# THE REGULATORY PROCESS RELATED TO NUCLEAR FACILITIES AND ITS IMPLEMENTATION

## 1.0 Introduction

Atomic Energy Regulatory Board (AERB) was constituted on November 15, 1983 by the President of India by exercising the powers conferred by the Atomic Energy Act, 1962 to carry out certain regulatory and safety functions. Since then AERB has been discharging the assigned responsibilities w.r.t safety of nuclear and radiation facilities. Over the years, AERB has established a well defined, sound and effective regulatory mechanism for safety review of nuclear projects and facilities. The following gives a brief overview of the regulatory review process being followed in AERB.

## 2.0 Consenting Process for Siting & Construction of Projects

AERB issues clearances for nuclear power projects and plants in stages after detailed safety review. For nuclear power projects, regulatory consenting process is based on requirements specified in AERB Safety Code on "Regulation of Nuclear and Radiation Facilities" and associated Safety Guides. As per this code, Major Stages of Consent are: Siting approval, Start of Construction, Commissioning and Operation and eventual Decommissioning. AERB Guide on Consenting Process for NPPs and Research Reactors, "AERB/SG/NPP&RR/G-1" provides more details such as: Contents and Format of safety documents like Site Evaluation Report, Safety Analysis Report; Lead-Time for submission of documents for review; Review topics/areas for each stage of consent; Method for review and assessment; Application-Formats for various consents; etc. Detailed technical safety requirement developed by AERB including those for siting and design of NPPs are published in the safety Codes and Guides, which are available on AERB website (www.aerb.gov.in). These requirements are in line with safety standards of International Atomic Energy Agency (IAEA) and other international guidelines.

AERB performs very detailed multi-tier safety reviews for the projects for all major consenting stages. For siting consent, Site Evaluation Committee performs first tier review and Advisory Committee for Project Safety Review performs second tier review and Board of AERB performs third tier review. For Construction and Commissioning stages, first tier review is by Design Safety Review Committee. Second tier review is by Advisory Committee for Project Safety Review and Board of AERB performs third tier review. In addition, these Safety Committees in turn appoint large number of working groups/specialist task forces to carry out in-depth review of specific topics of high safety significance and resolution of specific issues.

These committees include experts from outside organizations, academic institutions and individuals who are specialists in relevant fields.

Review for site clearance is done in accordance with AERB Safety Code on siting and associated guides. Issues considered include impact of plant on site (radiological effect) and effect of site on plant including earthquake and flooding potential of the site. Annexure-1 gives some highlights of siting requirements of AERB.

The review of design is done to ensure compliance with relevant codes and guides of AERB and mostly for assessment to evaluate that adequate safety provision exists to prevent unacceptable consequences. Structural safety analyses, which postulate a large number of possible failures are performed to demonstrate robustness in design.

Environmental radiation impact arising out of operation of nuclear power plant is addressed during Siting review stage and is further regulated during operating phase through out the life of the reactor. Regulatory limits on radioactive emissions from the plant during operating phase are established as per the AERB Safety documents.

To give a flavour of the depth and extensiveness of review, some numbers are given below for the regulatory review performed for a recent project (TAPS-3&4):

| | | |
|---|---|---|
| No of Safety Committee meetings | : | 530 |
| No of Working Group meetings | : | 325 |
| Approx. total man days spent for safety review | : | 28800 |

## 3.0 Regulatory Control of operating Nuclear Power Plants

After the issuance of licence for operation, AERB establishes the system of regulatory review and assessment by way of reporting obligations and periodic safety review. Compliance to the regulatory requirements is verified by conducting periodic regulatory inspections.

The operational performance and significant events are reviewed and the required modifications are implemented by the utility. Analysis of internationally reported events and their applicability to Indian NPPs is also checked and accordingly the systems, procedures and aspects related to training & safety culture are further improved. Some of the important events from which lessons learnt were Three Mile accident, Chernobyl accident and Narora Fire incident. The Fukushima accident is under review by AERB and the measures taken by AERB post this accident is given in Annexure-2.

A periodic safety review (PSR) by AERB of operational and safety performance of NPPs which includes factors like changes in safety standards, ageing, new information, etc. are carried out at the time of renewal of licence or major refurbishment or for plant life extension. Such reviews bring out requirements for modification and safety up-gradation, if any. Following these reviews, a number of NPPs have undergone such safety upgrades.

Each station is required to plan and prepare annual budget for collective exposure of occupational workers and get it approved by AERB. The budget preparation takes into account the operational experience, in-service inspections, surveillance checks, bi-ennial maintenance activities and any other major upgrades planned.

AERB approved document “Technical Specifications for Operation” specifies very stringent limits on radioactive releases to the environment for each of the operating stations. Over the years, actual liquid and gaseous rad-waste discharged to the

environment from all the operating plants were only a small fraction of the specified limits in the Technical Specifications for Operation. Independent monitoring and assessment of impact of the discharges is done by Environmental Survey Laboratories (ESL) of BARC which carries out measurements of radionuclide concentrations regularly in items such as vegetables, cereals, milk, meat, fish, air, water, soil, plants etc using detectors of high sensitivity. The details of monitoring and further details are available in the annual reports published by AERB. The annual reports are available in our web site www.aerb.gov.in.

AERB has adequate Scientific & Technical personnel for conduct of safety review as per the above explained well defined procedure. AERB, apart from its own expertise, draws on the technical support and expertise available in other institutions in specific area, including Bhabha Atomic Research Centre, Mumbai and Indira Gandhi Centre for Atomic Research, Kalpakkam, etc. To obtain input from a wider cross section, AERB involves large number of outside experts from academics, R&D institutions, industry and Government bodies.

## 4.0 Independence of AERB

AERB has been independent in exercising its decision making powers in matters of regulation and safety. A key test of the effectiveness of independence and autonomy of a regulatory body is its ability to take enforcement actions. In the past twenty six years of existence, there has not been a single instance when the decision of AERB has been challenged. There have been several instances when AERB has taken enforcement actions against units of DAE. Some examples are given below:

- In 1994, subsequent to the failure of the inner containment dome of unit 1 of the Kaiga Atomic Power Project, AERB suspended the civil construction activities related to the inner containment domes of Kagia unit 2, and units 3 and 4 of the Rajasthan Atomic Power Project. AERB lifted the hold only after satisfactory resolution of related safety matters.
- In 2004, there was an incident involving failure of reactor regulating system resulting in un-intended increase in reactor power I KAPS-I. Following the incident, both the units were shut down and restart of the units was permitted only after ascertaining the satisfactory implementation of corrective measures including re-training and re-licensing of key operating staff and station management.
- In 2004, following deterioration in the civil structures of one of the chemical plants of Nuclear Fuel Complex, the plant operations were suspended till the process operations were relocated to a new building.
- In 2007, the AERB withdrew the construction licence of units 5 and 6 of the Rajasthan Atomic Power Project when it found poor industrial safety status. It lifted the hold only after NPCIL ensured enhanced safety arrangements.

Other than the above stoppage actions of operating and construction projects, AERB has directed several actions which were complied by the nuclear power plants such as mockups/additional confirmatory analyses to confirm various issues, augmentation of testing provisions (such as on line tests), additional logics, more

redundancy in DG driven fire motor pumps, use of high density shielding concrete in Fuel Machine Vault wall etc.

## 5.0 Conclusion

The success and effectiveness of Indian regulatory process can be gauged from the history and statistics of safe operation of the nuclear facilities in India. The monitoring of doses to the workers, public and environment assure that safety practices in various aspects of NPP operation are well implemented. The dose limit to a member of public is 1mSv. As seen form Annexure-3, the public dose due to operation of nuclear power plants is only 1-2% of the limit. The occupational dose limit for worker in a year is 30mSv. As seen from the Annexure-4, the average dose received by the workers is only a fraction of the dose limit. Till date, there has been no event in any of the nuclear power plants of India which has resulted in adverse radiological impact on the environment. As per the International Nuclear and Radiological Event Scale (INES), events are rated in the scale 1 (anomaly) – 7 (major accident) depending on the radiological release and its impact. The two major events of Indian Nuclear Power Plants and their INES rating is given in Annexure-5. In both these events, there had been no radiological impact on the workers, public or the environment.

AERB has more than 25 yrs. of experience in Safety review of NPPs and is well prepared for safety review of a large number of projects of different designs envisaged to be set-up, in near future, in our country.

## Annexure-1

## Highlights of siting requirements of AERB

AERB's Code of Practice on Safety in Nuclear Power Plant Siting specifies various requirements to address the seismic and tsunami hazard potential. It requires that the proposed sites for nuclear power plants shall be examined with respect to the frequency and the severity of external events and phenomena that could affect the safety of the plant. For this purpose historical data relating to past earthquakes in the tectonic province covering an area of about 300 km radius around the proposed site is to be collected. As per codal requirements, no NPP is allowed to be sited in a location that falls under seismic zone –V, which has a potential to generate earthquake beyond 7.0 magnitude. If the site is closer than 5 km to a capable fault, then also is deemed unacceptable.

Code also specifies that design bases for external events to be used in the design of the plant shall be determined for the combination of the proposed site and nuclear power plant. With respect to earthquake, the design basis vibratory ground motion is to be based on two levels of earthquakes S1 and S2. The S1 level is the maximum ground motion which can be reasonably expected to be experienced at the site area once during the operating life of the nuclear power plant with an estimated rectum period of about 100 years. The S2 level is the level of ground motion that has a very low probability of being exceeded and represents the maximum level of ground motion to be used for design purposes of safety related structures. The S2 is to be derived on the basis of maximum earthquake potential associated with tectonic structures and maximum earthquake potential associated with seismo-tectonic provinces in the region.

With respect to Tsunami hazard, the effects of Tsunami and long period ground waves at a site during earthquake is to be considered. The finished grade elevation at the site shall be above high water level to provide adequate safety margin.

For coastal sites, the potential for flooding by combination of high tides, wind effects and wave runup on bodies of water needs be examined to arrive at the design basis flood for the site.

Further the Code also specifies that if the minimum water supply required for long term heat removal from the core cannot be ensured under all circumstances, then the site shall be deemed unsuitable. Availability of adequate quantity of water to maintain the reactor under safe shutdown state for atleast thirty days needs to be ensured under all circumstances.

**Annexure-2**

**MEASURES TAKEN POST FUKUSHIMA NUCLEAR ACCIDENT IN JAPAN**

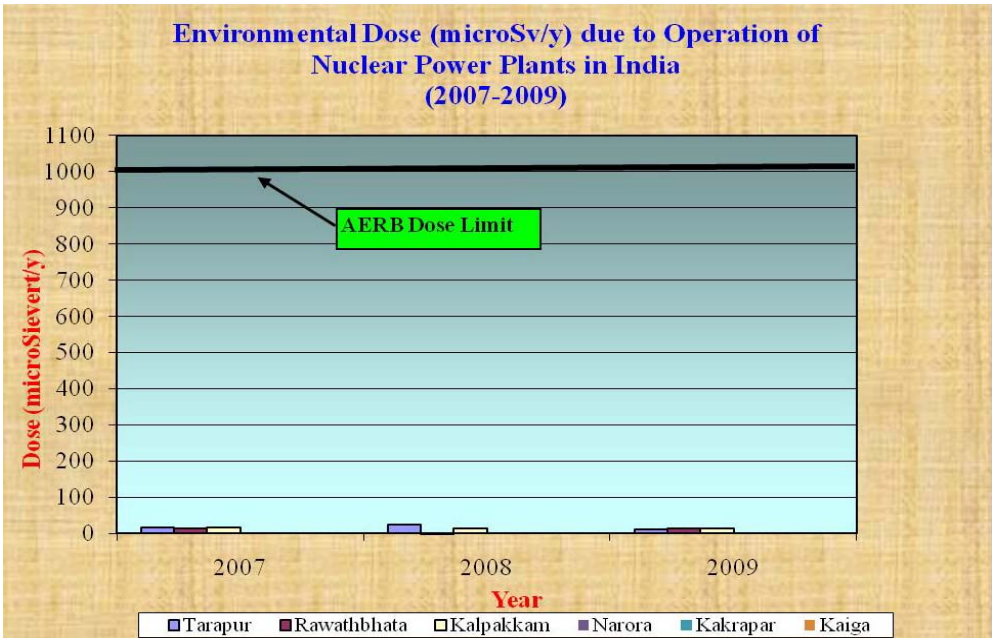
Post the Fukushima Nuclear Accident in Japan, AERB has taken several proactive measures, which are as follows:

- A High Level Committee under the Chairmanship of Shri S. K. Sharma, Former Chairman, AERB and consisting of experts from Central Water and Power Research Station, Indian Institute of Tropical Meteorology & IIT (Madras) apart from BARC, NPCIL & AERB was constituted to review safety of Indian NPPs in the light of the lessons from Fukushima. The Committee shall assess the
  - The capability of Indian Nuclear Power Plants to withstand earthquakes and other external events such as tsunamis, cyclones, floods, etc.
  - Adequacy of provisions available to ensure safety in case of such events, both within and beyond design basis.

  The Committee has started functioning and has formed several working groups.
- An inhouse Monitoring Cell has been constituted to continuously follow the events at Fukushima and to keep a close vigil on the radiation/contamination levels in Japan and India.
- Daily updates on AERB website
  - on radiation levels recorded by Indian Environmental Radiation Monitoring Network (IERMON) for 9 locations encompassing whole of India
  - report of the monitoring cell
- Press releases issued
  - March 15, 2011 (assurance that all the reactors in India are designed to withstand the earthquake and tsunami of specific magnitude based on conservative criteria and programme to carry out comprehensive reassessment of safety and emergency mitigation measures at all Indian NPPs)
  - March 17, 2011 (information that there is no radiological impact in India from Fukushima incident as of now)
  - March 28, 2011 ( on action taken by AERB post Fukushima incident).
  - April 12, 2011 ( on revision of INES rating of Fukushima Nuclear Accident)
- AERB has also informed to the Food Safety and Standards Authority of India (FSSAI) that currently there are three laboratories in India which have been identified for testing of food items for contamination. AERB representative attended the Meeting organized by FSSAI for taking a decision related to import of Food items from Japan
- With respect to screening of passengers coming from Japan, AERB has informed National Disaster Management Authority (NDMA) that at present there is no such requirement.
- Statements and responses by Chairman, Vice Chairman and Secretary, AERB to the queries from Journalists, Electronic Media, All India Radio with respect to safety of Indian Nuclear Power Plants as well as effect of Japan incident on India.

**Annexure-3**

**Environmental Dose due to operation of Nuclear Power Plants in India**




**Remarks:**

Public Dose Limit- 1 mSv/year

Actual Dose: 1-2% of the limit

**Annexure-4**

## Radiation Doses Received by Workers in NPPs (2009)

| NPP | Number of monitored persons | Average dose for monitored persons (mSv) | Number of persons receiving dose | Average dose among dose receivers (mSv) | Dose Limit in a year |
|---|---|---|---|---|---|
| TAPS-1&2 | 2202 | 2.36 | 1831 | 2.84 | 30 mSv |
| RAPS-1&2 | 1280 | 1.05 | 882 | 1.52 | |
| MAPS-1&2 | 1162 | 1.51 | 995 | 1.76 | |
| NAPS-1&2 | 2135 | 3.63 | 1912 | 4.05 | |
| KAPS-1&2 | 2337 | 2.80 | 2030 | 3.22 | |
| KGS -1&2 | 1493 | 1.74 | 1074 | 2.43 | |
| RAPS-3&4 | 1938 | 0.87 | 1205 | 1.40 | |
| TAPS -3&4 | 1581 | 0.27 | 892 | 0.47 | |
| KGS -3&4 | 978 | 0.06 | 196 | 0.30 | |

**Remarks:**
Worker Dose Limit- 30 mSv/year
Observed Average Dose: < 5mSv/year

**Annexure-5**

**Events Reported in International Nuclear and Radiological Event Scale (INES)**

| Year | Incident | Scale | Remarks |
|---|---|---|---|
| 1993 | Fire Incident in Turbine Building at Narora Atomic Power Station | 3 | No radiological release |
| 2004 | Power Excursion in Kakrapar Atomic Power Station | 2 | |