations of RAPS Unit-1 beyond the above SARCOP stipulation was not desirable and should not be permitted.

Partial Flow Blockage in One of the Channels in RAPS Unit 3

On November 2, 2001 when RAPS-3 was getting restarted, the Primary Heat Transport (PHT) outlet temperature for one of the coolant channels was significantly higher than the nearby channels. The reactor was shut down. During subsequent investigations, including radiography of the feeder pipes of the coolant channel, no blockage could be detected. On restarting the PHT pumps, it was found that the flow became normal in the channel. It was suspected that the blocking

material is located in the PHT headers and could have shifted due to disturbance caused by stopping/starting of PHT pumps.

NPCIL/RAPS plans to take up detailed investigations with visual inspection tools like camera and fibroscope during the forthcoming annual shut down of the Unit in April 2002. In the mean time, RAPS Unit-3 is operating with appropriate plans in place, to handle a similar incident.

2.2.3 Madras Atomic Power Station (MAPS)

MAPS-1&2 operated normally up to a power level of 170 MWe. MAPS Unit-2 was shut down on January 9, 2002, for en masse replacement of coolant channels.

Health of Coolant Channels and En-masse Coolant Channel Replacement in MAPS Unit-2.

In the older Indian pressurized heavy water reactors using Zircaloy-2 pressure tubes and two loose 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 resulting in degradation of mechanical properties. In view of this, pressure tubes in these reactors require en masse replacement after about 8-11 years depending on the reactor specific status of the coolant channels and life management activities.

MAPS Unit-1 and Unit-2 were shut down in August 2001 and July 2001 respectively for carrying out jobs related to coolant channel life management and health assessment. Based on extensive review of the health assessment of the coolant channels, MAPS Units 1&2 were permitted to operate up to 9.5 and 8.5 EFPYs respectively.

MAPS Unit-1 is expected to complete 9.5 EFPY in July 2002. In MAPS Unit-1, 207 out of the total number of 306 coolant channels have been inspected so far. This would mean that the efforts required for coolant channel life management activities such as in service inspection, garter spring repositioning, etc, for life extension of coolant channels is comparatively low for continuing operation of the Unit beyond 9.5 EFPY.

In the case of MAPS Unit -2, the number of channels inspected so far is only 76 out of the 306, and a large number of channels are required to be addressed for extension of life. The magnitude of life management activities of coolant channel required to be taken up in this Unit would be very high for continuing operation of the unit even for a short span of time. Also, a number of steam generator tube leaks have occurred in the past in this Unit and presently five heat exchangers of the steam generators are kept out of service due to leaks and require replacements.

In view of these, NPCIL/MAPS decided to take up en-masse coolant channel replacement of MAPS Unit-2 ahead of MAPS Unit-1. Accordingly, on completion of 8.5 EFPYs, MAPS Unit-2 was shut down on January 9, 2002 for en-masse coolant channel replacement.

The Unit is expected to remain shut down for a period of 600 days. In addition to replacement of coolant channels, NPCIL is also carrying out certain safety related up-gradation jobs such as incorporation of appropriate high-pressure injection in the emergency core cooling system and installation of a supplementary control room. NPCIL also plans to replace the steam generator.

The activities related to the en-masse coolant channel replacement and safety system upgradations are being closely reviewed by a special group constituted by AERB.

Water Leak from Biological Shield Cooling Coil from MAPS-2

MAPS Unit-2 was shut down on September 29, 2001 following a water leak from the Biological Shield Cooling System (BSC). This system cools the concrete in the biological shield around the reactor by circulation of water though pipes embedded in the concrete. The leak occurred in an area where the heating due to neutron and gamma irradiation is relatively low. MAPS had proposed to operate the plant after isolating the affected cooling coil. The estimated temperature increase in concrete due to lack of cooling from this coil was found to be acceptable. Based on these assessments, AERB permitted operation of MAPS Unit-2 till the proposed shut down for en-masse replacement of coolant channels.

2.2.4 Narora Atomic Power Station (NAPS)

Both NAPS units operated normally during the year up to a power level of 220 MWe.

Heavy Water Leak from End Fitting Blank of a Coolant Channel

On 20.11.2001, when NAPS-1 was operating at 220 MWe, the end-fitting blank for one of the coolant channels (G-17) developed a leak. The reactor was immediately shut down.

Investigations revealed that the end fitting on this channel had a larger bore diameter than what was specified. This resulted in improper seating of the seal plug and consequent leakage. Subsequently a new seal plug and end fitting blank to match the actual size of the end fitting were fabricated and installed before restart of the reactor.

In this incident about 1.4 tonnes of heavy water leaked from the Primary Heat Transport System. Most of the heavy water which had leaked out could be recovered using the mopping system available in the plant. One person involved in the recovery operation received an internal radiation dose of 18.49 mSv due to uptake of tritium activity. This, in combination with his previous dose resulted in a cumulative dose of 30.87 mSv for the year, which marginally exceeds the regulatory limit of 30 mSv per year. The incident did not result in any release of radioactivity from the plant, in excess of Technical Specification limits.

2.2.5 Kakrapar Atomic Power Station (KAPS)

Both units of KAPS operated normally up to a power level of 220 MWe. KAPS Unit-1 had an annual shut down from September 4, 2001 to September 30, 2001 for maintenance and surveillance activities, including in service inspection of selected coolant channels.

Light Water Leak from End-Shield Cooling System in KAPS-2

The end shields in Pressurized Heavy Water Reactors perform the dual function of supporting the coolant channels and providing radiation shielding on both sides of the reactor. Water used to cool the end shields also acts as an additional radiation shield.

On April 12, 2001, when KAPS-2 was operating at 220 MWe, during maintenance of a stand by pump a leak occurred form the end shield cooling system. Drainage of some amount of water from the end shield resulted in partial loss of shielding and increase in radiation fields in fuelling machine vaults adjacent to the reactor. The leak was isolated and the water in the end shield was made up.

It was noted that during the incident, the end shield cooling system expansion tank could not compensate for loss of water from the end shield. AERB asked KAPS to review the design and piping lay out of the end shield cooling system in the light of this incident and make necessary changes.

Incident of Flashover in Circuit Breaker Resulting in Failure of Power Supply to Important Equipment in KAPS-1

On September 27, 2001 when KAPS Unit-1 was under annual shut down, there was an incident of flash over and burning of the power supply cable of one of the process water pumps. This resulted in complete loss of power to the emergency power supply buses. All the loads connected to these buses, became unavailable. After the source of fire was identified and isolated, the power supplies and the connected loads were restored, in about 1 hour and 15 minutes. During this period of non-availability of power supply, forced circulation of Primary Heat Transport (PHT) and moderator systems were not available. Due to this, the temperature of these systems increased marginally by about 5°C. There was no release of any radioactivity or any other abnormalities due to this incident. The reactor had been shut down for about 24 days before this incident.

As per the existing design, certain important equipment in the plant, including process water pumps are provided with Dual Power Supply by which power could be given to the equipment from two different sources. This provision is made to improve the reliability of power supply to such equipment.

The flashover incident occurred due to a malfunction in the control logic of one of the circuit breakers, which feed power to the process water pump. Due to this, the pump got inadvertently connected to two independent power sources simultaneously, resulting in the flash over of the tie cable.

Subsequently, KAPS has carried out modifications

in the control logic for the circuit breakers of this pump. AERB/SARCOP asked NPCIL to carry out a detailed review of similar power supply schemes existing in all NPPs and carry out modifications, if necessary.

2.2.6 Indira Gandhi Centre for Atomic Research

Sodium Water Reaction Test Facility (SOWART)

AERB approved commissioning and operation of an experimental facility, SOWART, at IGCAR. The facility is designed to study various aspects of sodium-water reaction. These studies are important in the design and development of the steam generators, which would be used for the Prototype Fast Breeder Reactor (PFBR). The PFBR, which is currently under going design review, uses sodium heated steam generator. The heat removed by the sodium is transferred to water in the steam generator. The study will focus on the damage caused by sodium-water reaction due to very fine leaks in the steam generator system. The experimental facility would also develop various methods for detection of water/ steam leaks in sodium-water steam generators.

Shri S. B. Bhoje, Director, Indira Gandhi Centre for Atomic Research briefing the Members aof the Board

Fast Breeder Test Reactor

The Fast Breeder Test Reactor was operational up to a power level of 12.9 MWt.

Enhancement of Burn-Up Limit for FBTR Fuel

The fuel used in the FBTR consists of a mixture of Plutonium Carbide and Uranium Carbide. Since the experience on the performance of this fuel is very limited, irradiation of this fuel is being carried out with utmost care and regular monitoring of the fuel performance. Post Irradiation Examination (PIE) of 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. Based on the results of these studies and assessment of safety margins, AERB/SARCOP has extended the limit on fuel burn-up for FBTR fuel up to 102,000 MWd/T.

Leakage in Biological Shield Cooling System of FBTR

Some of the cooling coils of the Biological Shield Cooling System, which are embedded in concrete, developed leaks in May 2001. Investigations were carried out to identify the leaky coils. Four out of twelve coils were identified as leaking. Subsequently the leaks in these coils were successfully sealed using a chemical sealing technique. The Biological Shield Cooling System is now operating normally.

KAMINI

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

2.2.7 Regulatory Inspections of Operating Nuclear Power Plants and Research Reactors

Regulatory inspections of operating nuclear power plants and research reactors are carried out periodically to:

* Check for any radiological and industrial unsafe conditions existing at the Nuclear Power Plant/ Research Reactor
* Confirm whether plant operation is as per the approved Technical Specifications and AERB/ SARCOP directives;
* Confirm compliance with the maintenance, in-service inspection and quality assurance programmes.
* Confirm proper maintenance of records/ documentation.
* Check that deficiencies pointed out in earlier inspection have been rectified.

AERB Manual on Regulatory Inspections has been prepared and is being reviewed before issue. From this year, inspection related to industrial safety, civil structures and waste management etc, have been combined with normal scheduled inspections of operational and related aspects. Each plant is generally inspected twice in a

year during which all the identified areas are covered at least once.

An un-announced special inspection was carried for the first time at NAPS where in the station was informed only on the day of inspection. Special inspections (announced or unannounced) are carried out, if the on going safety review at AERB necessitates it. Some of the conditions, which warrant unannounced inspections, are violation of safety and radiation protection practices, generic problems, increasing number of unusual incidents, etc. At NAPS, the special inspection was carried out to check for compliance with the Technical Specification requirements with respect to certain important systems.

A special regulatory inspection was carried out for RAPP#4 to check for its readiness to operate continuously at its rated power. Operational aspects, maintenance and other areas of importance were reviewed. Completion of construction and commissioning activities were also reviewed. The inspection findings were discussed in safety committees of AERB prior to authorizing RAPP #4 to continuously operate at 100 % of its rated power.

During the year 2001-2002, a total of 20 regulatory inspections including three special inspections were carried out. The break-up is given in Table-2.

Table 2 Regulatory/Special Inspections of Operating Nuclear Power Plants and Research Reactors during 2001-2002

Unit	Inspections	
	Number	Type
TAPS 1-2	3	Regulatory
RAPS 1-2	3	Regulatory
MAPS 1-2	1	Regulatory
NAPS 1-2	2 1	Regulatory Special (Unannounced)
KAPS 1-2	2	Regulatory
KGS 1-2	3	Regulatory
RAPS 3-4	1 2	Special (Announced) Regulatory
FBTR and KAMINI	-	-
RAPCOF	2	Special (Announced)
Total	20	

The deficiencies brought out during the Regulatory Inspections are classified into five categories, in decreasing order of importance. **Table 3** details the deficiencies observed during the inspections.

Table 3 Regulatory/Special Inspections and categorization of findings during inspection of Operating Nuclear Power Plants and Research Reactors during 2001-2002.

Unit	Number of Ins-pections	Cat-I	Cat-II	Cat-III	Cat-IV	Cat-V
TAPS 1-2	3	2	5	4	78	30
RAPS 1-2	3	5	Nil	18	73	29
MAPS 1-2	1	4	2	1	35	30
NAPS 1-2	3	5	7	13	56	31
KAPS 1-2	2	1	6	21	64	20
KGS 1-2	3	1	6	21	38	68
RAPS3-4	3	Nil	16	30	181*	45
FBTR and KAMINI	-	-	-	-	-	-
RAPCOF	2	-	-	-	-	-

* A special regulatory inspection was carried out for RAPP 3 and 4 while authorizing for continuous operation. During such inspection, a large number of observations are made by the inspection team. Many of these relate to improvements required in procedures and quality assurance requirements to further improve safety. Many of the noted deficiencies generally belonged to Cat-IV.

Some of the major findings brought out during inspections and follow up action taken is as follows:

Category-1: Deviations from Technical Specification Requirements

1. The frequency of testing/surveillance of safety related equipment/systems of NPPs are stipulated in Technical Specifications. Some of these tests can be done only during shut down of the unit. Due to continuous runs, the units are not able to meet these requirements. This year 13 Instances of non-compliance of surveillance requirements were observed. Major non-compliance are Boiler room and F/M vault leak tests at RAPS-1, Various system Relief Valve's testing at most of the units, substantial delays in ECCS and PHT high-pressure trip instruments calibration in RAPS-2 and Fuel handling system surveillance at MAPS. SARCOP has asked NPCIL to review the testing/surveillance requirements identified in Technical Specification for various systems considering their reliability and operating experience to avoid non-compliance, which is in progress.

2. Unplanned over exposure of two contractors was noticed at RAPS where in SRUOR has not been submitted. Subsequently, station submitted the SRUOR and SARCOP discussed the same.

3. As per SARCOP directive Primary Shutdown System rod drives should be replaced once in two years. However, this was not being met by KAPS.

4. At TAPS, Specific authorization from AERB for Transfer of radioactive liquid and solid wastes from Away From Reactor (AFR) facility under Atomic Energy safe disposal of radioactive waste Rules GSR 125 was not obtained, since it is with in Site premises. Now the procedure has been established.

5. At KAPS, High rate discharge tests for 220 V DC battery banks in both units showed discharge time less than specified 30 minutes. New batteries Procurement started for replacing the batteries.

6. Nitrate concentration in moderator system should be analysed as part of chemistry control as mentioned in technical specifications, However this was not being followed at Kaiga.

Category 2: Deficiencies in System/Structures/ Components of the Plant

The performance of safety and safety related systems in the plants is under close monitoring by AERB. Any deficiencies identified are reviewed in detail in the safety committees for the root causes and their rectification. Some of the issues identified during regulatory inspections in year 2001-2002 are as follows:

i) Persistence of higher biological shield temperatures in both TAPS units.(See Section 2.2.1 for details)

ii) Failure of some of the temperature detectors in RAPS-1 due to aging related deficiencies. The station was asked to take up a detailed study and come up with an action plan to rectify the deficiencies.

iii) Increase in radiation fields in Fuelling Machine Vaults observed due to decrease in water level in end shield cooling system at KAPS. (Details given in section 2.2.5)

iv) Use of the small leak handling system water at RAPS 3&4 during normal PHT cooling, which is against the design intent. The station was asked not to resort to practices against the design intent.

Category 3: Shortcomings Identified in the Plant System Design, Based on Operating Experience

Some of the observations made in this category are:

i) Separate monitoring of Fission Product Noble Gas and Argon-41 from stack discharge system, which is necessary for better accounting and trending of the nuclides, is yet to be implemented at all stations.

ii) Spent Fuel Storage Bay area ventilation was found inadequate at Kaiga and RAPP 3&4 resulting in higher area temperature. NPCIL is in the process of modifying the air supply duct for augmenting ventilation.

iii) The training simulator at Kaiga has not reached its full scope capability as only 16 out of 64 Emergency Operating Procedures (EOP) are incorporated in the simulator for training purposes. It was suggested that at least some important EOPs like those for Loss of Coolant Accident, Station Black Out and failures of Programmable Logic Controllers should be included at the earliest.

iv) Shielding on spent fuel transfer duct was observed to be inadequate at KGS-1&2 and RAPP-3&4, causing radiation streaming in accessible areas during transfer of spent fuel. SARCOP discussed the matter. NPCIL has proposed design modifications in shielding blocks.

v) A non-return valve in the Emergency Core Cooling Systems was found to be passing at KAPS-1&2 and RAPP-3&4. It was suggested that monitoring be provided to take corrective actions.

Category 4: Adequacy of procedures, QA requirements, radiobiological emergency preparedness is checked.

Observations related to adequacy of procedures, quality assurance requirements, radiological emergency preparedness etc., are checked.

Category 5: Observations/ recommendations concerned with improvements required in house keeping.

2.2.8 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 which 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 all the installations. This is in addition to measurement of surface dose rate of waste containment, which is the basis for disposal of solid waste.

Regulatory Inspections were carried out in all facilities to ensure that safe radioactive waste management practices were followed and to verify the waste disposal records

2.2.9 Licensing of Operating Staff for Operating Plants

As a part of the responsibility of the regulatory body, the operating staff of the nuclear power plants is licensed for a specific period (generally three years) to ensure that the plants are operated by competent and qualified persons. The operating staff is 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 a higher level committee has been appointed by AERB. This committee met once in the year 2001-2002.

Table-4 gives the details of licensing of operating personnel and management personnel at various NPPs during 2001-2002.

2.2.10 Activities in the Field of Probabilistic Safety Analysis (PSA)

The present policy of AERB is to integrate PSA based study results into regulatory decision-making in an evolutionary and progressive manner. AERB's current view on PSA is as follows: -

(a) PSA results should be increasingly used in regulatory matters.

Table 4 Number of Persons Licensed for Different Positions

Plants	No. of candidates cleared for the positions						Licensing committee meetings
	Management	SCE	ASCE	ASCE(F)	CE	CE(F)	
TAPS 1-2	-	6	3	-	2	-	2
RAPS 1-2	-	4	6	2	6	6	2
MAPS 1-2	1	3	3	1	6	4	2
NAPS 1-2	1	4	7	2	12	3	2
KAPS 1-2	-	1	-	1	6	-	1
KGS 1-2	2	5	3	1	8	4	2
RAPS 3-4	2	5	5	3	8	4	3
FBTR/KAMINI	-	3	2	1	7	-	3
TOTAL	6	31	29	11	55	21	17

Abbreviations used:

SCE : Shift Charge Engineer ASCE : Asst. Shift Charge Engineer

CE : Control Engineer (F) : Fuel Handling

* In FBTR, the personnel are designated as Control Room Assistants (CRA)

(b) PSA results supported by the present state of the art and plant specific failure data can only be used as complementary tool to current regulatory practice.

(c) PSA and associated sensitivity studies and importance measures should be used extensively during designing of new NPPs to achieve a balanced design.

(d) PSA based studies with appropriate consideration of uncertainties should be used during regulatory decision in the context of plant modification, back fitting of new requirements and resolution of safety significant issues.

AERB has decided to enforce in a phased manner, submission of PSA reports and reliability study results along with all license applications. The requirement also calls for utilities to develop a plant specific failure database for components, common cause failures and human reliability within a fixed time frame. In line with AERB requirements, NPCIL has completed a PSA Level-1 study for Kakrapar Atomic Power Station. A PSA Level-1 study for Tarapur Atomic Power Station is also nearing completion. PSA report on Kaiga Generating Station is undergoing a revision based on the recommendations of the AERB review group.

Well-understood methodology, experienced team members, state of the art analysis models, reliable and comprehensive failure databases are necessary for preparing high quality PSA. A comprehensive PSA guide is being prepared which would integrate the above and present the ways and means to achieve the goal of maintaining the highest quality. AERB has drawn on expertise from BARC, NPCIL and IGCAR for this purpose.

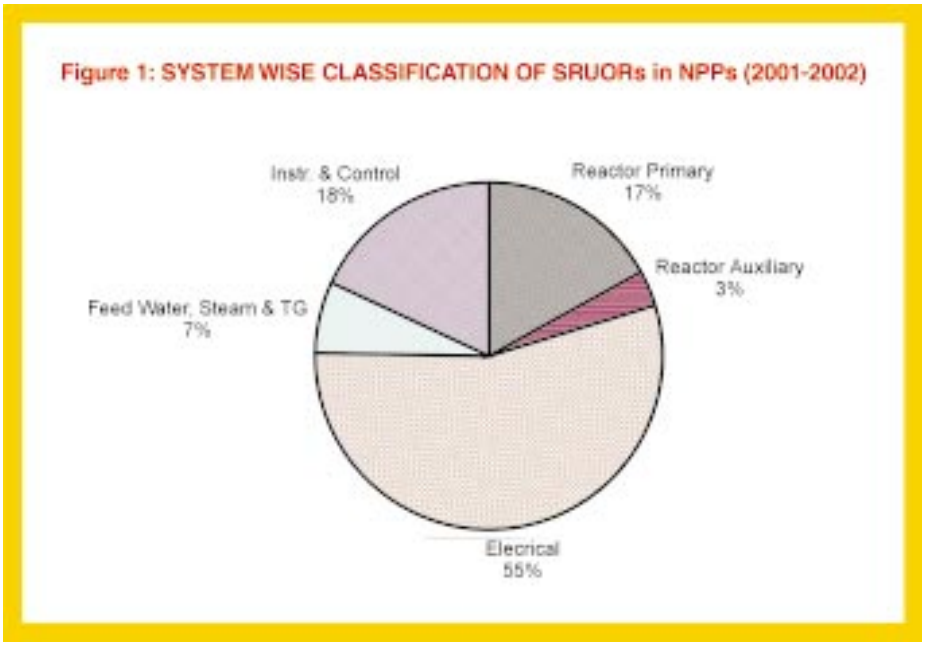
2.2.11 Significant Events

Safety Related Unusual Occurrences Reports

It is obligatory for all NPPs to report to AERB, all safety significant events occurring in a plant. The reports of such events are presently called Safety Related Unusual Occurrences Reports (SRUOR). The criteria and procedures for reporting these events are specified in the Technical Specifications of the plant.

In the year 2001-2002, there were a total of 45 events compared to 54 last year. A pie diagram showing the system-wise break up of SRUORs in NPPs (IAEA Incident Reporting System format has been followed) are given in **Figure-1.** Out of these, 7 were due to factors external to the plant, mainly related to disturbances in the electrical grid.

The SRUORs received from the operating Indian



NPPs are also being analysed on the International Nuclear Event Scale (INES). The break up of the number of SRUORs and their levels on INES for the periods 1999-2000, 2000-2001, 2001-2002 is given in Table-5. There were only two events at level one compared to ten last year. In one of the incidents that occurred at KAPS Unit-1, an electrical cable got burnt and resulted in loss of Class III, 415V power supply. (See Section 2.2.5 of report)

In another incident, a person received total radiation exposure which led to his receiving more than the annual limit specified by AERB when he was trying to stop the leak from the end-fitting blank on a coolant channel at NAPS-2 during reactor shut down condition (See section 2.2.4 of the report). All the other SRUORs (38) were rated at Level 0 on INES.

The plant wise classification of SRUORs (total number 45) for 2001-2002 on INES scale is given in Table-6. There were no events at RAPS 1&2. This year the number of events was significantly less at NAPS, KAPS and KGS, compared to the previous year (2000-2001). During the year, 6 events were reported from TAPS as compared to no events last year. Two of the six events at TAPS were because of electrical grid disturbances. Three events at RAPS 3&4 and two at KGS 1&2 are attributed to initial commissioning problems.

Table 5: Classification of SRUORs in NPPs as Rated on INES

INES Levels	1999-2000	2000-2001	2001-2002
Not in the Scale	3	2	0
0	16	42	43
1	2	10	2
2	0	0	0
3	0	0	0
>3	0	0	0
Total	21	54	45

Table 6: Classification of SRUORs in Individual NPPs (2001-2002)

Plant	Not in the Scale	International Nuclear Event Scale					
		0	1	2	3	> 3	Total
TAPS		6	0	0	0	0	6
RAPS		0	0	0	0	0	0
MAPS		2	0	0	0	0	2
NAPS		4	1	0	0	0	5
KAPS		4	1	0	0	0	5
KAIGA		12	0	0	0	0	12
RAPP3-4		15	0	0	0	0	15
	0	**43**	**2**	**0**	**0**	**0**	**45**

2.2.12 Industrial Safety

Regulatory inspections on industrial safety aspects were carried out during 2001-2002 under the Factories Act, 1948 and Atomic Energy (Factories) Rules, 1996 in the following power stations:

Madras Atomic Power Station
Kaiga Generating Station
Tarapur Atomic Power Station
Kakrapar Atomic Power Station
Narora Atomic Power Station

Recommendations to nuclear power stations included appointment of certifying surgeon, improvements in the implementation of safety work permit system and periodic medical examination of staff, improvement in housekeeping in the chlorination plant, demineralised water plant and furnace oil storage areas, availability of the ambulance van at the First - Aid Centre and round-the -clock operation of the First - Aid Centre.

The fire protection system at Tarapur Atomic Power Station was reviewed vis-à-vis AERB fire standard and a report was submitted to SARCOP. Some of major recommendations/ highlights of the review are as follows:

AERB asked the station

- to comply with the requirement that the Main and the Emergency Control Room shall not be housed in the same building, Essential equipment should be capable of starting from local points / breaker compartments.

- to separate Diesel Generators from each other / from other areas of the plant by fire barriers having fire resistance ratings of at least three hours.

2.2.13 Civil Engineering Safety

The Civil Engineering Safety Committee for Operating Plants (CESCOP) met four times to review various civil engineering aspects of operating plants.

The task force constituted by the Civil Engineering Safety Committee for Operating Plants (CESCOP-ITF) conducted thirteen inspections of operating plants. The plants inspected by CESCOP-ITF include NAPS, MAPS, KAPS, TAPS, RAPS, IGCAR, NFC Hyderabad, UCIL Jaduguda and Heavy Water Plants at Baroda, Hazira, Kota, Thal and Manuguru,. Inspection of stressing galleries of the reactor building, annular space between the outer and inner containment wall, secondary containment dome, general condition and maintenance of civil engineering structures of chemical plants, maintenance schedules, in-service inspection schedules, etc., were the major items covered by the inspection teams.

AERB constituted an Expert Committee for seismic qualification of existing DAE installations (ECSQ). ECSQ met two times 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 for determination of the Review Basis Ground Motion following USNRC RG 1.165, "Identification & Characterisation of Seismic Sources and Determination of Safe Shut Down Ground Motion" using probabilistic seismic hazard analysis also met once during this period.

2.3 OTHER NUCLEAR FACILITIES

2.3.1 Nuclear Fuel Complex, Hyderabad

The Advisory Committee on Fire Safety visited Nuclear Fuel Complex on February 8, 2001 to assess the fire safety aspects of the plant. Four plants, viz. New Uranium Oxide Plant (Oxide), New Uranium Oxide Plant (Pelletising), New Uranium Fuel Assembly Plant and New Zircaloy Fabrication Plant handling large quantities of flammable chemicals were set up in 1999. In view of this, the Committee recommended upgradation of the Fire Station at NFC. It suggested that a two-crew system with a staff strength of 66 be deployed with proper utilisation of facilities.

The NFC Safety Committee met on January 25, 2002 at Nuclear Fuel Complex to review the application for authorisation of operation of New Uranium Oxide Fabrication Plant (NUOFP). It recommended renewal of the provisional authorisation granted earlier for a further period of six months up to June 30, 2002. Some of the other issues discussed by the Committee were as follows:

Action Plan to Bring Down Average Air Activity Level in Roll Press Area

Average air activity for roll compaction area of Ceramic Fuel Fabrication Plant (CFFP) for the year 2001 was 1.87 Bq/m3. For achieving further improvement in Uranium average air activity levels following actions have been planned.

(1) To replace pneumatic conveyor for UO2 powder by container concept.

(2) Modification of existing ventilation system in Roll Compaction area, which is expected to be finalized before June 2002.

Management of Pyrophoric Waste

Waste which is pyrophoric in nature is generated in Zirconium Sponge Plant (ZSP). Freshly generated pyrophoric waste from ZSP is being incinerated on daily basis. It has also been planned to start incineration of the accumulated waste kept in the fenced area of Solar Evaporation Pond (SEP).

Handling of Uranium Wastes/Material

(i) To control spreading of contamination, drums containing active solid waste, lime cake, etc. have been shifted to Magnesium Di Uranate store and storage sheds at Solar Evaporation Pond area for temporary storage.

(ii) Two new storage sheds will be constructed in SEP area by Dec. 2002 and temporarily stored drums will be shifted to these sheds.

New Schemes for Effluent Treatment/Disposal

At present in old plants non process active and

non active effluents are treated together. Separate facilities have been proposed for treatment of the above effluent from old fuel plants.

Contamination of Cooling Water

In fuel plants cooling water is found to be contaminated. NFC Safety Committee recommended isolation of cooling water lines of fuel plants to prevent contamination of main cooling water system. Accordingly a dedicated scheme for isolation of supply and return cooling water lines of old system in fuel plants and separating air conditioners lines from other system has been prepared..

2.3.2 Heavy Water Plants

The Safety Committee for Heavy Water Operating Plants (SCHWOP) met a few times and reviewed the following documents/reports:

(i) the In-Service Inspection documents in respect of Heavy Water Plants at Kota and Tuticorin,

(ii) Revised Safety Report of R & D pilot plant for the production of Di-2-Ethyl Hexyl Phosphoric Acid (D2EHPA) at Heavy Water Plant, Talcher, (The report was cleared and AERB issued an operational clearance with the stipulation that the Heavy Water Plant should prepare an In-Service Inspection plan for the Glass-Lined Reactor and the Technical Specifications for the Plant.)

(iii) Safety-Related Unusual Occurrence Report on flashover at Heavy Water Plant, Manuguru.

(iv) Technical Specifications of the Captive Power Plant at the Heavy Water Plant, Manuguru, (The major recommendations made were that a chapter on Administrative Control should be added and that the temperature limit should be given under specifications for Monitoring of Temperature inside Coal Heap.)

(v) Safety Report of Tri-Butyl Phosphate plant being put up at Heavy Water Plant, Talcher. Major points brought out in the review were that the effluent treatment scheme should be finalised, that the Hazard and Operability Study (HAZOP) of the plant should be expedited, and that Consequence Analysis for some likely scenarios should be conducted.

(vi) In-Service Inspection requirements of Ammonia crackers. (The Heavy Water Board was requested to work out details regarding acceptance criteria for tests, possibility of eddy current testing, etc.)

2.3.3 Indian Rare Earths Limited (IREL)

IRE Safety Committee met six times during the year. It reviewed documents and discussed the issues related to:

- Review of the revised Technical Specifications of IRE, Manavalakurichi and IRE, Chavara and IRE, OSCOM;
- Revised Safety Assessment Report of New Thorium Plant to operate on Thorium Oxalate route at IRE, OSCOM;
- Annual performance report of New Thorium Plant at IRE, OSCOM;
- Processing of Thorium Concentrate, Rare Earths Hydroxides, Uranium Carbonate received from Thorium Plant, Trombay at IRE, OSCOM;
- Review of Safety Report of Zirconia Pilot Plant at IRE, OSCOM;
- Report of Non-Destructive Tests carried out in Dredge and Wet Concentration Plant at IRE, OSCOM;
- Storage of Monazite in additional trenches at IRE, OSCOM;
- Safety Report on additional recovery of Zircon and Rutile at IRE, Manavalakurichi;
- Safety Report on stockpiling of Monazite Tailings in earthen trenches at IRE, Manavalakurichi;
- Providing hoods and exhaust on Air Tables for Monazite Segregation at IRE, Manavalakurichi;
- Construction of additional silo for Thorium Oxalate storage at IRE, Udyogamandal;
- Expansion plans of IRE plants at Chavara, Manavalakurichi and Chhatrapur
- Safety Report of Zirconia Plant, etc.

IRE Safety Committee in its meeting held at IRE, Udyogamandal from 7th to 9th February 2002 reviewed documents and discussed various issues related to:

- Storage and transport of Thorium Nitrate in double - lined HDPE jumbo bags,

- Safety Report of THRUST project for retrieval of Thorium concentrate and processing at IRE, Udyogamandal,

- Review of Technical Specifications and Health Physics Reports of IRE, Udyogamandal.

2.3.4 Uranium Corporation of India Ltd.

AERB reconstituted the Safety Committee for Uranium Corporation of India Ltd. and Atomic Minerals Directorate on May 2, 2002. During a review of the pending issues, the committee was informed among other matters that UCIL has issued radon personal dosimeters to 1000 out of around 3000 miners in the Unit during the year, and that the fencing of the Tailings Pond has been completed in October 2001. However, there is continuous tampering of the fencing by the villagers for using tailings pond area as a shortcut to go from one village to the other. The Committee requested UCIL to have better vigilance and to ensure that the tampered fencing is repaired on a regular basis.

The Committee noted that installation of a ventilation fan 75 m3 / sec capacity (Adit 4) is in progress in Jaduguda Mines and is expected to be completed by July 2002. This would augment the ventilation of the mine to 130 m3 / sec.

UCIL applied for authorisation to extract Uranium ore from Turamdih Mines and to transport it to Jaduguda Mill. The initial development of the mine was started in 1987, but it was closed due to operational reasons in 1992 under a directive from the Department of Atomic Energy. The openings to the mine made at that time were sealed. The mine, planned to have a production of 750 tonnes / day, is expected to come up in the next four years.

The Committee asked UCIL to prepare the Safety Report for the mine in three stages:

i) Opening of the seals of the mine
ii) Development of the mine to operate up to 2nd level
iii) Mining of Uranium ore and its transportation

The Safety Report for the 1st stage i.e. 'Opening of the seals of the mine' was submitted to AERB in October 17, 2001. UASC scrutinized the Report and recommended opening of the seals. AERB issued the Authorisation on December 28, 2001 with certain stipulations. UCIL will submit a report after completion of the 1st stage.

UASC held another meeting on March 26, 2002 at Jaduguda, and discussed various issues. It desired that the number of air changes in the Jaduguda mines with the existing ventilation fans (Adit 2 and Adit 5) and the new fan (Adit 4) should be measured. The Committee also desired that the Plant should submit the requirement of increase in capacity of Adit 5 fan and the detailed schedule for its installation. Maintenance of adequate ventilation is required to reduce airborne radioactivity.

UCIL has submitted the Safety Report of the next stage i.e. 'Development of the Mine to operate up to 2nd level' to the Committee.

2.3.5 Industrial Safety Licences, Authorisations and Clearances Issued

a) Licences under the Factories Act, 1948

AERB renewed the licence of the following nuclear power stations for a further period of five years.

- Tarapur Atomic Power Station 1-2 (TAPS 1-2) from 27th August 2001.
- Madras Atomic Power Station 1-2 (MAPS 1-2) from 27th October 2001.
- Rajasthan Atomic Power Station 1-2 (RAPS 1-2) from 20th October 2001.
- Kaiga Generating Station 1-2 (KGS 1-2) from 12th December 2001.

b) Heavy Water Plant, Baroda Revival Project

Construction clearance for phase 2 of Heavy Water Plant, Baroda Revival Project was issued in addition to the clearance for Phase 1.

2.3.6 Significant Events

Fatalities due to Industrial Accidents

There were four work-related fatalities due to industrial accidents during 2001-2002 in various DAE units during the year. The Unit-wise break up is given in **Table-7.**

Table 7 Fatalities due to Industrial Accidents in DAE Units in 2001-2002

Unit	Category of worker	Cause
Kaiga Atomic Power Project 3-4 (8th Nov. 2001)*	Contractor's worker (Driver of Tractor)	Fall of object / material.
Variable Energy Cyclotron Centre, Kolkata (18th December 2001)	Contractor's worker	Fall of the person from height.
Tarapur Atomic Power Project 3-4 (23rd Dec. 2001)	Contractor's worker (Foreman-Rigger of a Fabrication Shop)	Fall of object / material.
Kaiga Atomic Power Project 3-4 (11th January 2002)*	Contractor's worker (Helper)	Fall of object / material.

* AERB withdrew the excavation clearance to Kaiga-3&4 because of these incidents. Permission to resume excavation was granted only after NPCIL implemented certain stipulations.

Investigation reports of fatal accidents submitted by the concerned DAE units and the reports submitted by members of Assessment Committee after visiting the accident site were reviewed by the Fatal Accidents Assessment Committee of AERB. Its comments and recommendations were conveyed to the Unit concerned and all other DAE units for implementation.

2.3.7 Licensing of Plant Personnel

a) Approval of Competent Persons under the Factories Act

AERB granted approval to two persons nominated by Madras Atomic Power Station one person nominated by Heavy Water Plant, Thal and eleven persons nominated by Indian Rare Earths Ltd., OSCOM, Chhatrapur to act as 'Competent Persons' in the Plant under various Sections of the Factories Act, 1948.

b) Approval of Certifying Surgeons under the Factories Act

Approval was granted under Section 10 of the Factories Act, 1948 to Indian Rare Earths Plants at Chhatrapur (OSCOM), Manavalakurichi and Chavara, and Heavy Water Plants at Kota, Tuticorin, Thal and Manuguru for appointment of the designated Medical Officers of the plants as Certifying Surgeons for their respective plants.

c) Licensing of Operating Staff for Operating Plants

Officers of AERB participated in the meetings of Plant Level Authorisation Committees of Heavy Water Plants for authorisation / and qualification of staff for the job positions of Senior Operators and Junior Operators of the Heavy Water Plants.

2.3.8 Industrial Safety: Regulatory Inspections

Regulatory inspections on industrial safety aspects were carried out during 2001-2002 under the Factories Act, 1948 and Atomic Energy (Factories) Rules, 1996 in the following DAE units:

Indian Rare Earths Ltd., Udyogamandal
Indian Rare Earths Ltd., Chavara
Indian Rare Earths Ltd., Manavalakurichi
Indian Rare Earths Ltd., OSCOM
Heavy Water Plant, Tuticorin
Heavy Water Plant, Thal
Heavy Water Plant, Hazira
Heavy Water Plant, Kota
Heavy Water Plant, Manuguru
Heavy Water Plant, Baroda
Nuclear Fuel Complex, Hyderabad

Uranium Corporation of India Ltd., Jaduguda
Electronics Corporation of India Ltd., Hyderabad
Atomic Minerals Directorate, Hyderabad
Variable Energy Cyclotron Centre, Kolkata
Centre for Advanced Technology, Indore

In each case, a detailed inspection report was sent to the concerned units with the major shortcomings being highlighted. Some of the recommendations made are mentioned in the following paragraphs.

In respect of IREL Plants, AERB recommended revision of the Fire Order, review of Safety Work Permit system, preparation of plant radiation protection procedures manual, colour coding of all pipelines, laying/ updating fire hydrant layout and reporting of any violation of Technical Specifications.

AERB recommendations to UCIL included designating Competent Persons for testing / examination of various equipment and carrying out load testing of lifting machines and hydrostatic pressure testing of pressure vessels periodically as per schedule. Inadequacy of fire staff and the need for a deluge system for transformers at various locations were pointed out.

Based on the inspections of Heavy Water Plants, AERB recommended that they should update frequently the display of positions of diode pins on Programatrix board in the Control Room, enforce 'No Smoking' strictly in hazardous areas, rectify the problem of spurious alarms on the fire panel, apply fire retardant coating to critical cables, prepare in-service inspection manual, expedite authorisation of operating personnel, impart refresher training in the use of personal protective equipment.

2.4 SAFETY UP-GRADATIONS IN DAE INSTALLATIONS

During the year, AERB continued to monitor the implementation of the action plans for safety issues in DAE installations.

As on March 31, 2002, 119 out of the 134 safety issues have been resolved completely. The process of implementing the action plan for the remaining safety issues is progressing satisfactorily. The monitoring of the safety status of the installations of DAE is a continuing process. In addition to the initial assessment, the staff of AERB verifies whether the resolution of each issue is satisfactory or not during regulatory inspections and review meetings.

The pending issues coming under the purview of AERB have been classified into four categories.

Category1: Hardware Related Issues requiring replacement of defective components (3*)

Category 2: Ageing related issues needing elaborate studies to assess the healthiness of various components as well as possible replacement of components which have been showing signs of deterioration(1*).

Category 3: Issues involving analytical studies or computer based calculations on certain systems to assure that the earlier designs are safe (0*).

Category 4: Upgradation Related Issues - Plants that have been built to earlier safety standards require an upgradation according to the current safety standards and this may involve an assessment and modification (6*). ■

* Number of pending issues

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 six meetings from April 2001 to March 2002. Based on the recommendations of SARCAR, AERB issued type approval certificates to the manufacturers/suppliers of devices incorporating radioactive materials and radiation generating equipment. Type approvals were issued for 169 devices and equipment during the year. The following is the break-up:

Medical diagnostic X-ray units	:	68
Mammography units	:	2
Medical simulators	:	4
Teletherapy units	:	2
Gamma knives	:	2
Medical linear accelerators	:	10
Medical cyclotrons	:	1
Remote controlled brachytherapy units	:	2
Gamma chambers	:	7
Nucleonic gauging devices	:	63
Ionisation chamber smoke detectors	:	8

AERB reviewed the application for siting, design and design modifications, and commissioning of the following facilities as applicable:

AERB gave clearance to M/s. Radiant Cables Private Limited, Hyderabad to operate an electron beam irradiator.

The Board gave site clearance to M/s. Agrosurg Irradiators (India) Private Limited, Vasai, Thane and Rahuri Taluka Shetimal Prakriya Sahakari Santha Limited, Rahuri, Ahmednagar to locate high capacity gamma irradiation plants.

Representatives of AERB inspected the sites for the following new gamma irradiation projects:

1. M/s Sterikit India Ltd., New Delhi
2. M/s Rahuri Taluka Shetimal Prakriya Sahakari Sanstha Ltd., Rahuri, Ahmednagar, Maharashtra.

Three more institutions have approached AERB for site clearance for setting up of gamma irradiation facilities in Kolkata, Mysore and Hyderbad. AERB has advised them on requisite regulatory requirements to be complied with for obtaining clearances.

3.1.2 Approval of Radiological Safety Officers

During the year, approval certificates were issued in respect of 194 Radiological Safety Officers. The break-up is as follows:

RSO Level-III (Medical)	:	100
RSO Level-II (Nuclear medicine diagnosis)	:	12
RSO Level-III (Industry)	:	9
RSO Level-II (Industry)	:	7
RSO Level-I (Industry and research)	:	66

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

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-8** below:

Table 8 Number of Authorisations Issued

Radiation facilities	No. of authorizations issued
Teletherapy	16
Brachytherapy	51
Blood irradiator	1
Nuclear medicine	490
Unsealed sources in research	116
Industrial radiography	1624
Nucleonic gauging	268
Manufacture of consumer products	100
Total	2666

3.3 RADIOLOGICAL SAFETY SURVEILLANCE

3.3.1 RAPPCOF

Operations at the Cobalt facility at RAPP (RAPPCOF) were suspended in October 1999 as directed by AERB after an incident of excessive radiation exposure took place on October 15, 1999. Investigations into the incident indicated gross deficiencies with respect to hardware, safety provisions, administrative controls etc. After this, RAPPCOF was required to carry out a number of safety related improvements (including engineering modifications), training and qualification of personnel, procedural improvements and restructuring of the organization. In April 2001, AERB carried out a special regulatory inspection at RAPPCOF to check the implementation of the improvements, other recommendations of the safety committees of AERB and the overall safety status of the plant.

After a thorough review, AERB permitted resumption of normal operation of RAPPCOF Operation of RAPPCOF resumed on June 18, 2001.

3.3.2 High Intensity Gamma Irradiation Facilities

AERB staff carried out regulatory inspections of the following seven gamma irradiation facilities.

1. Panoramic Batch Irradiation Technology (PANBIT), Thiruvananthapuram, Kerala
2. Radiation Vulcanization of Natural Rubber Latex (RVNRL), Kottayam, Kerala
3. Radiation Sterilization and Hygenisation of Medical Products (RASHMI), Bangalore
4. Shriram Applied Research Centre (SARC), Delhi
5. Demonstration Facility for Irradiation of Spice, BRIT, Vashi, Navi Mumbai
6. ISOMED Facility, BRIT, Mumbai
7. Raksha Anusandhan Vikas Irradiator, Defence Lab, Jodhpur.

AERB gave general directions to improve the status of radiological and industrial safety at these facilities. These include periodic calibration of radiation survey instruments, removal of waste and inflammable materials from inside the irradiation cell and cell roof, extension of trip wire up to personnel access door, civil maintenance of walls of irradiation cell, proper tension to be maintained in trip wire, training of personnel in handling and operation of fighting equipment, replacement of source raise wire rope, replacement of false ceiling over the control room and updating of safety records.

AERB received safety status reports for all the four quarters in the year 2001. The occupational exposures in the 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 proposals to replenish Co-60 sources in four gamma irradiation facilities and issued clearances for the same.

Design modifications in Shriram Applied Research Centre (SARC) Irradiation Facility, Delhi.

AERB reviewed the proposal from SARC Irradiation Facility for modification in design and layout aimed at improving operational performance and efficiency of the plant. The proposal included modifications such as provision of a separate sliding door from the control room to box transfer station, shifting the manual hydraulic operation switches, modification in - C of box transfer station, replacement of Ram A and minor modifications in loading conveyor. AERB issued clearance subject to the conditions that the modification work would be undertaken with the source in the fully shielded position in the water pool under the

supervision of RSO, that QA procedures would be adopted in selection and replacement of the components, and that adequate trial runs would be conducted to indicate safe operation.

Decommissioning of Gamma Irradiation Facility

AERB reviewed the proposal to decommission Panoramic Batch Irradiation Technology facility located in M/s Western India Plywood Ltd., Cannanore, Kerala. The facility was not in operation since April 1998. AERB issued approval for decommissioning subject to conditions such as safety coverage by a Health Physicist during decommissioning, swipe test of accessible areas near the source cage, safe transport of flask containing Co-60 source from Cannanore to Mumbai. The facility was successfully decommissioned during October 10-12, 2001. The Co-60 source (351.5 TBq) was safely transported under special arrangement provisions approved by AERB and brought to Mumbai on 15-10-2001. The radiation dose incurred during the entire decommissioning by the operators was insignificant.

3.3.3 Radiation Diagnostic and Therapy Facilities

AERB staff inspected nineteen teletherapy and brachytherapy installations all over the country. On the basis of pre-commissioning safety analysis, AERB also issued authorisations for the commissioning of 14 teletherapy units and 7 remote after-loading brachytherapy units during the year. AERB staff inspected twenty-five 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 40 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 forty-two medical X-ray diagnostic installations for confirming compliance with the regulatory requirements. Deviations and violations of regulatory requirements which were observed during the inspections were taken up with the users. In some cases, AERB initiated appropriate regulatory actions such as suspension of licence of the institutions.

Dr. A. R. Reddy (Centre), Chairman, Safety Review Committe for Application of Radiation, presiding over the meeting of the Committee.

3.3.4 Industrial Radiography

Thirty industrial radiography sites and installations were inspected for confirming compliance with the regulatory requirements. Each user sends monthly safety status reports. These help AERB to monitor the radiological safety status continuously.

3.3.5 Nucleonic Gauging

The application of nucleonic gauges for level monitoring, thickness gauging, density measurement and moisture detection in many industries such as steel, paper, plastic, textile, cement, power, coal and oil exploration recorded a notable increase. AERB inspected thirty-seven such installations. Each user is required submitted six-monthly safety status reports. Besides providing inputs for radiological safety surveillance, these reports help to update the source inventory. AERB compiled a database of the radioactive materials used in nucleonic gauging.

3.3.6 Manufacture of Consumer Products

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

3.3.7 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 approval for BRIT Lead Container BLC-100. In addition, AERB renewed the package design approvals of Gamma Chamber GC-5000 and COF-285.

Twenty-two authorizations for transport of radioactive material were issued, while twenty-one regulatory inspections of packages were carried out during the year.

Safety in transport of radioactive materials in the public domain is ensured by strict compliance with the "Surveillance Procedures for Safe Transport of Radioactive Materials, 1987" and the AERB Safety Code on "Transport of Radioactive Materials, 1986". Regulatory activities include safety assessment and package design approval for transport, renewal of package design approvals. As a measure of compliance assurance, representatives of AERB witnessed the testing of two Type A packagings by and one Type B packaging by NPCIL.

3.3.8 Disposal of Radioactive Material

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

Local disposal	: 42
For transfer at disposal sites	: 40
Number of consignments transported for disposal	: 34

3.3.9 Public Announcement for Medical X-ray Installations

In December 2001, AERB made a public announcement in all the leading national and regional newspapers informing the users of medical X-ray units about the regulatory requirements and procedures for registering their units with AERB. Currently over 30,000 medical X-ray installations are registered because of the massive registration campaign conducted by AERB a few years ago. AERB directed all the suppliers of X-ray units in India to get the new users registered with AERB.

3.4 UNUSUAL OCCURRENCES

The airport authorities informed AERB that there were 67 packages containing radioactive material at the international airports at Mumbai, Delhi, Kolkata and Chennai. Most of the packages contained radiopharmaceuticals (radioactive materials used in nuclear medicine). Others contained radioactive sources used in nucleonic process control systems and ionising chamber smoke detectors.

AERB identified the consignees from the transport documents and issued show cause notices to them. The reasons for not collecting the packages varied. Some claimed that they could not get the clearing papers in time. A few claimed that they received the papers late. Most of the packages contained radioactive materials of low activity and short half-life. In such instances, if the packages are collected late, the sources are useless, as the activity has decayed considerably. Though the hazard potential of these sources is very low, the practice is not desirable. There is also the possibility that the package may get auctioned. The Waste Management Division, BARC assisted AERB in disposing of some of the unclaimed packages. The Board has initiated action to dispose of the rest.

AERB initiated several steps to prevent recurrence of such situations. After identifying the procedural weaknesses, AERB informed the Airports Authority of India (AAI) that if a package containing radioactive material remains unclaimed for more than 15 days, AAI should inform the Radiological Physics and Advisory Division, BARC and AERB. This practice is currently in place.

AERB decided to monitor periodically the godowns meant for in-transit storage of radioactive material. The Board will also maintain an inventory of sources right from the stage of authorization to safe disposal. AERB also decided to organize short term awareness programmes for cargo handlers and customs and airport authorities. One such programme has already been conducted.

One density gauge incorporating a caesium 137 source of low activity (approximately 1.12 GBq) was lost in a coal washery. Even after a detailed survey, the gauge could not be retrieved. The gauge was provided with adequate radiation shielding. However, the coal washery was directed to search all possible locations and establish complete control over all other gauges in their possession.

Three well logging sources 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 or interfere with the oil production.

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

3.5.1 Gamma Irradiation Facility

On June 28, 2001, AERB withdrew the Certificate of Approval issued to the plant for Radiation Processing of Spices at Vashi, Navi Mumbai operated by BRIT. This action was based on the report of an inspection team which found certain procedural lapses needing urgent correction. Representatives of AERB visited the facility to verify the performance of the safety systems and work procedures at the facility. The inspection team found that the facility had violated the terms and conditions specified in the regulatory consent issued by the Competent Authority. Violations observed included non-adherence to the stipulated preventive maintenance schedule and unsatisfactory performance of one safety system. Although public safety had not been compromised in any way, it was felt necessary to withdraw the Certificate of Approval. As a result, operation of the plant was suspended.

BRIT rectified the deficiencies. After satisfying itself that adequate remedial steps had been taken, AERB revoked on July 17, 2001 its directive withdrawing the Certificate of Approval so that normal operation could be resumed.

3.5.2 Industrial Radiography

During inspections, AERB inspection teams observed that seven industrial radiography institutions had violated the regulatory provisions stipulated for industrial radiography. The following were some of the violations: Carrying out radiography in day time by an uncertified person, non-availability of certified personnel at radiography site while conducting radiography work, non-availability of emergency handling tools, inadequate number of radiation survey instruments, storing the exposure device in unlocked condition, and operation of the device by removing the radiography source from the exposure device.

A few cases of overexposures received by radiography personnel were also investigated and regulatory actions enforced against the concerned institutions. The actions taken included issuance of warning letters, suspension of radiography work for a certain period, submission of undertakings to AERB and adverse entries in the certificates of radiography personnel.

The following are examples of some incidents which occurred and the actions taken:

(i) An empty industrial radiography exposure device (IGRED) was taken away by the employee of an industrial radiography institution and not returned to the owner. Since the device was empty, the incident did not pose any radiation hazard. However, the matter was investigated and the device traced.

(ii) An industrial radiographer handled a defective IGRED without emergency handling tools. The institution was directed not to handle the device until the investigation was completed.

(iii) A trainee radiographer handled an unshielded industrial radiography source and received radiation burns on his fingers. The effective dose received by him was not very high and the fingers healed quickly. The device involved in the incident was not permitted to be used until the investigation was completed.

3.5.3 Nuclear Medicine Laboratories

During the year, AERB sent teams of officers to inspect nuclear medicine facilities in twenty-eight

hospitals. The overall safety status was found to be satisfactory. However, the inspectors observed violations in some of the laboratories. These included deviations from approved plans, shifting of laboratories to unapproved locations, non-availability of properly functioning radiation survey meters and radioactivity measuring equipment, improper furnishing, inadequate isolation of patients and employing of under-qualified persons. Some of these violations may lead to unsafe conditions. The radiation doses to workers in these cases are not likely to be high as the amount of radioactivity handled is small.

AERB sent show cause notices to the defaulting institutions on the basis of the reports of inspection teams. The responses to the notices and the inspection reports were reviewed by a special committee. Based on the recommendations of this committee, AERB suspended the authorisation of three nuclear medicine laboratories for periods up to three months. Nuclear medicine procedures were indefinitely stopped in one hospital because of lack of facilities for high dose therapy. AERB directed defaulting institutions to comply with safety provisions. Six institutions were then re-inspected.

3.5.4 Facilities Manufacturing Devices Containing Radioactive Materials

During the inspection of firms manufacturing products like gas mantles and fluorescent lamp starters containing thorium, AERB staff observed the following conditions in some of the institutions:

1. Finished products were stored in occupied areas such as offices.

2. Ventilation was not adequate in working areas.

3. Floors were not lined with tiles with impermeable surfaces.

4. Workers were not using appropriate personnel protective equipment while handling thorium compounds.

As a result, workers were being exposed to small amounts of radiation. AERB directed the firms to remedy the undesirable conditions and informed them of the relatively simple measures which would enhance radiological safety in their working environment. ■

SECTION 4
ENVIRONMENTAL AND OCCUPATIONAL SAFETY

4.1 ENVIRONMENTAL SAFETY

Environmental surveillance of all operating plants under DAE is done by an Environmental Survey Laboratory of the Health, Safety and Environment Group, BARC at each site. The radiological impact due to operation of these plants is assessed on a continuous basis. The radioactivity released to the environment during the year 2001 from the operating units was well within the prescribed technical specification limits. **Figures 2a to 2e** show the various liquid and gaseous discharges from the plants. Data for previous years is also included for comparison. **Figure 3a** shows the committed dose to the members of public due to release of radioactive effluents from the plants. Radiation dose to members of public near the operating NPPs is estimated based on measurements of radio nuclide concentrations in the items 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 boundary of the exclusion zone) is much less than the dose limit of 1000 microSv.

4.2 OCCUPATIONAL EXPOSURES

AERB has prescribed an annual dose limit of 30 mSv for radiation workers and a limit of 100 mSv over a period of five consecutive years. A Standing Committee reviews radiation exposures above the prescribed limits. The Committee also reviews the circumstances under which any radiation worker in the country has been exposed to more than 20 mSv in any particular year. This review is in addition to the review by the in-house committees.

The Committee met three times during the year. It reviewed 51 instances of exposures during the year 2000 above the specified limits from non-DAE institutions. The Committee had earlier reviewed 32 cases of the year 2000 in the meetings held during 2000-2001. Thus totally 83 instances were reviewed. Five of the cases became instances of less than 20 mSv, when the circumstances of the exposure were considered and evaluated. After deliberation the Committee identified that out of the remaining 78 cases, 40 were non-genuine. Out of the 24 instances of single year exposures of the year 2001 reviewed so far, 18 were found to be non-genuine. The non-genuine exposures were due to the callousness on the part of workers, e.g., leaving the dosimeters inadvertently or deliberately in the radiation field. It was also observed that some X-ray workers wore the dosimeters above the lead aprons, contrary to instructions. In such cases, the actual doses received will be substantially lower than the recorded dose because of the shielding offered by the apron.

The Committee noted that the concerned institutions had been warned and asked to take preventive steps. The Committee suggested that BARC and AERB should carry out periodic and unannounced radiological protection surveys to identify the defaulting institutions.

Fifteen cases of single year exposures of the year 2001 from DAE units, were also reviewed by the Committee. Out of these, one case was declared to be non-genuine. The Committee reviewed the investigation reports of in-house committees of DAE units and found that the explanations given were satisfactory.

The number of workers who received radiation doses greater than 30 mSv (Annual limit) and 20 mSv (Investigation limit) during the year in NPPs 2001 is given as in Table-9a. The percentage of workers who received doses above the limits is given Table-9b. Data from earlier years is also given for comparison. Only two cases of exposures greater than 30mSv occurred, one at RAPS-1&2 and one at NAPS. At RAPS-1&2, one temporary worker crossed the annual limit and received a dose of 38.3mSv while working in the vicinity of a high radioactive source in the Fuelling Machine Vault. He was unaware of the presence of the source. At NAPS, one regular worker marginally exceeded the annual limit and received 30.87mSv. During the recovery of heavy water that had leaked from one of the coolant channels, he received a high internal uptake of tritium. As a result, his whole body dose marginally exceeded the annual limit. 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.

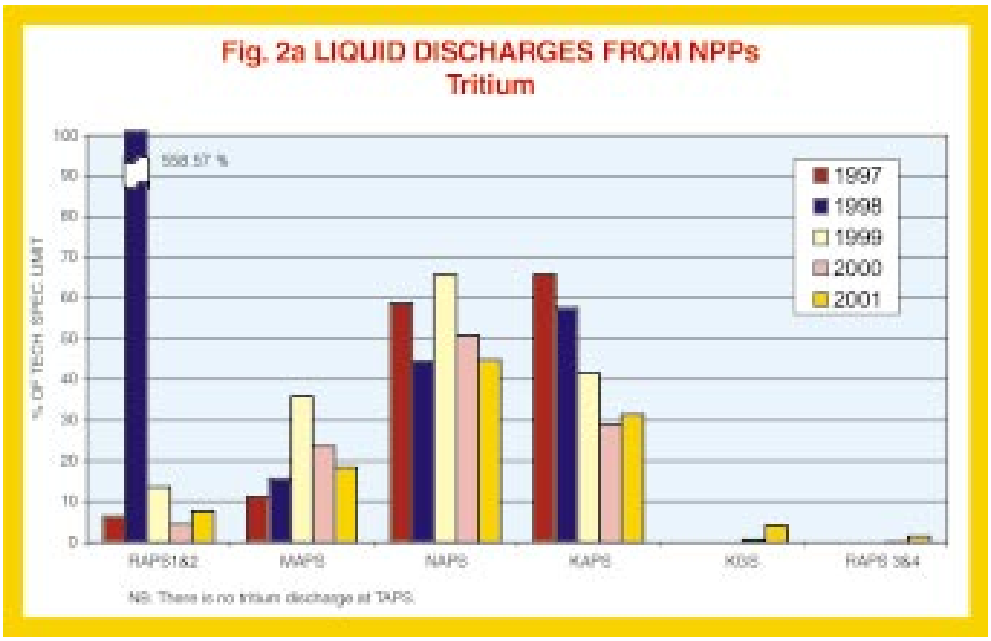


Fig. 2a LIQUID DISCHARGES FROM NPPs
Tritium
% OF TECH. SPEC. LIMIT
558.57 %
1997
1998
1999
2000
2001
RAPS1&2
MAPS
NAPS
KAPS
KGS
RAPS 3&4
NB: There is no tritium discharge at TAPS.

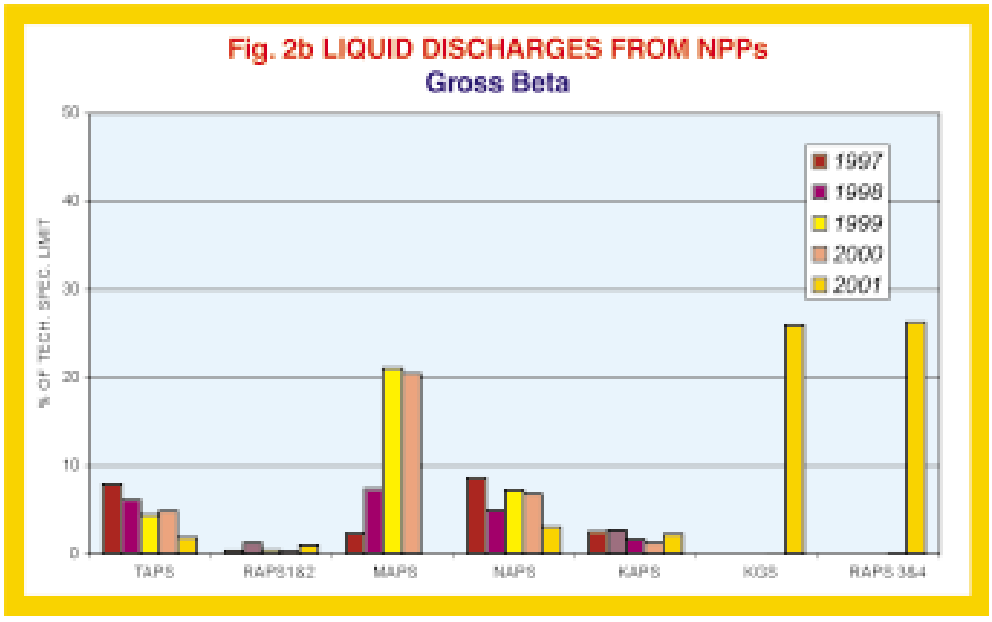


Fig. 2b LIQUID DISCHARGES FROM NPPs
Gross Beta
% OF TECH. SPEC. LIMIT
1997
1998
1999
2000
2001
TAPS
RAPS1&2
MAPS
NAPS
KAPS
KGS
RAPS 3&4

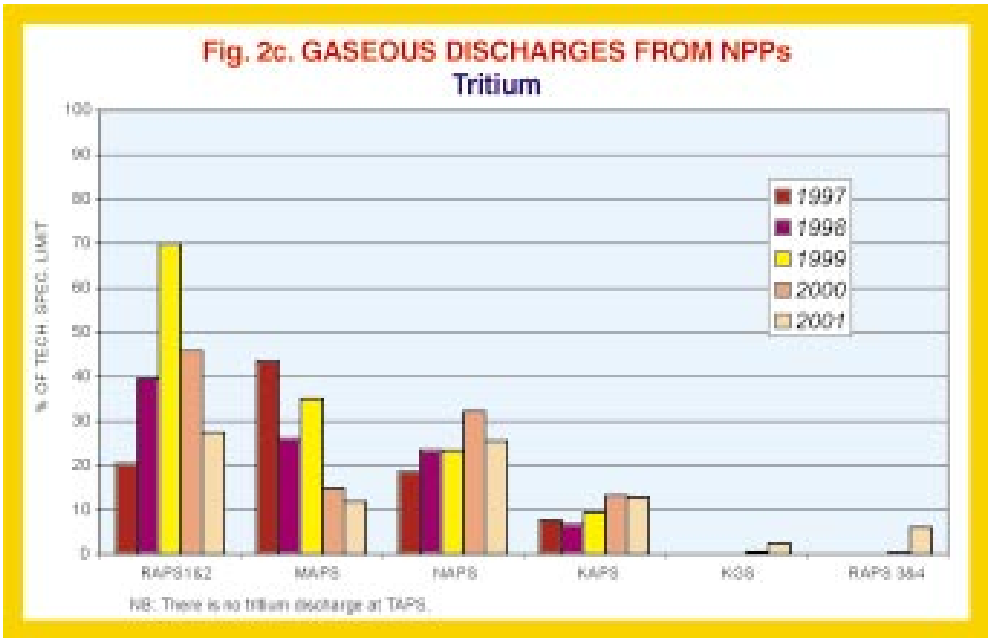


Fig. 2c. GASEOUS DISCHARGES FROM NPPs
Tritium
% OF TECH. SPEC. LIMIT
100
90
80
70
60
50
40
30
20
10
0
1997
1998
1999
2000
2001
RAPS1&2
MAPS
NAPS
KAPS
KGS
RAPS 3&4
NB: There is no tritium discharge at TAPS.

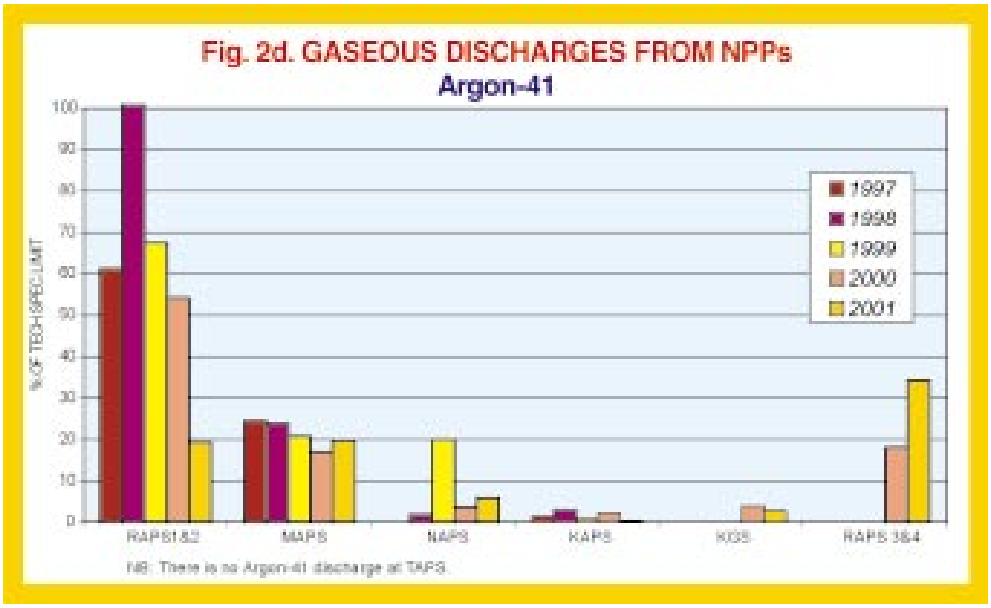


Fig. 2d. GASEOUS DISCHARGES FROM NPPs
Argon-41
% OF TECH SPEC LIMIT
100
90
80
70
60
50
40
30
20
10
0
1997
1998
1999
2000
2001
RAPS1&2
MAPS
NAPS
KAPS
KGS
RAPS 3&4
NB: There is no Argon-41 discharge at TAPS.

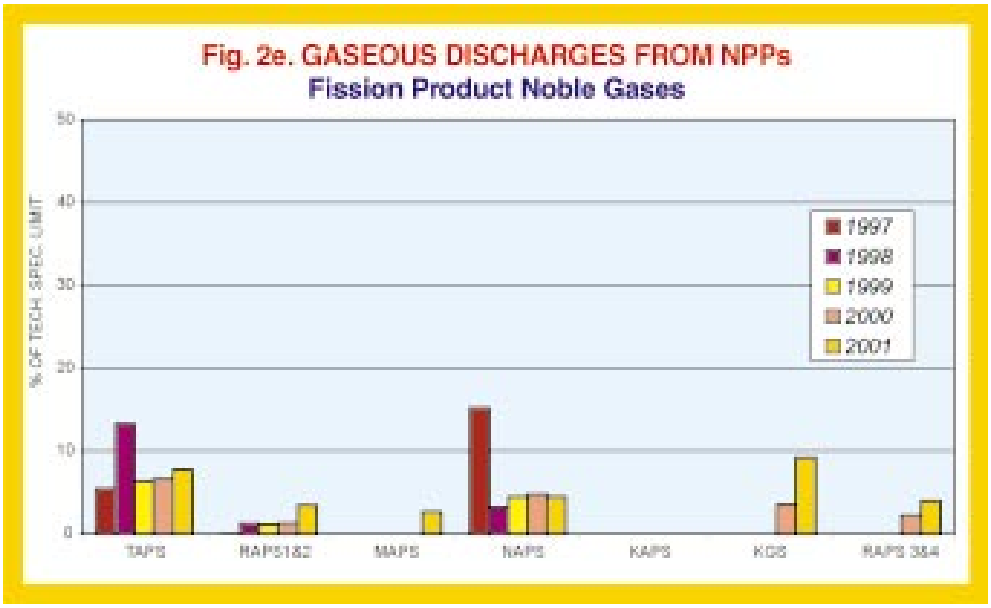


Fig. 2e. GASEOUS DISCHARGES FROM NPPs
Fission Product Noble Gases
% OF TECH. SPEC. LIMIT
50
40
30
20
10
0
1997
1998
1999
2000
2001
TAPS
RAPS1&2
MAPS
NAPS
KAPS
KGS
RAPS 3&4

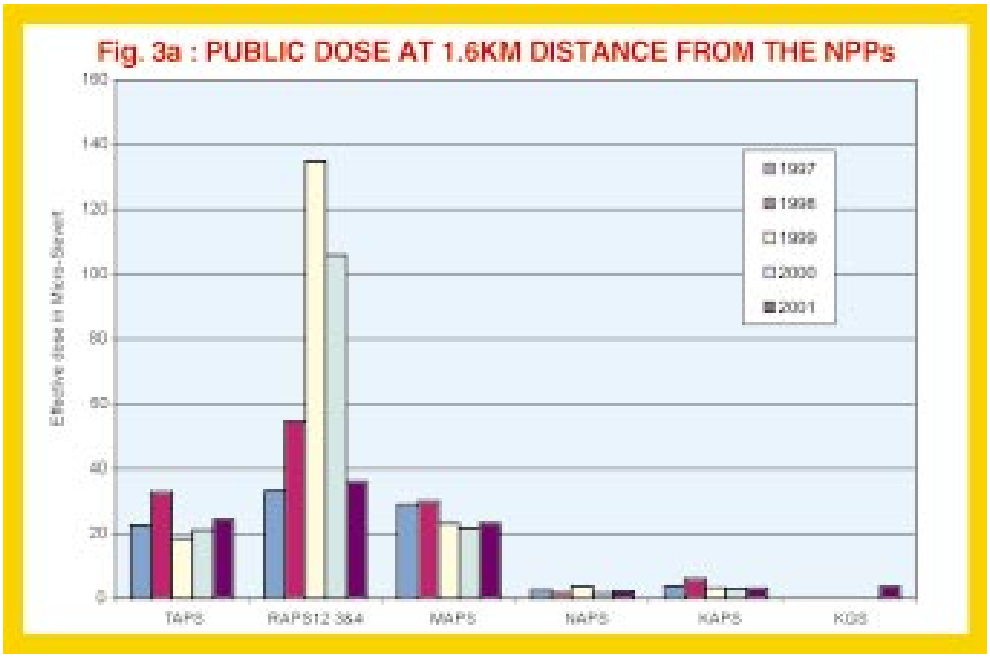
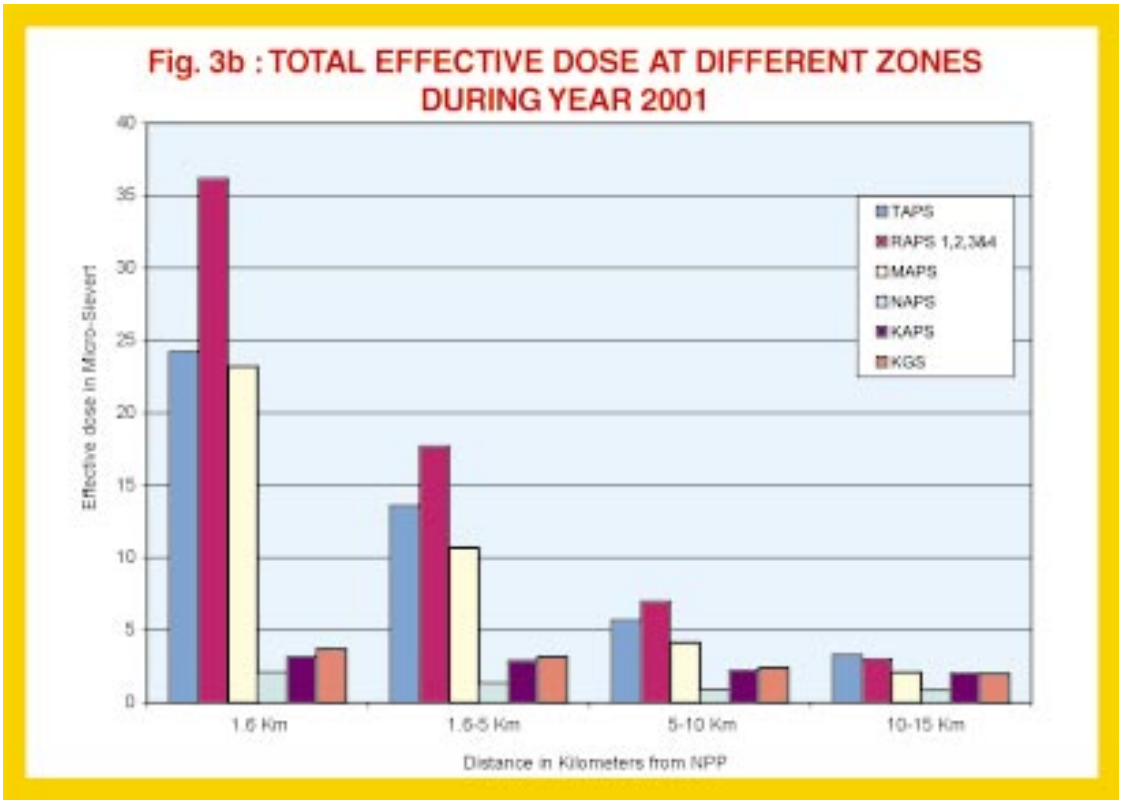


Fig. 3a : PUBLIC DOSE AT 1.6KM DISTANCE FROM THE NPPs
Effective dose in Micro-Sievert
160
140
120
100
80
60
40
20
0
1997
1998
1999
2000
2001
TAPS
RAPS1 2 3&4
MAPS
NAPS
KAPS
KGS



Although the overall picture on occupational exposures in DAE units was satisfactory, certain trends were noted. It was observed that the radiation exposures to plant personnel in NPPs due to tritium uptake were increasing over the years. One of the main reasons for this is the increasing tritium level in the moderator and primary heat transport system with increasing number of years of operation. It is also due to inadequate care in the use of protective equipment. SARCOP asked all power plants to implement appropriate measures to reduce tritium levels in moderator and PHT heavy water on priority basis and to strictly enforce radiological protection procedures while handling heavy water.

It was also observed that a significant number of contractor workers employed by NPPs for routine jobs were exceeding the annual regulatory limit of 15mSv. (The annual regulatory limit on the radiation doses for the contractor workers is more restrictive than for the regular employees). The reasons identified for exceeding the limit are i) Working in radiation areas without supervision, ii) working with inadequate personnel protective equipment, and iii) lack of awareness of procedural requirements such as time restrictions. AERB issued a letter to all plants expressing its concern in the matter and asked the plants to take concrete actions to ensure that no contractor worker receives an annual dose beyond 15mSv.

Data on the occupational exposure in medical, industrial and research institutions (non-DAE institutions) during the year 2001-2002 is given in Table-9c. 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.

There were four instances of workers getting exposed to doses above 50 mSv during the year. In one instance a radiographer got exposed to 147.6 mSv while carrying out gamma radiography with a 40 Ci Ir-192 source. The exposure took place due to carelessness on the part of the worker. After reviewing the incident, the radiation exposure investigation committee has decided that the worker will not be allowed to do radiation work till June 2006.

In another case a service engineer in an X-ray manufacturing company received radiation dose of 75.8 mSv. The worker claimed that the badge got inadvertently exposed. But based on the nature of the work the committee decided that his exposure was genuine. The person was banned for carrying out radiation work till December 2002.

In the third instance, a technician operating a remote controlled low dose brachy therapy equipment

got exposed to 50.55 mSv. He has handled the sources closely as they got stuck in the channel.

In the fourth instance, a technician handling a manual after loading kit containing 435.9 mCi got exposed 57.6 mSv. Based on the nature of his work, the dose was taken as genuine and the investigation committee decided that he will not be permitted to do radiation work till December 2001.

Warning letters were sent to each of these institutions informing them of the need to improve the work practices.

Table 9a. Number of Workers in NPPs Exposed to > 20 mSv & > 30 mSv

Year	1997		1998		1999		2000		2001	
	20-30mSv	>30mSv	20-30mSv	>30mSv	20-30mSv	>30mSv	20-30mSv	>30mSv	20-30mSv	>30mSv
TAPS	4	1	0	0	0	0	0	0	0	0
RAPS1&2	20	2	0	0	29	1	1	0	37	1
MAPS	4	0	3	1	10	4	1	0	0	0
NAPS	2	0	6	2	41	0	10	1	16	1
KAPS	0	0	0	0	0	0	0	0	1	0
KGS							0	0	0	0
RAPS3&4							0	0	0	0
Total	30	3	9	3	80	5	12	1	54	2

Table 9b. Percentage of Total number of Workers in NPPs Exposed to Between 20-30mSv and > 30 mSv

Year	Total number of workers	Those exposed to annual dose of			
		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	14276	12	0.08	1	0.01
2001	13059	54	0.47	2	0.02

Table-9c Occupational Exposure in Medical, Industrial and Research Institutions

Category	No. of Institutions Persons	No. of Dose mSv	Average Annual	No. of persons receiving Annual Dose (mSv)	
				>20	>30
Industry	547	5088	0.77	14	6
Medicine	2160	17794	0.56	7	5
Research	197	2542	0.31	0	0

SECTION 5
EMERGENCY PREPAREDNESS

Nuclear power plants are provided with adequate safety features to minimize the probability of any accidents. Also engineered safety features are built in to mitigate the consequences of any accidents. However, in order to protect the plant personnel, the public and the environment from any undue exposures to radiation in the rare event of an accident, a high degree of emergency preparedness is established and maintained. The emergency preparedness plans are site specific and involve joint participation of station authorities, the district administration and members of public.

The different emergency preparedness exercises conducted at the plants in the year 2001 are indicated in Table-10

Table-10 Emergency Exercises

Plant	FEE	PEE	SEE	OSEE
TAPS	6	4	1	1
RAPS 1&2	6	3	1	0
MAPS	5	4	1	1
NAPS	4	2	1	1
KAPS	8	4	1	0
KGS	9	4	1	1
RAPS 3&4	-	2	1	1
HWP (Kota)	12	4	1	0
HWP (Manuguru)	30	3	2	1

FEE : Fire emergency exercise
PEE : Plant emergency exercise
SEE : Site emergency exercise
OSEE : Off-Site emergency exercise

The readiness of various agencies involved and the public, to respond to any emergency situation are checked periodically by conducting the emergency exercises. For off-site emergency exercises in which in addition to plant personnel, district officials and neighbouring populations are also involved, special observers are posted by AERB to witness these exercises.

During the year off-site emergency preparedness exercises were carried out at HWP (Manuguru), TAPS, RAPS-3&4, MAPS and NAPS. The response of the plant personnel, public and officials involved in the exercise was generally good. The general level of emergency awareness of the members of public was also found to be satisfactory. However, some of the important observations/recommendations made by the AERB observers witnessing these exercises are given below:

1) **Co-ordination with district officials:** At the Rajasthan Atomic Power Station, the designated rallying point was a secondary school. However, the school authorities did not get any intimation about the emergency exercise. All the plant managements were asked to appraise the district officials on the importance of good co-ordination between the agencies during such exercises.

2) **Improvement in infrastructure:** At the Narora Atomic Power Station, the condition of the approach roads to some villages and the condition of wireless communication equipment was found to be poor. The plants were instructed to take suitable corrective actions.

3) **Training of district officials:** Due to frequent transfers of district officials responsible for implementing certain actions during emergency preparedness there is a need to carry out training/ familiarization sessions for various district officials and also the primary health center doctors. This has been communicated to all stations. ■

SECTION 6

DEVELOPMENT OF STANDARDS, CODES, GUIDES AND MANUALS

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:

1. Medical Diagnostic X-ray Equipment and Installations [AERB/SC/Med-2 (Rev.1)]

This code is a revision of an earlier code having the same title issued by AERB in 1986. The code stipulates the specifications for medical diagnostic X-ray equipment and installations. The specifications include those for the X-ray tube housing, beam limiting devices, beam filtration, tube positioning, locking devices and control panel. The limits for leakage radiation are also specified in the code. The equipment which are covered in the code include those for dental X-ray, mammography X-ray, photofluorography, fluoroscopy X-ray, image intensifier television system X-ray, digital subtraction angiography X-ray, CT units, protective barrier, fluoroscopy chair, protective aprons and gloves, gonad shield and cassette pass box. The installation specifications include the requirements relating to the layout, room size, radiation shielding, ventilation, illumination, radiation warning lights, dark room and patient waiting. Radiation protection requirements in the X-ray installation, protection of workers, patient and public, qualifications and responsibilities of workers and regulatory requirements such as type approval of equipment, approval of the layout and registration of X-ray equipment are stipulated in the code. The application forms for the various approvals are included in the appendix.

2. Industrial Radiography (AERB/SC/IR-1)

The requirements for radiation safety of persons handling industrial gamma radiography are given in this code. The specifications for the source housing, marking and labelling and safety and security of an industrial gamma radiography exposure device (IGRED) and also a source changer are included. The sealed source classification for industrial radiography sources is specified in accordance with the specifications of ISO. The equipment for which specifications are stipulated include X-ray units, crawlers and accelerators. The requirements for type approval of equipment, servicing and maintenance, layout of shielded radiography enclosures, conditions for open field radiography, qualifications and responsibilities of personnel and regulatory requirements for type approval of equipment, authorization for procuring radiography sources, storage, operation and transport of radiography equipment and emergency provisions are specified in the code in addition to the various application proforma which form part of the appendix.

3. Nuclear Medicine Facilities [AERB/SC/MED-4 (Rev.1)]

This is the first revision of the AERB Safety Code for Nuclear Medicine Laboratories which was published in 1989. The revision differs from the earlier version in many details. The earlier version included items which would be more suitable for inclusion in a safety guide on the topic. Therefore, the revised version is crisp and specific. The code specifies the requirements of personnel and their responsibilities. It specifies mandatory requirements for a nuclear medicine facility,

covering the entire spectrum of operations ranging from the setting up of a facility to its ultimate decommissioning, including procedures for emergency situations. The various application forms are updated and provided in the code.

4. Testing and Classification of Sealed Radioactive Sources [AERB/SS/3 (Rev.1)]

This is the first revision of the AERB safety standard of the same title which was published in 1990. The revised standard specifies the design standards for sealed sources used in industrial radiography, telegamma therapy, brachytherapy (interstitial and intracavitary) applications, nucleonic gauges incorporating beta sources and gamma sources, oil well logging, portable moisture and density gauges, neutron sources excluding reactor start-up sources, gamma irradiator sources and ion generators used in chromatography, static eliminators and smoke detectors. The revised version includes specifications for special tests for brachytherapy sources and tests and classification requirements for long sources used in high intensity gamma irradiators. The revision also includes specifications for metallic and sealed sources to qualify as special form radioactive material as required by the AERB Safety Code on Transport of Radioactive Material which is currently in force. It is noteworthy that the specifications of this standard are in conformity with the relevant ISO standards, ANSI standards and IAEA safety standards.

5. Design and Construction of Industrial Ionising Radiation Gauging Devices [AERB/SS/2 (Rev.1)]

This is the first revision of the AERB safety code entitled "Radiological Safety in the Design, Construction and Use of Industrial Gauging Devices" which was published in 1990. Many types of gauging devices are designed and manufactured in India. The revision differs from the earlier version in many details. It provides for a system of classification of gauges on the basis of the test parameters to which the design of the gauges conform. Similar systems of classification are recommended in the ISO and ANSI standards. The classification would enable the informed user to decide whether the device is suitable for use in the environment where it is proposed to be installed. The revised standards specify rational criteria for the evaluation of the response of the devices to the test conditions. For the sake of completeness, the document includes the classification of the sealed source for different applications.

6. Design of Concrete Structures Important to Safety of Nuclear Facilities (AERB/SS/CSE-1)

The requirements for design/detailing of concrete structures important to safety of Nuclear Power Plants (NPP) are different in some respects as compared to those of normal conventional structures. This standard aims at stipulating the design requirements of the concrete structures important to the safety of nuclear facilities in line with the stipulations of AERB/SS/CSE "Safety Standard for Civil Engineering Structures Important to Safety of Nuclear Facilities". Pressurized concrete reactor vessels and containment structures are excluded from the scope of this standard. The standard covers limit state and allowable stress design methods for both reinforced and prestressed concrete structures. The design aspects of liquid retaining structures as well as precast and composite construction are also dealt with.

7. Design, Fabrication and Erection of Steel Structures Important to Safety of Nuclear Facilities (AERB/SS/CSE-2)

The requirements for design/detailing of steel structures important to safety of NPPs are different in some respects compared to those of normal conventional structures. This document is an Indian design standard for steel structures important to the safety of nuclear facilities. It aims at describing the design criteria and methodology for the design, fabrication and erection of steel structures and liners important to safety of nuclear facilities in line with the stipulations of AERB/SS/CSE "Safety Standard for Civil Engineering Structures Important to Safety of Nuclear Facilities". The standard covers both allowable stress design method and plastic design method. Additional requirements for built up members and column base; and design requirements of composite construction as well as steel liners are also dealt with in the standard.

8. Emergency Electric Power Supply System (AERB/SG/D-11)

This safety guide provides guidance on all aspects

of safety in designing emergency electric power supply system and about the basic requirements of other types of power supply systems in Nuclear Power Plants. The objective of this guide is also to elaborate on the basic safety requirements set out in the AERB Code of Practice on Design for Safety in Pressurized Heavy Water Reactors (AERB/SC/D) and to provide guidance for the designer.

9. Control of Airborne Radioactive Materials in Pressurized Heavy Water Reactors (AERB/SG/D-14)

This document prescribes guidelines to assess potential hazards due to release of airborne radioactive materials during normal operation and accident conditions and design for control of airborne radioactive materials. It covers design considerations for limiting the radiation exposure for plant personnel and public by using control measures like controlled ventilation for normal operation and accident conditions and use of Engineered Safety Features (ESF) such as suppression pool, containment coolers and air cleaning systems. The objective of this safety guide is also to elaborate the basic safety requirements set out in the AERB Code of Practice on Design for Safety in Pressurized Heavy Water Reactors (AERB/SC/D) and to provide guidance for the designer.

10. Loss of Coolant Accident Analysis (AERB/SG/D-18)

Necessary guidelines for developers and users of computer codes for LOCA analysis are provided in this guide. Loss of coolant accident (LOCA) is one of the postulated initiating events that are required to be analysed for the design of a nuclear power plant to assess the effectiveness of the systems important to safety.

11. Codes, Standards and Guides to be Prepared by the Regulatory Body for Nuclear and Radiation Facilities (AERB/SG/G-6)

The present safety guide on Codes, Standards and Guides to be Prepared by the Regulatory Body has been prepared as a follow-up to the safety code envisaged on Regulation of Nuclear and Radiation Facilities (AERB/SC/G). The guide indicates the various documents to be prepared by the Regulatory Body, along with the format / structure to be adopted while preparing these documents.

12. Regulatory Consents for Nuclear and Radiation Facilities: Contents and Formats (AERB/SG/G-7)

Guidance on the consenting process requirements and the regulatory consent formats is provided. The steps to be followed while submitting the application for consent are also covered. For the benefit of users and in particular the applicant, this guide details the Acts, Rules and other regulatory documents which form the basis for regulation and issuance of regulatory consents. The guide identifies other documents, which provide formats for consent application. Guidelines to identify the type and quality of information needed to be furnished in an application for renewal or modification of consents are also covered. The Guide summarizes the roles and responsibilities of the Regulatory Body and the Consentee, and the obligations of the Consentee. Guidance to the staff of Regulatory Body, for issuance, renewal, modification, and revocation of regulatory consents, is also included in this guide. It also includes the consenting requirements for transportation of radioactive materials arising during operation of the above said facilities.

13. Criteria for Regulation of Health and Safety of Nuclear Power Plant Personnel, the Public and the Environment (AERB/SG G-8)

This safety guide provides guidance on the safety-related requirements for setting up of a Nuclear Power Plant. It deals with the health and safety requirements to be met by the applicant in selecting a suitable site for a NPP and outlines the design safety aspects and safety during construction and operation. It also spells out the basic or minimum health, safety and environmental safety criteria to be considered at the stages of commissioning, operation and waste management. Emergency preparedness, environmental surveillance and decommissioning aspects of the NPP are also covered.

14. Preparation of Safety Report of Industrial Plants other than Nuclear Power Plants in the Department of Atomic Energy

This document is meant for the industrial plants of DAE other than NPPs. The submission of

a Safety Report to AERB is one of the mandatory requirements before authorisation is given to operate any industrial plant. The document gives guidelines for preparation of the Safety Report as specified in the Manufacture, Storage and Import of Hazardous Chemicals Rules framed under the Environment (Protection) Act, 1986. This document gives the guidelines to be followed with respect to the preparation of the Safety Report and the detailed information to be provided, e.g., radiation hazard control, chemical hazard control, waste management, safety systems, safety analysis, safety organisation, medical facilities, etc.

15. Quality Assurance in the Design of Nuclear Power Plants (AERB/SG/QA-1)

During the design phase of a nuclear power plant it is necessary to develop and implement a quality assurance programme which describes the overall arrangements for management, performance and assessment of nuclear power plant design. The QA programme provides the means to ensure that all work is suitably planned, correctly prepared and properly assessed. This document deals with all the above aspects. It is intended for the design organisation of a nuclear power plant.

16. Quality Assurance during Site Construction of Nuclear Power Plants (AERB/SG/QA4)

This safety guide pertains to the quality assurance programme needed in the construction stage of a nuclear power plant and covers items, services and processes impacting safety. The construction phase is one of the most important phases having a bearing on the safe performance of a nuclear power plant throughout its operating life. This guide is also applicable during the construction work carried out when major modifications are made to a nuclear power plant which has been in service.

17. Maintenance of Civil Engineering Structures Important to Safety of Nuclear Power Plants (AERB/SM/CSE-1)

This safety manual is issued to specify the minimum requirements for the maintenance of civil engineering buildings/structures that are to be fulfilled to provide adequate assurance for safety of nuclear installations, such as pressurized heavy water reactors and related systems. The emphasis in the manual is on protection of site personnel and public from undue radiological hazards. The manual covers the civil engineering maintenance programme, organization and responsibilities of the civil engineering section, administrative control, maintenance facilities, modifications arising from maintenance and quality assurance for maintenance activities. For aspects not covered in the document, applicable and acceptable national and international codes and standards shall be followed.

18. Design Basis Flood for Nuclear Power Plats at Coastal Sites (AERB/SG/S-6B)

The guide considers safety aspects of NPPs during design basis floods at coastal sites. Various conditions of flooding and methodologies for estimating water levels likely to be reached during the flooding are identified. ■

SECTION 7

SAFETY RESEARCH & DEVELOPMENT; WORKSHOPS; CONFERENCES; SCIENTIFIC PUBLICATIONS

7.1 SAFETY ANALYSIS

Two approaches are adopted for safety analysis: Deterministic Safety Analysis (which is also known as Accident Analysis) and Probabilistic Safety Analysis as a defence-in-depth concept for safety assessment of a nuclear plant. The 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, high consequence accidents.

Probabilistic Safety Assessment (PSA) is performed in three levels: Level 1 PSA does the assessment of Postulated Initiating Events (PIEs) leading to the determination of core damage frequency. A Level 1 PSA provides insights into design weaknesses and into ways of preventing core damage, which in most cases is the precursor to accidents leading to major release with potential health and environmental consequences.

A Level 2 PSA does the assessment of containment response taking inputs from Level 1 PSA, leading to the determination of containment release frequencies. A Level 2 PSA provides additional insights into the relative importance of accident sequences leading to core damage in terms of the severity of the radioactive releases they might cause, and insight into weaknesses in the ways of mitigation and management of core damage accidents.

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

PROBABILISTIC SAFETY ANALYSIS

AERB has adopted the "Risk-informed" approach for PSA, considering the present state-of-art and international trends in PSA. A draft paper on 'AERB Policy on PSA' has been prepared. This paper 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/criteria which the utility should try to achieve/comply with, 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 approach paper is being finalised. A committee has also been constituted by Chairman, AERB to prepare guidelines on PSA, which will help the utility as well as reviewers to perform and review PSA related studies.

NPCIL has submitted to AERB a Level 1 PSA with internal events for Kaiga Generating Station (KGS) and for Tarapur Atomic Power Plant (only for Loss of Coolant Accident and Main Steam Line Breaks). AERB has completed the reviews of the above-mentioned studies and comments were sent to NPCIL for their responses. The Primary Shutdown System (PSS) reliability analysis of Kakarapar Atomic Power Station (KAPS) has also been reviewed. Although, the present reliability study was satisfactory further improvements have been suggested. A task force on PSA of MAPS has completed the development of fault trees (FTs) for system analysis. The event trees have been developed by the Task Force and will be used for qualification after computerization of FTs. The standardisation of CCF analysis methodology has been debated at length by the working group of AERB PSA committee and issue of a report is awaited.

ACCIDENT ANALYSIS

The review of the Preliminary Safety Analysis Report (PSAR) on accident analysis of KK Project submitted by NPCIL has been taken up in AERB. There are 13 packages covering analyses with regard to Anticipated Operational Occurrences, Design Basis Accidents, Severe Accidents and Hypothetical Accidents. Review of 12 packages by the Specialists Group (SG) has been completed. Further work is in progress.

As a part of an ongoing AERB project at IIT Bombay on development of a coupled neutronics & thermal hydraulics code for loosely coupled reactors, the

pressuriser modelling is completed. The modules are now being developed/modified for inclusion of parallel coolant channels and coupling of neutronics feed back.

7.2 SAFETY RESEARCH & DEVELOPMENT

AERB gave grants for the following new research projects during the year.

1. Radiation dose to relations/attendants of patients treated with I-131 for hyperthyroidism or Ca-thyroid, All India Institute of Medical Sciences, New Delhi.

2. Monte Carlo simulation of medical linear accelerator, Osmania University, Hyderabad.

3. Studies on environment radioactivity levels around Lampur, Peddagatu area of Nalgonde district and along the East Coast areas between Bheemunipatanam and Kalingapatanam, Andhra Pradesh, Osmania Uinversity, Hyderabad.

4. Integrated studies on radionuclide migration at shallow land disposal facility, Indian Institute of Technology, Mumbai.

5. Dose audit and optimisation in diagnostic radiology, Christian Medical College, Vellore.

In addition to the above, AERB has recommended extension of grants for ten on-going research projects. AERB has also extended grants to Twenty-five Organisations for conducting various seminars / symposia / conferences during the year.

SRI building under construction.

SRI Guest House nearing completion.

7.3 AERB - SAFETY RESEARCH INSTITUTE

Since its formal inauguration on February 20,1999, the Safety Research Institute at Kalpakkam has been making steady progress towards establishing the basic infrastructure required for organising research activities in the following areas

- Nuclear Plant Safety Studies
- Environmental Safety Studies
- Fire Safety and Industrial Safety Studies

Besides research, other components of SRI activities as planned include

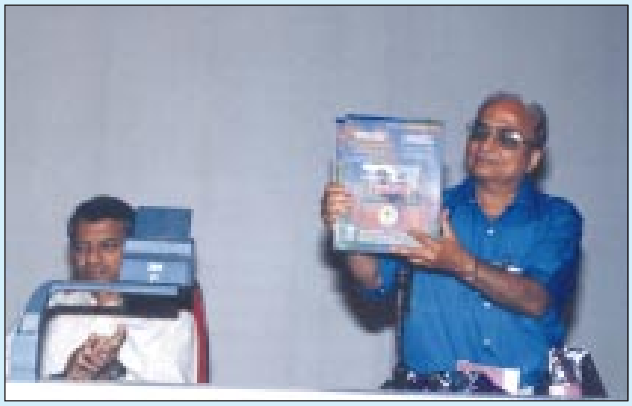
- Periodic training workshops and discussion meetings
- Archiving of technical and research reports, course materials and management of data bases

The progress made in the above activities during the year 2001-2002 is described below.

7.3.1 Nuclear Plant Safety Studies

Reliability Analysis of the Decay Heat Removal System of PFBR

Fault tree analysis to calculate the unreliability and unavailability of Safety Grade Decay Heat Removal System (SGDHR) for different initiating events has been carried out as part of the safety analysis of PFBR.



Shri G.R. Srinivasan, Vice Chairman, AERB releasing a report from the Safety Reasearch Institute, Dr. S.M. Lee.

Shri A. R. Sundararajan, Director, SRI and Head,

Discussion meeting on Computer Based Safety System in Nuclear Power Plants organised by AERB Safety Research Institute and Indian Nuclear Society.

7.3.2 Reactor Safety Studies

Life Assessment of High Temperature Components

An important area of work undertaken by SRI is the life extension of nuclear power plant components. A finite element computer code is being developed for the online assessment of stress-strain to calculate the cumulative damage.

7.3.3 Radiation Safety Studies

Radiation Shielding Codes

A new code GUI2QAD-3D has been developed in visual basic 6.0. This is an improvement over the GUI2QAD package (CCC-697) released earlier. The new code has the following additional features:

1. Handles off-centred multiple identical sources
2. Cylindrical sources can be oriented parallel to any axis.
3. Provides plots of material cross sections and build-up factors
4. Estimates dose rate for point source-slab shield situations
5. Facility to give input geometry interactively
6. 3D view of the geometry with arbitrary rotation around X,Y or Z axes
7. Optional facility to indicate detector location.

8. Provision to view picture input file

9. Provision to calculate fission product gamma emission rates with elapsed time.

10. Provides plots of photon responses from ANSI-1977 and ICRP-2.

Radiation Shielding Computations

Gamma Dose Rate Computations outside RCB during Core Disruptive Accident at PFBR

Computations of external gamma dose rates outside the Reactor Containment Building (RCB) of Prototype Fast Breeder Reactor (PFBR) due to radioactive fission products released into RCB during a hypothetical Core Disruptive Accident (CDA) were repeated for the revised RCB shape and dimensions.

PFBR Bulk Shielding Experiments

Neutron Reaction Rates within the shield models used for SET-1, SET-2 and SET-3 of bulk shielding experiments at APSARA Reactor were computed using MCNP code.

7.3.4 Environmental Safety Studies

Environmental Impact Assessment for NPPs

SRI is setting up a Remote Sensing - Geographic Information System (RS-GIS) Facility at Kalpakkam for Environmental Impact Assessment for NPPs. This project, being carried out in collaboration with Space Applications Centre (SAC), Ahmedabad is aimed at generating and maintaining a digital data base on all the existing nuclear facilities using past RS data and other collateral information on population, ground water, land use/land cover, radiation level etc. The data base will be useful in the long term environmental assessment around nuclear facilities. The procurement of all the important hardware and software needed for the project has been completed.

Radionuclide Migration Studies

As part of the safety assessment of radioactive waste burial facilities, the following studies are in progress.

- In the context of deep geological disposal of high level radioactive waste, modelling of the transport of the radionuclide in a fractured porous medium is being studied.

- Accelerated diffusion experiments using a high speed centrifuge were carried out at IIT, Bombay to study the diffusion of chloride ion (as NaCl) through intact (without fractures) and fractured rock. Tests were also carried out to study the diffusion of Cs and Iodide ions.

- An explicit finite difference scheme was applied to a parabolic partial differential equation to model the radionuclide migration in the saturated zone. Work is in progress to apply the code to radionuclide migration studies at PFBR site after obtaining the field data on ground water velocity and other geochemical parameters.

7.3.5 Discussion Meetings

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 Computer Based Safety Systems in NPPs was organized at Kalpakkam during November 28-29, 2001. The meet was jointly organized by SRI-AERB and the Indian Nuclear Society.

7.3.6 Establishment of Code Depository at SRI

As part of the efforts to establish and maintain a safety related computer code depository, the following codes have been installed at 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. **ORIGIN** (Fission product inventory calculation code)

5. **QADCG-GP** (A point kernel code for shielding calculations)

6. **GUIMCNP** (A graphical user interface program for MCNP code)

7. **SAND -II** (A code for Spectrum Analysis for Neutron Detectors)

The following codes are available for public access on the web server :

1. GUI2QAD A GUI to Point kernel shielding code QAD-CGPIC

2. QAD-CGPIC For DOS users

3. VIEW-NG-CXS Neutron and gamma cross sections plotting program

7.3.7 Projects Awarded by Safety Research Institute

Projects on some studies in the chosen areas of work were awarded to academic institutions 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. Characterisation of Thermal Internal Boundary Layer (TIBL) structure along the eastern coast of India Dept. of Meteorology and Oceanography, Andhra University

   The modelling experiments with codes FITNAH and MM5 are in progress. Meterological data collected through the tethered balloon system and the terrain data over Visakhatpatnam are being used to characterise the formation of the Thermal Internal Boundary Layer.

2. Investigation of wind characteristics and other site-specific parameters by intensive meteorological measurements at Kalpakkam SERC, CSIR, Chennai For carrying out the measurements proposed, three meteorological towers have been located at IGCAR site, 0.5km from the seashore; Amaipakkam, 5km from the seashore and Thirukalukundram, 15 km from the seashore. Data collection is done on a continuous basis using a computer based data acquisition system. The studies which include aspects of stationarity, mean wind profile, turbulence intensity and spectrum of wind are continuing.

3. Development of tracer release, sampling and analysis technique Excel Lab, CLRI, Chennai.

   The calibration of the gas chromatograph system with electron capture detector has been carried out for the analysis of SF6, the tracer gas to be used in the atmospheric dispersion field studies.

4. Formal methods for development of safety critical software School of Computer Science, Anna University, Chennai.

As part of the studies on the development of safety critical software and quality assurance, Formal method analysis of on line computational requirement of FBTR has been carried out.

7.3.8 Invited Lectures Delivered

'Radioactive Waste Management' by P. Sasidhar, SRI under the auspices of Indian Nuclear Society, Kalpakkam Chapter at three engineering colleges.

7.3.9 Technical Papers Presented in Conferences/Published in Journals

1. GUI2QAD-3D, A Graphical User Interface for QAD-CGPIC Program, K.V. Subbaiah and R. Sarangapani, Contributed to RSICC-CCC-697 and presented in 14th National Symposium on Radiation Physics held at GND University, Amritsar, November 1-3, 2001.

2. Sorption studies of Cerium (III) on Vermiculite", P. Sasidhar et al, Proc. of Nuclear Chemistry and Radiochemistry Symposium, Pune, Feb. 2001.

3. Mobile Shield Design for the West Beam Port of KAMINI Reactor, C. Sunil Sunny, S. Baskar, and K.V.Subbaiah, 14th National Symposium on Radiation Physics held at GND University, Amritsar, November 1-3, 2001

4. KAMINI Reactor South Beam Port Shield-

Structure of Optimisation, C. Sunil Sunny, S. Baskar, and K.V. Subbaiah, American Journal of Nuclear Technology, issue Vol.135, pp265, September-2001.

5. Shielding Evaluation of 3.0 MeV 50 mA Dynamitron, P. Pravin Kumar and K.V. Subbaiah, 14th National Symposium on Radiation Physics held at GND University, Amritsar, November 1-3, 2001.

6. VIEW-CXS: Neutron and Photon Cross-sections Viewer, K.V. Subbaiah and C. Sunil Sunny, 14th National Symposium on Radiation Physics held at GND University, Amritsar, November 1-3, 2001.

7. Environmental Impact Assessment for NPPs using RS-GIS Data, P. Sasidhar and A.R. Sundararajan Int. Conf. on Industrial Pollution and Control Technologies (ICIPACT-2001) organized by the Centre for Environment, JNTU, Hyderabad, December 6-10, 2001.

7.4 ANNUAL MEET OF DAE SAFETY PROFESSIONALS

As an on-going program, the 18th DAE Safety Professionals Meet was held from 3rd to 5th December 2001 for exchange of safety related information. It was organised jointly by AERB, TAPS and TAPP at Tarapur. The program included a seminar on the first day on 'Safety Culture and Behavioural Aspects in Industrial Safety' followed by a two-day workshop. Occupational Health Professionals from DAE units as well as from outside held a parallel session on 'Ergonomics at Work Places' and discussed topics like musculo-skeletal disorders among riggers, ergonomic problems of teachers and nurses & in bag stitching work.

Around 120 participants from various DAE units attended the Seminar. Fire Safety Award (jointly to Heavy Water Plant, Manuguru along with Rajasthan Atomic Power Station 1-2) and Green Site Award (jointly to Indian Rare Earths, OSCOM Plant along with Heavy Water Plant, Thal) for the year 2000 were presented at the Meet. There was also a video presentation on TAPP 3 & 4.

7.5 WORKSHOPS/DISCUSSION MEETINGS

7.5.1 Discussion Meeting on Consenting Process

AERB continuously reviews each of its regulatory processes and activities to update and improve them based on national and international experience. These reviews are done through meetings in which experts from licensee, licensor and other relevant organisations participate. AERB organised such a review meeting on the consenting process. It was considered prudent to consolidate the valuable experience gained through the consenting process adopted for NAPP-1&2, KAPP-1&2, Kaiga-1&2 and RAPP-3&4.

During the discussions, the participants arrived at several improvements and refinements in the area of construction clearance, scope and methodology of reviews and stages of clearances. One of the important decisions at the meeting was to consider three clearance stages for the construction authorisation, namely excavation, first pour of concrete and installation of major equipment.

7.5.2 Workshop on AERB Safety Code and Guides for Safety in Operation of Nuclear Power Plants

AERB organized a three day Workshop on AERB Safety Code and Guides for Safety in Operation of NPPs at Niyamak Bhavan from May 30, 2001 to June 1, 2001. The workshop was inaugurated by Shri G. R. Srinivasan, Vice-Chairman, AERB. Talks were delivered by senior officers from AERB, NPCIL and Consultants who have been actively involved in the preparation of these documents. This was followed by a panel discussion

From Left - Shri B.K. Bhasin, Director (Operations), NPCIL; Shri S. K. Agarwal, Head Safety Analysis & Documentation Division, AERB; Shri G. V. Nadkarni, Chairman Advisory Committee on Codes and Guides for Operation and formerly Director (Public Awareness), NPCIL;,Shri G.R. Srinivasan, Vice Chairman, AERB

session. Officers from all operating stations, sites and NPCIL headquarters participated in the Workshop. Officers from all Nuclear Training Centres/Station Training Centres were specially invited to attend.

The purpose of the workshop was well appreciated. It provided a forum for dissemination of the vast amount of information contained in the existing 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.

As a follow-up to the above Workshop, workshops on AERB Safety Codes & Guides were conducted at KAPS, TAPS and NAPS. Officers from AERB delivered lectures in these workshops.

7.5.3 Discussion Meeting on VVER Safety

AERB held a one-day discussion meet on VVER Reactor Safety on January 11, 2002. Prof. Bal Raj Sehgal, of the Royal Institute of Technology, Sweden was the main speaker. Subjects of discussion were severe accident scenarios for light water reactors and the design of the core catcher.

7.6 PARTICIPATION IN WORKSHOPS, SEMINARS AND TRAINING COURSES

a) R. Bhattacharya attended a Certificate Course on 'Environmental Regulations' organised by Administrative Staff College of India, Hyderabad in October 2001.

b) K. Ramprasad attended a course on 'Safety Engineering Management' organised by Central Labour Institute, Mumbai from 19th to 23rd November 2001.

c) P. K. Ghosh, S. Bhattacharya, K. Ramprasad, P.S. Virdi and V. B. Gholap attended the 18th DAE Safety Professionals Meet at Tarapur, 3rd to 5th December 2001.

d) Prabir C. Basu, L.R. Bishnoi and P. Shylamoni attended the Workshop on Safety of Nuclear Power Plant Structures, July 21 & 22, 2001, Indian Institute of Science, Bangalore, India

e) Ajai S Pisharady attended the workshop on 'Quality Control and Quality Assurance in Concrete Construction' conducted by National Council for Cement and Building Materials (NCCBM) at Goa during June 11-15, 2001.

f) A. D. Roshan attended the workshop 'Earthquakes of Chamoli and Bhuj' conducted by Department of Earthquake Engineering, University of Roorkee during May 22-25, 2001.

g) P. Shylamoni attended the short course on 'Seismic Design of Reinforced Concrete Buildings' conducted at Indian Institute of Technology, Kanpur during May 28 - June 1, 2001.

h) Ajai S Pisharady attended the short course on 'Seismic Design and Retrofitting of Reinforced Concrete Buildings' conducted at Ahmedabad during December 17-21, 2001.

i) P. K. Ghosh attended the Lead Auditor's course on 'ISO 14000' organised by Administrative Staff College of India, Hyderabad from 18th to 22nd March 2002.

7.7 PAPERS PUBLISHED/PRESENTED, INVITED TALKS

7.7.1 Papers Published

Officers from AERB published the following papers:

1. Singh R.K., Iyer V.S. and Sonawalker V.M., 'Shipment of Spent Fuel by Road from Origin to Destination under Special Arrangement - An Experience' Radiation Protection and Environment, Vol. 24, No. 1 & 2, pp 332 - 335, Jan - June 2001.

2. Parihar. M, Agarwal S.P., Singh R.K., Nandakumar A.N., 'Transport and Disposal of Disused Sealed Radioactive Sources - An Indian Scenario' Radiation Protection and Environment, Vol. 24, No. 1 & 2, pp 336-339, Jan - June, 2001.

3. Basu P.C., 'High Performance Concrete: Mechanism and Application', ICI Journal, Vol.2, No.1, April-June 2001, Indian Concrete Institute.

4. Nandakumar A.N., Yadav R.K., Kher R.K., Kannan R. and Vishwakarma R.R., 'Occupational Exposure in Industrial Radiography, Radiation Protection and Environment', Vol. 24, Nos 1 & 2, pp 258-262, 2001.

5. Nandakumar A.N., 'Nucleonic Control Systems in Industry', IANCAS Bulletin, Vol. 16, No. 4, pp 33-37, 2001.

6. Arunkumar, et. al., 'Safety and Security of Radioactive Materials: Indian Scenario', Proceedings of the International Conference on Security of Material, Measures to Prevent, Intercept and Respond to Illicit Uses of Nuclear Material & Radioactive Sources, Stockholm, Sweden, May 7-11, 2001.

7. Upadhyay K.C., 'Shipment of Radioactive Material by Road : A Study of Sensitive Parameters', International Journal of Radioactive Material Transport, Vol 12, No.1, pp, 45-49, 2001.

8. Basu P.C., 'Approach for Seismic Qualification of Existing Nuclear Installations in India', Workshop on Safety of Nuclear Power Plant Structures, 21 & 22 July 2001, Indian Institute of Science, Bangalore.

9. Basu P.C., Gupchup V.N., Bishnoi L.R., 'Delamination of Prestressed Concrete Containment Dome', Transaction of 16th International Conference on Structural Mechanics in Reactor Technology (SmiRT-16), Division H, 12-17 August 2001, Washington DC.

10. Basu P.C., Mittal A, 'Development of Construction Methodology for NPP Containment Structures Using High Performance Concrete', Proceedings, Post Conference Seminar No. 2 of SmiRT-16, August 20-21, 2001, Albuquerque, USA.

11. Nandakumar A.N, 'A Method of Assessment of Dose Resulting from an Accident Involving a Multiple-Package Shipment', Proceedings of the International Symposium on Packaging and Transportation of Radioactive Materials, PATRAM 2001, September 3-7, 2001, Chicago, USA.

12. Nandakumar A.N, K. Upadhyay, Jawahar Bisht, 'Response of Type A Packages to Accident Conditions of Transport', Proceedings of the International Symposium on Packaging and Transportation of Radioactive Materials, PATRAM 2001, September 3-7, 2001, Chicago, USA.

13. Nandakumar A.N, 'Release of Radioactivity Due to an Accident Occurring on a Fly-over in the Urban Environment', Proceedings of the International Symposium on Packaging and Transportation of Radioactive Materials, PATRAM 2001, September 3-7, 2001, Chicago, USA.

14. Nandakumar A.N, 'Interdependence of Variables Used in the Estimation of Dose to Workers and Public Due to Radioactive Shipments', Proceedings of the International Symposium on Packaging and Transportation of Radioactive Materials, PATRAM 2001, September 3-7, 2001, Chicago, USA.

15. Nandakumar A.N, Upadhyay K, Agarwal S, Singh R, 'Shipments Under Special Arrangement Criteria', Proceedings of the International Symposium on Packaging and Transportation of Radioactive Materials, PATRAM 2001, September 3-7, 2001, Chicago, USA.

16. Nandakumar A.N, Agarwal. S, Muralidhar K, 'A Comprehensive National Network for Handling Emergencies Involving Radioactive Shipments', Proceedings of the International Symposium on Packaging and Transportation of Radioactive Materials, PATRAM 2001, September 3-7, 2001, Chicago, USA.

17. Nandakumar A.N, 'Comparison Between a Real Accident Involving a Hazardous Chemical and a Postulated Accident Involving Radioactive Material', Proceedings of the International Symposium on Packaging and Transportation of Radioactive Materials, PATRAM 2001, September 3-7, 2001, Chicago, USA.

18. Basu P.C., 'NPP Containment Structures: Indian Experience in Silica Fume-Based HPC', The Indian Concrete Journal, Special Issue on Use of Silica Fume in Concrete, Vol.75, No.10, pp, 656-664, October 2001.

19. De Deepak and Gupta R.P., 'Safety Review during Regulatory Consenting Process of Nuclear Power Projects', Annual Conference of Indian Nuclear Society at Indore, October 10-12, 2001.

20. De Deepak and Warrier S.K. 'Implementation of Quality Assurance in NPPs', Seminar JIT-2K1, Indian Association for Radiation Protection, Karnataka Chapter, November 19-20, 2001.

21. De Deepak, Dave D.K., Gupta R.P. and Dhotre V.R., 'Safety Review Experience from KGS-1&2 and RAPP-3&4', Seminar on JIT-2K1 Indian Association for Radiation Protection, Karnataka Chapter, November 19-20, 2001.

22. Singh R.K., Upadhyay K.C., Agarwal S.P., 'Transport of Nuclear Medicine Sources and its Radiological Impact in India' Proceedings of the International Conference on Medical Physics and Radiation Safety, Mumbai, Nov. 26-29, 2001 (ICMP-2K1).

23. De Deepak, Warrier S.K., and Dhotre V.R., 'Role of In-service Inspection in Management of Ageing in Nuclear Power Plants - a Regulatory Perspective', National Conference of ISNT, NDE-2001, Lonavala, December 7-9, 2001.

24. Parihar M., Singh R.K., Upadhyay K.C. and Agarwal S.P., 'Quality Assurance in the Transport of Radiography Sources', Proceedings of the International Conference on Application of Radioisotopes and Radiation Technology in the 21st Century, National Association for Application of Radioisotopes and Radiation in Industry (NAARRI), Dec 12 - 14, 2001.

25. Nandakumar A.N. and Kaushik A, 'Estimation of the Effect of Fluid Density Gradient in Process Column on Level Detection, Applications of Radioisotopes and Radiation Technology in the 21st Century, Proceedings of the National Association for Applications of Radioisotopes and Radiation in Industry, December 12-14, 2001, Mumbai.

26. Warrier S.K., 'Regulatory Aspects of ISI of Research Reactor', IAEA RCA Training Course on ISI of Research Reactors, Navi Mumbai, January 29, 2002.

7.7.2 Invited Talks

1. Chande S.K., 'Present Regulatory Issues in India', Management Workshop on Operational and Safety Issues of NPPs with Special Focus on Management Competencies Required for Competitive Environment at Haiyan, China, May 21-25, 2001.

2. Basu P.C. Deshpande Y., Mavinkurve S., 'Construction of Structures with High Performance Concrete', Invited Keynote Paper, Proceedings of International Conference on Civil Engineering, Vol. I, pp 23-25, Indian Institute of Science, Bangalore, July 2001.

3. Chande S.K., 'Indian Experience with Use of Technical Specifications', IAEA-COG Workshop on Safe Operating Envelop, Toronto, Canada July 23-25, 2001.

4. Bhattacharya R. ,'Factories Act 1948 and Role of AERB', Senior Officers of Nuclear Fuel Complex, Hyderabad August 6, 2001.

5. Parthasarathy K.S., ,Unusual Occurrences in Radiation Therapy, VIIIth Annual Conference on Medical Physics Cancer Institute, Adyar, August 18, 2001

6. Chande S.K. and Koley J., 'Regulatory Approach to Risk-Informed Decision Making in India', International conference on Topical Issues in Nuclear Safety, Vienna, Austria, September 3-6, 2001.

7. Chande S.K., 'Probabilistic Safety Assessment and Development of International Standards', International Conference on Topical Issues in Nuclear Safety, Vienna, Austria, September 3-6, 2001.

8. Pande V.V., 'Role of Competent Persons' and 'Legal Aspects in Construction Safety', Training Program at Tarapur Atomic Power Project 3-4, Tarapur, September 12, 2001.

9. Parthasarathy K.S., 'Current Trends in Radiological Protection Practices in Diagnostic Radiology', 8th National Conference of the Indian Society of Radiographers at the Tata Memorial Hospital, Parel, September 29, 2001.

10. Chande S.K., 'India Annual Report-2001', Annual Meeting of Senior Regulators of Countries Operating CANDU Type Reactors, Buenos Aires, Argentina, October 29 to November 2, 2001.

11. Pande V.V., 'Techniques for Major Hazard Assessment', Seminar on Major Hazard Management organised by Loss Prevention Association, Mumbai, November 2001.

12. Chugha R.K., 'Enhancing NPP Safety by Recognizing Early Deterioration Signals', Technical Committee Meeting on Self-assessment of Operating Experience Feedback and the PROSPER Guidelines, Vienna December 3-7, 2001.

13. Parthasarathy K.S., 'Why Radiological Safety?', Vth Annual National Conference of the Association of Radiation Therapy Technologists of India, BYL Nair Charitable Hospital, Mumbai, December 23, 2001.

14. Parthasarathy K.S., 'Radiation, the Myth and the Reality', Regional Workshop on Impact of Applications of Radiation on Food and Agriculture, Kerala Agricultural University, Trichur, December 27, 2001.

15. Bhattacharya R., 'Safety, Fire & Environmental Engineering', Lectures to Scientific Officer Trainees (engineering graduates / post-graduates) of NFC - HWB Training School at NFC, Hyderabad, February 5-9, 2002.

16. Pande V.V., 'Fire Safety' to staff and engineers of Indian Rare Earths Ltd., OSCOM at Chatrapur, March 15, 2002.

17. Bhattacharya R., 'Disposal of Hazardous Wastes by Landfill' at Workshops organised by National Safety Council, Mumbai on 'Hazardous Wastes', October 2001, January 2002 and March 2002.

18. Sukheswala S.A., delivered lectures

a) on Radiological Protection to Health Physics stipendiary trainees, April-23-25, 2001.

b) on Emergency Preparedness to Public authorities at KAPS, February 6, 2002.

c) on Disaster Management at BYTCO Institute Nasik, October. 4, 2001

d) on Safety Guides on Radiation Protection at KAPS on August 16, 2001.and NAPS at March 13, 2002.

7.8 AERB COLLOQUIA

AERB organised three colloquia during 2001 - 2002. The details are as follows:

No.	Title	Speaker
1.	Radiation Hormesis	Dr. R. D. Lele, Consultant Physician and formerly Director of Nuclear Medicine, Jaslok Hospital & Research Centre, Mumbai.
2.	Bhuj Earthquake	Dr. Sudhir K. Jain, Professor & Head, Department of Civil Engineering, IIT, Kanpur.
3.	Some Highlights of the Design of AHWR	Shri R. K. Sinha, Associate Director, Reactor Design & Development Group, BARC.

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 and three Safety Information Notices in the area of radiological safety, diagnostic radiology and radiation therapy. These bulletins were based on information released by the International Atomic Energy Agency and other regulatory authorities. These bulletins were sent to users of radiation equipment in India.

8.1 PRESS RELEASES

The following press releases were issued:

1. Operation of Vashi Plant Suspended (July 3, 2001)

2. Action against Vashi Plant Revoked (July 17, 2001)

3. Zoning Requirements for Nuclear Power Plants (August 29, 2001)

4. Atomic Energy Regulatory Board (AERB) Reconstituted (September 26, 2001)

5. AERB Authorises Continuous Operation of Rajasthan Reactor-4 (October 12, 2001)

6. AERB Limits Operation of RAPS Unit-1 (February 9, 2002)

7. Heavy Water Plant at Tuticorin and Narora Atomic Power Station Share AERB Industrial Safety Awards (March 5, 2002)

8. AERB Issues Clearance for the First Pour of Concrete for Kudankulam Nuclear Power Reactors (March 26, 2002)

8.1.1 Operation of Vashi Plant Suspended

Atomic Energy Regulatory Board has withdrawn the certificate of approval issued to the Demonstration Plant for Radiation Processing of Spices at Vashi, Navi Mumbai. As a result, operation of the plant has been temporarily suspended. The AERB decision was based on the report of an inspection team which found certain procedural lapses needing urgent correction. These lapses had not compromised public safety in any way.

8.1.2 Action against Vashi Plant Revoked

Atomic Energy Regulatory Board has today revoked its directive withdrawing the certificate of approval issued to the Demonstration Plant for Radiation Processing of Spices at Vashi, Navi Mumbai. An inspection team from AERB visited the plant on July 13, 2001 and verified that the Board of Radiation and Isotope Technology (BRIT) has implemented administrative and technical measures to ensure that all regulatory requirements are complied with.

8.1.3 Zoning Requirements for Nuclear Power Plants

The safety criteria for siting nuclear power stations in India were formulated several decades ago and were based on a very conservative approach. The criteria included an exclusion zone, a sterilized zone and specified dose limits to individual citizens at the site boundary in accident conditions. Since then, nuclear power plants have undergone major design changes. There is a wealth of national and international experience available. AERB has been collecting and reviewing such information for evolving appropriate criteria.

AERB had also appointed a specialist committee to examine aspects such as the size of exclusion zone and sterilized zone around nuclear power plants keeping in mind the international regulations, current design practices and the type of reactors. The Committee has been asked to study the problem in detail and to recommend changes, if any, in the current zoning requirements. The report of the committee is awaited.

8.1.4 Atomic Energy Regulatory Board (AERB) Reconstituted

The Atomic Energy Regulatory Board (AERB) has been reconstituted. The members of the Board

are Prof. S.P. Sukhatme, Chairman, Shri G.R. Srinivasan, Chairman, Safety Review Committee for Operating Plants, Dr. M.V.S. Valiathan, Honorary Adviser, Manipal Academy of Higher Education, Prof. J.B. Joshi, Director, University Department of Chemical Technology, Mumbai and Dr. K.V. Raghavan, Director, Indian Institute of Chemical Technology, Hyderabad.

8.1.5 AERB Authorises Continuous Operation of Rajasthan Reactor-4

The Atomic Energy Regulatory Board has authorised continuous operation of Unit-4 of the Rajasthan Atomic Power Project (RAPP-4) for a period of three years. As is the currently accepted practice, the Board reviewed the operational safety status of RAPP-4 for over 90 days before giving clearance.

RAPP-4 is a pressurised heavy water reactor of 220 MWe. Its safety features meet the current international design safety standards.

8.1.6 AERB Limits Operation of RAPS Unit-1

Unit-1 of the Rajasthan Atomic Power Station (RAPS) was constructed in 1972 and is the first Pressurized Heavy Water Reactor (PHWR) in India. Being the first of its kind, RAPS-1 has had to face a number of problems associated with the adoption of a new technology. Turbine blade failures, formation of cracks in the end-shields, leak in the calandria over pressure relief device, leak in many tubes in the moderator heat exchanger are some of the technical issues which occurred and were resolved from time to time. Some of these issues required novel engineering solutions and considerable time and effort for implementation. The operating experience of the reactor over these years gave invaluable insights in designing PHWRs of improved designs. The plant has also served the important purpose of developing human resources and honing their skills. This is reflected in the improved performance of the subsequently built nuclear power plants.

Of late, some of the components of RAPS-1 have shown signs of ageing. Since it was built more than 30 years ago, the Unit needs upgradation of some safety systems. The Atomic Energy Regulatory Board in its 73rd meeting held on February 2, 2002 reviewed the safety status of RAPS-1 based on the technical evaluations carried out by its Safety Review Committee for Operating Plants. The Board noted that RAPS-1 was currently operating after having undergone some repairs recently. However, taking a holistic view of the problems encountered and as a measure of abundant caution, the Board has decided that in its present condition, the operation of RAPS-1 will be allowed only up to April 30, 2002.

8.1.7 Heavy Water Plant at Tuticorin and Narora Atomic Power Station Share AERB Industrial Safety Awards

Heavy Water Plant, Tuticorin and Narora Atomic Power Station shared the Atomic Energy Regulatory Board's (AERB) Industrial Safety Awards for the year 2001. Shri S. K. Saxena, Director General, Factory Advice Service and Labour Institutes presented the award at a simple function held on March 5, 2002 at the AERB auditorium.

At this function, Prof. S.P.Sukhatme, Chairman, AERB released a report entitled "Industrial Safety Statistics of Department of Atomic Energy Units for the Year 2001". DAE Units registered higher levels of industrial safety in comparison with similar units outside the DAE in terms of lower Incidence Rates (number of lost time injuries per thousand persons employed) and Frequency Rates (number of lost time injuries per million man-hrs worked) during 2001. For comparison, AERB used DAE data for 2001 with the 1997 data (the latest available from Labour Statistics publications) for similar industries outside DAE.

Lost time injuries (injuries causing death or disablement for 48 hrs or more) and the average Frequency Rates of injuries reported from all DAE units showed reducing trends over the years.

Incidence Rate (IR) for Nuclear Power Plants was 3.03 as against 15.30 for plants using gas and steam to generate electricity. The Incidence Rate in Heavy Water Plants was 26 times less than that in comparable chemical plants outside DAE.

Another notable fact is that the Heavy Water Plants at Baroda, Hazira, Talcher, Thal and Tuticorin, Kakrapar Atomic Power Station, Narora

Atomic Power Station, Directorate of Atomic Minerals for Exploration & Research and the Board of Radiation & Isotope Technology were accident free during the year 2001.

8.1.8 AERB Issues Clearance for the First Pour of Concrete for Kudankulam Nuclear Power Reactors

The Atomic Energy Regulatory Board in its 74th Meeting held on 22nd March 2002 has granted clearance to the Nuclear Power Corporation of India Limited (NPCIL) for the first pour of concrete for Kudankulam Nuclear Power Reactors. Accordingly, NPCIL will start pouring concrete initially for the reactor auxiliary building and later for the reactor building.

The Board issued the clearance on receiving the recommendations of its Advisory Committee for Project Safety Review, which examined the documents submitted by the Russian authorities for their compliance with Indian regulatory requirements.

Currently AERB issues clearance for construction of nuclear power reactors to NPCIL in three sub stages, namely, excavation, first pour of concrete and erection of major equipment. Excavation clearance for Kudankulam nuclear reactors was issued by AERB on October 9, 2001.

8.2 SAFETY INFORMATION NOTICES

8.2.1 Radiological Emergency at Panama: Errors in Treatment Planning System Cause Deaths of Radiation Therapy Patients

On June 4, 2001, the Atomic Energy Regulatory Board received information from the International Atomic Energy Agency on a radiological emergency at the National Oncology Institute in Panama. The emergency involved radiotherapy using a Cobalt-60 teletherapy machine and a computerized treatment planning system for calculating the radiation dose to be delivered to cancer patients.

A team of specialists deputed by IAEA reported that 28 patients suffered due to the emergency. Eight of them died. The deaths of five of them may be attributable to radiation overexposure. Of the other three deaths, one may be related to patient's cancer. There was insufficient information to draw conclusions on the other two.

The IAEA team found that the teletherapy equipment had been working properly and that the calibration was appropriate. The emergency appears to have been caused by improper entry of data into the computer used for the treatment planning system. It is reported that from August 2000, the practice used for entering data was changed. This resulted in incorrect calculated radiation doses and, consequently, treatment times. It appears that there was a lack of written procedures, and of a manual check when the data input procedure was changed. The combination of circumstances resulted in substantial overexposure to radiation of the patients involved.

AERB requested the institutions in India to review the treatment procedures and the use of all treatment planning systems. They were asked to take specific steps to identify whether the system would provide automatic warning for typical or potentially significant data entry errors. AERB sent this Safety Information Notice to all radiotherapy centres urgently to prevent overexposures wherever this configuration of treatment is in use. The institutions were asked to inform AERB of the steps taken to prevent overexposures of the type referred to in the notice.

8.2.2 Radiological Accident at a Medical Accelerator Facility in Poland

The Atomic Energy Regulatory Board received information on a radiological accident which occurred in the Bialystok Oncology Centre in Poland. Five patients while undergoing radiotherapy received significantly higher doses than intended. Currently they need further medical treatment to deal with the radiation induced injuries. The information was sent by the Emergency Response Centre of the International Atomic Energy Agency.

On February 27, 2001, a patient was being treated at the Centre using a Polish built linear accelerator model Neptun 10 P, when electrical power was lost temporarily. This caused an automatic shut down of the accelerator. After the restoration of power, the operator checked its controls, restarted the machine and continued to treat the same patient and four others.

Two patients felt an itching and burning sensation during their irradiation. Treatment was stopped. Measurements revealed that the radiation output was significantly higher than expected. Further checks revealed that the monitoring system was not functioning properly and one of the electronic components of the interlock system was damaged. Subsequently all the five patients developed local radiogenic injuries (radiation burns) of differing degrees.

On November 27, 2001, IAEA received a request for assistance with medical treatment of the patients and the assessment of their radiation doses. IAEA sent a medical team and a team of medical physicists and radiation safety experts. The medical team consulted with the World Health Organisation and provided advice on the future treatment of the patients.

The second team concluded that a single fault appeared to have affected the beam monitoring system of the accelerator, which led to a large increase in the dose rate, though the display indicated a lower value than normal. Furthermore, a faulty diode prevented the safety interlock from functioning. In addition, the limitation on the filament current for the electron gun was set at a higher level so that the dose rate was effectively unrestricted. These factors led to substantially higher doses to patients.

The accident highlighted the need for quality control programmes of accelerators, which should include relevant dosimetry checks after accelerator shut downs due to power failure or any other unusual event.

8.2.3 Radiation Doses in CT-Scan of Children Should be Reduced

CT-scan procedures are very useful in diagnosing diseases. However, these benefits are not without risks. A widely prevalent practice is for physicians to perform CT scans on children with the same technique factors that are used for adults. Thus children receive significantly larger doses.

Recently, the Centre for Devices and Radiological Health (CDRH) of the US Food and Drug Administration (FDA) noticed this undesirable development. CDRH recommended that radiologists must use CT operating conditions of their equipment optimally and maintain balance between image quality and radiation dose. The X-ray specialist must prepare and use a chart or table of current settings based on patient weight or diameter and anatomical region of interest.

In some instances, conventional radiography and other techniques such as sonography or magnetic resonance imaging (MRI) could be just as effective as CT. Physicians must eliminate inappropriate referrals or use procedures with less or no ionising radiation.

FDA noted that often CT scans are done before, during and after injection of contrast material. If it is medically appropriate, the physicians must eliminate pre-contrast images to reduce multiple exposures.

Why should there be special concern in X-raying children? According to the US National Research Council's Committee on Biological Effects of Ionizing Radiation, children less than 10 years of age are several times more radiation sensitive than middle aged adults. It is, therefore, necessary to take extra care while X-raying children. Physicians can reduce the radiation doses to children significantly without compromising clinical efficiency.

The individual risk from X-rays associated with a CT scan is quite small compared to the benefits of diagnosis, but it is important to keep the radiation doses during medical X-ray procedures as low as reasonably achievable. Total number of CT scan procedures are known to be only about 2% of the total medical X-ray procedures even in advanced countries. But the collective dose from these is about 40% of the total. The need to use this tool cautiously is thus obvious.

The above information was brought to the attention of owners of CT scan units in India.

8.3 AERB WEB-SITE

The AERB web site (http://www.aerb.gov.in) continued to disseminate information on AERB. Apart from AERB Annual Reports and press releases, the web site carried information on the composition of the Board, its important committees, a list of AERB publications and the format of various applications. The texts of the Atomic Energy Act 1962 and those of safety related rules under the Act are also available on the web-site.

8.4 INTERVIEW WITH PRESS / TV

Dr. K.S. Parthasarathy, Secretary, AERB was interviewed on Television / Press. Various safety related activities of AERB were covered in the interviews.

(a) Update of Chernobyl Accident - The Hindu on April 26, 2001.

(b) Radiotherapy Centres Told to Review Treatment Procedures -
Press Trust of India on June 12, 2001.
The Times of India on June 13, 2001.
The Economic Times on June 13, 2001.
The Hindu on June 17, 2001.

(c) Radiation Hazards in Hospitals - Zee News on 15.06.2001.

(d) Radiation Hazards in Uranium Mines - The Week on 10.08.2001.

(e) Atomic Plants and Terrorist Attacks - Press Trust of India on October 4, 2001.

(f) Nuclear Plants under Restricted Zones - Deccan Herald on October 12, 2001.

(g) AERB Starts Safety Reviews of Russian Reactors - United News of India on November 7, 2001.

(h) CT Scan Radiation - The Bombay Times on December 18, 2001.

(i) CT Scan Risks to Children - The Tribune on December 20, 2001.

(j) Operational Restriction on RAPS-1 - The Hindu on February 19, 2002.

(k) Operation of RAPS - The Asia Times on February 20, 2002.

(l) Fears about Plutonium Hazards - The Times of India on March 30, 2002.

(m) Construction Clearance to Kaiga-3&4 - The Deccan Herald on March 30, 2002. ■

SECTION 9
INTERACTIONS WITH OTHER INSTITUTIONS

9.1 BUREAU OF INDIAN STANDARDS

Comments on BIS document 'Code of Practice on Industrial Plant Layout' and draft documents 'Code of Safety for Stable Bleaching Powder' and 'Code of Safety for Hydro-Fluoro Carbon HFC-134a' were given.

9.2 JADAVPUR UNIVERSITY

Interaction with Jadavpur University, Kolkata, for the AERB sponsored research project on High Performance Concrete.

9.3 INDUSTRIAL PLANTS

a) Calculations for consequence analysis for a 50-mm pipe rupture, probability of the rupture and probability of damage to plant and personnel due to rupture were carried out for M/s. ICI Ltd., Navi Mumbai.

b) Interaction with Associated Cement Companies, Thane for the AERB collaborative project on High Performance Concrete.

RAJASTHAN ATOMIC POWER STATION UNIT-3&4

SECTION 10

INTERNATIONAL ACTIVITIES

10.1 DEPUTATIONS ABROAD

Name of Officer	Period of Deputation	Venue	Purpose
Prof. S. P. Sukhatme	28.5.2001 to 30.5.2001	Vienna	Meeting of Commission on Safety Standards.
	31.5.2001 to 1.6.2001	France	Under the Agreement between AERB & DSIN of France.
Shri G.R. Srinivasan	2.4.2001 to 6.4.2001	Vienna	Second part of the IRS Topical Study on executive of operational limits of conditions.
	17.9.2001 to 18.9.2001	Vienna	45th General Conference of IAEA
	22.10.2001 to 23.10.2001	Vienna	IAEA meeting on Safety of Nuclear Installations in Relation of Extreme Internal and External Events including Terrorist Attacks.
Dr. K. S. Parthasarathy	18.6.2001 to 22.6.2001	Vienna	IAEA/TCM on Nuclear Safety Perspectives for Public Communication.
Shri S. K. Chande	21.5.2001 to 25.5.2001	Haiyan China,	IAEA Workshop on Operational Safety Issues of NPPs.
	23.7.2001 to 25.7.2001	Toronto, Canada	IAEA/Workshop on Safe Operating Envelope for Nuclear Power Plants with Pressurised Heavy Water Reactors.
	3.9.2001 to 6.9.2001	Vienna Safety.	IAEA/International Conference on Topical Issues in Nuclear
	29.10.2001 to 2.11.2001	Buenos Aires, Argentina	IAEA/TCM at Annual Meeting of Senior Regulators of Countries Operating CANDU Type Reactors.
Shri Deepak De	7.4.2001 to 11.4.2001	Tehran	IAEA Expert Mission No.IRA/4/029-27.
Dr. P. C. Basu	12.8.2001 to 26.8.2001	USA	Present papers at 16th International Conference on Structural Mechanics in Reactor Technology (SmiRT), Post Conference Seminar (PCS) on "Reactor Containment Structure.
	26.11.2001 to 30.11.2001	Vienna	IAEA Expert Mission.
	22.12.2001 to 26.12.2001	Tehran, Iran	IAEA Assignment.

Name of Officer	Period of Deputation	Venue	Purpose
Shri A. R. Sundararajan	25.6.2001 to 29.6.2001	Vienna	IAEA Regional Workshop on National Capabilities for Response to Radiological Emergencies.
	2.7.2001 to 6.7.2001	Vienna	IAEA/TCM to Prepare an Action Plan on the Safety of Radioactive Waste Management.
	18.2.2002 to 21.2.2002	Vienna	IAEA/TCM to Prepare a Draft Safety Guide on the Specification of Radionuclide Content on Commodities Requiring Regulation for Purposes of Radiological Protection.
Shri S. K. Agarwal	7.5.2001 to 11.5.2001	Vienna	9th series of Peer Discussion on Regulatory Practices Entitled 'Quality Management of the Regulators'.
Shri D. K. Dave	20.8.2001 to 24.8.2001	Ulsan, Korea	IAEA Regional Workshop on Supporting and Strengthening Management of Operational Safety at NPPs and Utility Organizations.
Dr. A. N. Nandakumar	6.8.2001 to 10.8.2001	Bangkok, Thailand	IAEA/Regional Workshop on the Safety of Radiation Sources and Security of Radioactive Materials.
	3.9.2001 to 7.9.2001	Chicago, USA	Triennial International Symposium on the Packaging and Transportation of Radioactive Materials - 2001
	12.11.2001 to 16.11.2001	Vienna	IAEA/TCM to Revise the Regulations for the Safe Transport of Radioactive Materials.
Shri R. K. Chugha	3.12.2001 to 7.12.2001	Vienna	IAEA/TCM on Self Assessment of Operational Experience Feedback and the PROSPER Guidelines.
Shri S. P. Agarwal	24.9.2001 to 28.9.2001	Vienna	IAEA/TCM to Evaluate the Revision and Harmonized Adoption Process for the Agency's Regulation for the Safe Transport of Radioactive Material.
Shri P. Hajra	15.10.2001 to 19.10.2001	Vienna	IAEA/TCM on Safety Margins of Operating Reactors & Implications for Decision Making Including Considerations of Uncertainties of Analysis.
Shri P. R. Krishnamurthy	11.6.2001 to 15.6.2001	Daya Bay, China	IAEA Regional Workshop on Safety Culture.
Shri K. K. Chandraker	14.5.2001 to 18.5.2001	Vienna	IAEA/TCM to review National Experience on the Regulatory Control of Discharges to the Environment.
Shri C. P. Raghavendran	23.4.2001 to 27.4.2001	Vienna	IAEA/TCM on Technical Aspect of the Return of Spent Sealed Sources to Suppliers / Manufacturers.
Shri Arun Kumar	7.5.2001 to 11.5.2001	Stockholm, Sweden	International Conference on Security Measures to Prevent, Intercept & Respond to Illicit Uses of Nuclear Material & Radioactive Sources.
Shri A. U. Sonawane	19.11.2001 to 23.11.2001	Bangkok, Thailand	IAEA/RCA Regional Workshop on Radiation Safety at Industrial Irradiation Facilities.

Name of Officer	Period of Deputation	Venue	Purpose
Shri S. Harikumar	2.7.2001 to 6.7.2001	Haiyan, China	IAEA/Regional Workshop on Approaches to Improve the Safety of Operating NPP's Built to Earlier Standards.
Shri Deepak Ojha	3.12.2001 to 7.12.2001	Vienna	IAEA Consultants Meeting on IRS Data Base.
Shri P.K. Dash Sharma	9.7.2001 to 13.7.2001	Jakarta, Indonesia	IAEA/RCA Regional Workshop on the Regulatory Control of Radiation Sources: Notification, Authorization, Inspection and Enforcement.
Shri A. Ramakrishna	25.2.2002 to 28.3.2002	Trieste, Italy	IAEA Workshop on Nuclear Reactors: Physics, Design & Safety.

10.2 VISIT OF FRENCH EXPERTS

On invitation from AERB, Mr. A.C. Lacoste, Director, DSIN (French Nuclear Safety Authority) visited India from October 25, 2001 to November 2, 2001. He was accompanied by Mr. J.P. Clausner, Senior Executive, DSIN and Mr. Thomas Maurin, Head, Reactor Department, DSIN. The team discussed topics such as licensing of nuclear power plants, periodic safety reviews and life cycle management of nuclear facilities with the officers of AERB. The team visited Kaiga Generating Station on October 31, 2001.

On November 2, 2001, the team visited B.A.R.C. At B.A.R.C, Mr Lacoste delivered a lecture on "French Regulatory Philosophy with Specific Emphasis on Risk Informed Regulation". ■

A team of specialists from the French Nuclear Safety Authority (DSIN) visited AERB. (From left) Shri G. R. Srinivasan, Vice chairman, AERB, Shri V. K. Sharma, Senior Excutive Director NPCIL, Mr. J P Clausner Senior Executive (DSIN), Mr. A. C. Lacoste, Director (DSIN), Prof. S. P. Sukhatme, Chairman AERB, Mr. Thomas Maurin, Head, Reactor Department, DSIN.

The French Team during a meeting (from left to right) Mr. Thomas Maurin, Prof S. P. Sukhatme, Mr. A. C. Lacoste, Shri G. R. Srinivasan, Mr. J. P. Clausner, Dr. P. C. Basu.

Mr. A. C. Lacoste Addressing the staff of AERB

SECTION 11

HUMAN RESOURCE DEVELOPMENT

11.1 AERB TRAINING PROGRAMME

Availability of trained and competent personnel is an important requirement for a Quality Management System and for Regulatory Effectiveness. A training programme for AERB staff has been prepared keeping in view the job requirements, knowledge, skills and competence needed for fulfilling effectively the functional requirements by the various divisions of AERB.

The programme consists of Basic Safety Modules and modules specific to Radiation Safety, Industrial Safety and Civil & Structural Engineering aspects. The faculty is drawn from experts available on the specific topics from AERB, BARC, NPCIL and Consultants. An examination is conducted at the conclusion of each module.

The training programme was inaugurated on October 1, 2001 and the programme is conducted on every Monday. During the year 2001-2002, five training modules each in the areas of Basic Safety, Radiation Safety, Industrial Safety and Civil & Structural Engineering safety were completed. The programme has generated great enthusiasm among the officers of AERB.

11.2 TRAINING OF NUCLEAR MEDICINE TECHNOLOGISTS

All technologists working in nuclear medicine laboratories in India are required to obtain a diploma in nuclear medical radioisotope technology (DMRIT). Since there are a fair number of non-diploma workers with experience, a special training course was organized in close coordination with the Radiological Physics and Advisory Division and Radiation Medicine Centre, Bhabha Atomic Research Centre, for accreditation of non-DMRIT nuclear medicine technologists with more than five years experience.

In order to ensure proper implementation of AERB Safety Codes SC/MED/1 and AERB/SCV/MED/2, a training course on " Radiation Safety for Radiation Therapy Technologists" was conducted during December 18 - 21, 2001. The successful candidates were awarded certificates. ■

KUDANKULAM ATOMIC POWER PROJECT UNIT 1&2

SECTION 12

SAFETY PROMOTIONAL ACTIVITIES IN DAE

12.1 INDUSTRIAL SAFETY AWARDS

The Industrial Safety Awards Presentation function was held on 5th March 2002 in AERB auditorium. Heavy Water Plant, Tuticorin and Narora Atomic Power Station, Narora won the award jointly. Shri S.K. Saxena, Director General, Directorate General Factory Advice Service and Labour Institutes was the Chief Guest and presented the Safety Shields to the winners.

12.2 FIRE SAFETY AWARD

The Fire Safety Award is decided by taking into account the safety record on fire incidents and the fire potential at the site. The award is given on the basis of best performance in fire safety amongst all DAE units. Madras Atomic Power Station 1 & 2 has been selected as the winner of the award for the year 2001.

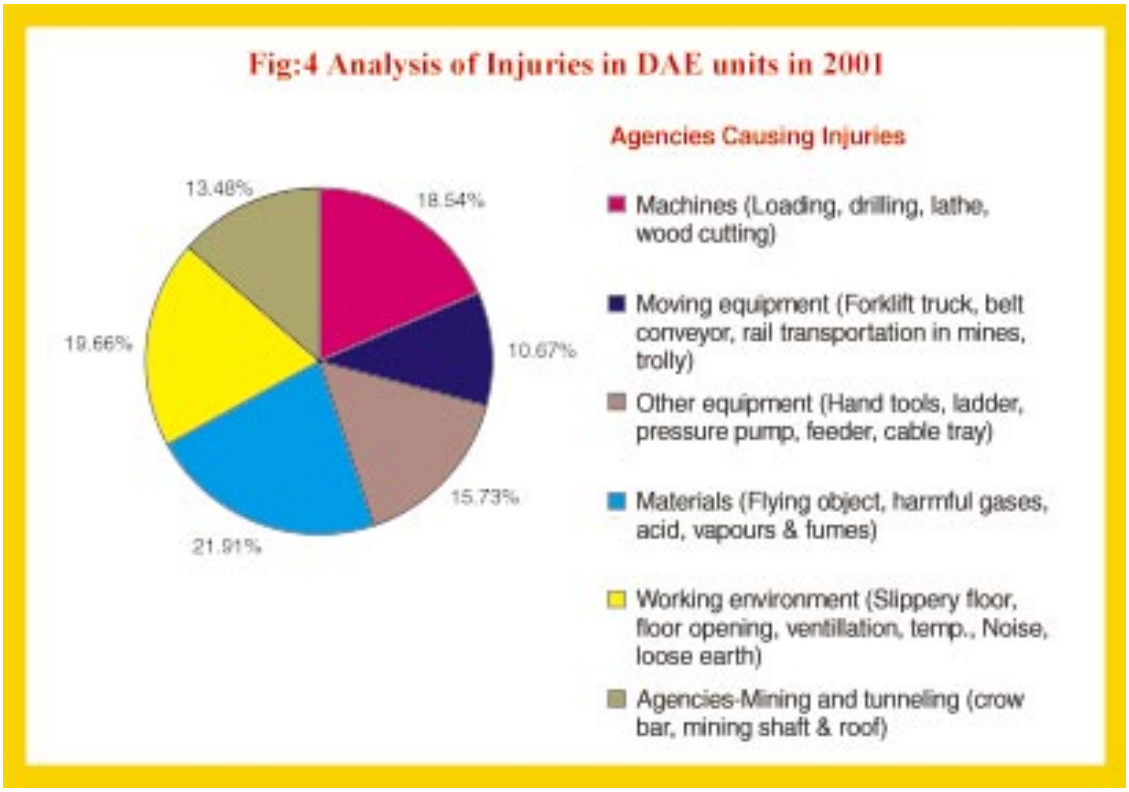
12.3 GREEN SITE AWARD

The Heavy Water Plant Thal and Indian Rare Earths, OSCOM won the AERB Green Site Award for the year 2001.

12.4 INDUSTRIAL SAFETY STATISTICS OF DAE UNITS FOR THE YEAR 2001

Lost - time injuries data sent by various DAE units were compiled and a document entitled 'Industrial Safety Statistics of DAE units for the year 2001' was released on 5th March 2002 during the Industrial Safety Awards presentation function.

The document contains data on lost - time injuries and tables and graphs of injury statistics among the individual units of DAE and non-DAE units and their trend over the years. The data gives an idea on the nature of injuries, location of injuries, agency of injuries, unsafe acts / conditions responsible for the injuries. An account of the fatalities in DAE units has also been included in the document. The percentage of agency-wise injuries in DAE units for the year 2001 has been depicted in **Figure 4.**



12.5 OTHER ACTIVITIES

12.5.1 Advisory Committee on Occupational Health (ACOH)

The Advisory Committee on Occupational Health analyses the occupational health data of workers working in DAE units, reviews the implementation of statutory requirements and suggests ways to improve the occupational health status. The following were some of the activities during the year :

- The Committee made some changes in the format and periodicity of health status reports submitted to AERB by all DAE units.
- The Committee's Report on the periodicity and type of medical examination in DAE units was accepted by the Board with some modifications.
- A three member sub-committee has been constituted by ACOH to prepare a 'Manual for Occupational Health' dealing with the following topics:

  a) Pre-Employment Fitness
  b) Special Assignments requiring Special Fitness
  c) Managing Injuries on Duty
  d) Medical Leave and Fitness thereafter
  e) Handicapping Disabilities
  f) Fitness as affected by Age Problems

12.5.2 Development of Data Bank

A database of various safety aspects of the industrial plants of DAE has been developed in AERB. It contains the following information:

- Database based on Tri-annual Safety, Health & Environment Reports
- Database based on Monthly and Quarterly Health Physics Reports
- AERB Industrial Safety, Fire Safety and Green Site Award Winners
- Accident Statistics
- Dangerous Occurrences
- Safety - Related Unusual Occurrences Reports (SRUORs)
- Fatal Accidents and Fatalities
- Competent persons, Certifying surgeons under the Factories Act, 1948
- Licences Issued / Renewed under the Factories Act, 1948
- Authorised Persons of HWPs
- Compliance Status of SARCOP Recommendations
- Compliance Status of Recommendations of Inspection Reports
- Fire Accidents / Incidents

Shri M. P. Mahajan, Director (Operations) and Shri T. K. Halder, General Manager, Tuticorin receiving the Industrial Safety Award from Shri S. K. Saxena, Director General, FASLI (extreme right)

Officials from IRE and HWP Thal receiving Green Site Award from Prof. S. P. Sukhatme. Shri G. Kalyana Krishnan, HWP, Thal, Shri P. Panduranga Rao, GM, IRE, Shri D. C. Goel, DGM, HWP, Thal, Prof. S. P. Sukhatme.

SECTION 13

OFFICIAL LANGUAGE IMPLEMENTATION

In order to promote the use of Hindi, AERB organised various Hindi competitions during the year. These included Essay Writing, Elocution, Debate, To-day's Words, Dictation and Quiz competitions. Officers and staff from AERB also participated and won prizes in the Hindi competitions organized jointly by six DAE units located at Anushaktinagar, Mumbai.

Three Hindi Workshops were organized by the Official Language Implementation Joint Co-ordination Committee of Anushaktinagar based DAE Units. Nine officers/employees of AERB participated in these workshops. One employee participated in the Hindi Computer Workshop.

On the occasion of Hindi Day on 14th September 2001, a Scientific Conference was organized jointly by six DAE units in Mumbai on the topic 'Atomic Energy & Environmental Protection'. In this conference, a scientific paper titled 'Atomic Energy & Environmental Protection- A Regulatory Perspective' was presented in Hindi by AERB.

The Incentive Schemes of DAE for promoting the use of Hindi in official work are implemented in AERB and two employees were awarded cash prizes under these schemes.

The first issue of the AERB House Magazine in Hindi called 'NIYAMIKA' was published. It was released by Chairman, AERB on 15th February, 2002 at the Prize Distribution function and Cultural programme. ■

Professor S.P. Sukhatme, Chairman, AERB releases the first issue of NIYAMIKA, (From Left) Shri S. K. Agarwal, head Safety Analysis and Documentation Divisiion and Chairman, Official Language Implementation Committee, Prof. S.P. Sukhatme, Shri G.R. Srinivasan, Vice Chairman, AERB.

SECTION 14

AERB PERSONNEL PROFILE

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

Sl.No.	Name	Designation/Grade
65	Singh R.K.	"
66	Titto E.R.	"
67	Anuradha Vangala (Smt.)	Scientific Officer (C)
68	Bhattacharya D.	"
69	Chikkanagaudar S.C.	"
70	Dubey S.K.	"
71	Inamdar M.V. (Smt.)	"
72	Kodwani R.K.	"
73	Mahendra Prasad	"
74	Mishra J.	"
75	Pimple D.V.	"
76	Pisharady A.S.	"
77	Pradhan S.K.	"
78	Rao R.S.	"
79	Solanki R.B.	"
80	Suneet K.	"
81	Sunil Sunny C.	"
82	Tripathi S.K.	"
83	Valiveti L.N.	"
84	Vijayan P.	"
85	Vivek	"
86	Virdhi P.S.	"
87	Gholap V.P.	Scientific Officer (SB)
88	Gurumurthy	"
89	Ingavale B (Smt.)	"
90	Singh B.K.	"
91	Choudhari M.S.	D'man F
92	Vadivala R.N. (Smt.)	Scientific Assistant (E)
93	Chodankar N.M.	Scientific Assistant (D)
94	Dhotre V.R.	"
95	Kodolkar S.M.	"
96	Rane D.M.	"
97	Sivaraman G.	"
98	Kavi Upreti	Scientific Assistant (C)
99	Bapat A.P.	Tradesman (F)

Sl.No.	Name	Designation/Grade
100	Bhoite S.S.	Chargehand
101	Salgaonkar R.D.	Tradesman (D)
102	Kajania B.D.	Tradesman (A)
103	Puran Singh	"
104	Nair N.S.	Admn. Officer-III
105	Sarojini L. (Smt.)	Principal Private Secretary
106	Elsie T.M. (Smt.)	Dy. Controller of Accounts
107	Kalyani V. (Smt.)	Sr. Accounts Officer
108	Kuriakose V.P.	Asstt. Personnel Officer
109	Vijayan C.K.	"
110	Nair S.M. (Smt.)	Asstt. Accounts Officer
111	Palamattam R.J.	Senior Private Secretary
112	Javed Jafri	Asstt. Accountant
113	Suma Panicker (Smt.)	Assistant
114	Chandrasekharan P. (Smt.)	Stenographer I
115	Sheela K. Menon (Smt.)	"
116	Latha Mohandas (Smt.)	Stenographer II
117	Mallika Nair (Smt.)	"
118	Narayanan P.	"
119	Radha Raghavan (smt.)	"
120	Gudekar G.D.	Cashier
121	Shukla M.K.	Jr. Hindi Translator
122	Neena J. (Smt.)	Stenographer III
123	Prakash K.V.	Upper Division Clerk
124	Shelar P.A. (Smt.)	"
125	Koli R.R.	Lower Division Clerk
126	More J.K.	"
127	Parvathi H. (Smt.)	"
128	Shettigar S.M. (Smt.)	"
129	Naktode J.S.	Hindi Typist

ABBREVIATIONS USED

ACNS	Advisory Committee on Nuclear Safety
MAPS	Madras Atomic Power Station
ACPSRS	Advisory Committee for Project Safety Review
MOU	Memorandum of Understanding
ACOH	Advisory Committee on Occupational Health
NAPS	Narora Atomic Power Board
AHWR	Advanced Heavy Water Board
NFC	Nuclear Fuel Complex
AERB	Atomic Energy Regulatory Board
NOC	No-Objection Certificate
AMD	Atomic Minerals Division
NPCIL	Nuclear Power Corporation of India Ltd.
BARC	Bhabha Atomic Research Centre
NPP	Nuclear Power Plant
BRIT	Board of Radiation and Isotope Technology
NUOFP	New Uranium Oxide Fabrication Plant
CESC	Civil Engineering Safety Technology
OPSD	Operating Plants Safety Division
CFFP	Ceramic Fuel Fabrication Plant
OSCOM	Orissa Sand Complex
CSIR	Council for Scientific and Industrial Research
PDSC	Project Design Safety Committee
CT	Computed Tomography
PFBTR	Prototype Fast Breeder Reactor
DAE	Department of Atomic Energy
PHT	Primary Heat Transport
DRDO	Defence Research and Development Organisation
PHWR	Pressuriesed Heavy Water Reactor
ECCS	Emergency Core Cooling System
QA	Quality Assurance
ECIL	Electronics Corporation of India Ltd.
RAPP	Rajasthan Atomic Power Project
ECSQ	Expert Committee for Sesmic Qualification
RAPPCOF	Rajasthan Atomic Power Project Cobalt Facility
EFPY	Effective Full-Power Years
RAPS	Rajasthan Atomic Power Station
FBTR	Fast Breeder Test Reactor
RSO	Radiological Safety Officer
HWB	Heavy Water Board
SARCAR	Safety Review Committee for Applications of Radiation
HWP	Heavy Water Plant
SARCOP	Safety Review Committee for Operating Plants
IAEA	International Atomic Energy Agency
SC	Safety Committee
ICRP	International Commission on Radiological Protection
SCHWOP	Safety Committee for Heavy Water Operating Plants
IGCAR	Indira Gandhi Centre for Atomic Research
SRI	Safety Research Institute
INES	International Nuclear Event Scale
SSSF	Solid Storage Surveillance Facility
IREL	Indian Rare Earths Ltd.
TAPP	Tarapur Atomic Power Plant
IRS	Incident Reporting System (of International Atomic Energy Agency)
TAPS	Tarapur Atomic Power Station
ISI	In-Service Inspection
TCM	Technical Committee Meeting
KAMINI	Kalpakkam Mini Reactor
Type B(U)	Type B (Unilateral)
KAPS	Kakrapar Atomic Power Station
UCIL	Uranium Corporation of India Ltd.
KGS	Kaiga Generating Station
VVER	
WIP	Waste Immobilisation Plant
ZSP	Zirconium Sponge Plant

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