

**Government of India**  
**Atomic Energy Regulatory Board**  
**Safety Research Programme**

**AREAS OF INTEREST TO AERB**

The studies in some areas are of special interest to AERB. Some such areas and the preferred topics under these areas are indicated in the following list.

**1. Effective use of Information Technology for Regulatory Activities**

- Survey of minimum and maximum data collection required for effective regulatory control for different applications of radiation.
- Development of a system of integrated management of data relating to different applications of radiation.
- Allotment of passwords to authorized licensees and online handling of applications for certain types of approvals (e.g., movement of radiography source from one site to another).
- Development of software for enabling authenticated online of submission of periodic safety reports.
- Development of automatic updating of data submitted on-line and a system of identifying discrepancies in the submitted data.

**2. Medical Applications of Radiation**

- Techniques of reduction of medical exposure in diagnostic radiology, particularly in Computed Tomography (CT) scanning, Interventional Radiology and Nuclear Medicine.
- Techniques of reduction of occupational exposure in Interventional Radiology and use of Positron Emission Tomography (PET) scanning.
- Methods of Quality Assurance (QA) and development of acceptance criteria for software used in treatment planning systems.
- Development of tamper-proof instrumentation for detection of removal of sources from teletherapy and brachytherapy installations with an alarm system, a real time logging unit and Uninterrupted Power Supply (UPS) so that unauthorized removal of sources can be detected and effectively prevented.

### **3. Industrial Applications of Radiation**

- QA in industrial radiography with gamma sources as well as X ray units and LINAC (Linear Accelerator).
- Study into the causes of individual occupational exposures being relatively high in industrial radiography and methods of reducing the exposure levels to ensure that workers always wear the individual monitors.
- Development of tamper-proof instrumentation for detection of removal of radioactive sources from industrial radiography installations / source storage areas with an alarm system, a real time logging unit and UPS so that unauthorized removal of sources can be detected and effectively prevented.
- Reduction in the activity of radiation sources used in nucleonic gauging systems with more sensitive instrumentation.
- Study of alternate sources of radiation to replace long-lived sources used in nucleonic gauging, particularly,  $^{241}\text{Am}$  and  $^{137}\text{Cs}$ .
- Nuclear techniques in pollution monitoring.

### **4. Radiobiology/Radiation Dosimetry/Radiation Protection**

- Investigations on low dose and dose rate effects and dosimetry.
- Population surveys on levels and effects of natural radiation environments.
- Studies on/surveys for assessment of exposure levels due to radiation and radionuclides in the environment, studies to determine transfer coefficients for radioactive iodine from pasture to cow to milk and for caesium from pasture to meat.
- Anthropometric surveys for compilation of data on Indian Standard Man and its application to internal dosimetry.
- Development of radiation monitoring/measuring equipment and radiation protection accessories.
- Development and standardization of protective apparel such as ventilated frog suits.
- Development of battery operated air samplers.

### **5. Use of Radiation Sources for Research Purposes**

- The type of research studies carried out with radiation sources from the standpoint of justification of practice.
- Development of criteria for application of radiation for research purposes from the standpoint of dose constraint.

## **6. Transport of Radioactive Material**

- Development of a software package for assessment of the response of a package to the regulatory tests.
- Survey of accident data in different modes of transport and severity categorization using regulatory tests as benchmarks.
- Development of a software package for determining the Criticality Safety Index (CSI) of a package containing fissile material.

## **7. Applied Chemistry in Nuclear Industry**

- Development of instrumentation for monitoring conventional pollutants such as H<sub>2</sub>S.
- Development of iodine filter system with provisions for cooling and life extension of existing design of charcoal filters from about 2 years to at least 6-9 years.
- Studies relating to determination of source term in severe accident situations, namely chemical speciation, release from fuel, aerosol formation and transport behaviour of fission products (in particular iodine) and associated aerosols in containment atmosphere, transport, distribution and reactions of hydrogen in containment atmosphere and development of catalytic methods for controlling the reaction rate.
- Studies relating to obtaining early warning about fires through methods based on detection on vapour released during combustion of cable sheaths, paints and other substances.
- Studies on development of more effective detection and environment-friendly extinguishers in case of fires in general and with special reference to fires involving liquid sodium.
- Development of techniques for chemical removal of radioactive contamination on exposed surfaces of reactor components/primary heat transport system.

- Development of technique for on-line high temperature pH monitoring in primary and secondary systems of Nuclear Power Plant.
- Development of methodology/instrumentation for on-line tritium monitoring.
- Development of methods of chemical decontamination of different nuclear reactor systems.
- Development of suitable leak proof and fire resistance coating (paints) for reactor containments.

## **8. Techniques for Radioactive Waste Management**

- Laboratory and field investigations on chemical behaviour of radioactive wastes in ground water, determination of the rates of movement and development of models to allow prediction of waste dispersion/movement.
- Development of ultra filtration techniques for treatment of alpha wastes containing colloidal particles.
- Development of methods for treatment and immobilisation of liquid wastes in suitable solid matrices, determination of leaching rates for wastes so fixed.
- Development of methods for control of spread of deposits of radioactive substances through quick drying polymer films.

## **9. Applied Metallurgy/Radiometallurgy**

- Studies on causes of failure of reactor components such as pressure tubes and calandria tubes in pressurised water reactors; crack in core shrink in BWR, cavities/cracks in reactor vessel in PHWR, Moderator/Bleed Cooler Heat Exchanger tubes, etc., application of methods based on fracture mechanics for failure prediction.
- Studies on the long term influence of neutron radiation on properties of structural materials with particular reference to fast reactors.
- Corrosion behaviour of steam generator materials.
- Studies on life extension measures for safety related components of nuclear power plants.
- Studies on long-term operational integrity of containment vessel.
- Studies on cracks/corrosion in liners of Reactor Vault, fuel pool inspection/storage bay.

## **10. Reactor Physics, Thermal Hydraulics/Fluid Structure Interactions in PHWRs, LWRs and FBRs under Accident Conditions**

- Development of mathematical models for space-time kinetics.
- Numerical techniques for Efficient Solutions of Neutron Transport Equations.
  - Neutron transport through low density Neutron Guides in FBR neutron detector locations.
- Monte Carlo Solutions for Radiation Streaming.
- Design Basis Event Analysis of large secondary sodium leak in FBR.
  - Development of numerical methods for diffusion of radioactive material through ground over long time period.
  - Actual measurement on thermo-mechanical and thermo-physical properties of highly irradiated mixed carbide fuel.
- Analysis of events involving failure in the primary coolant system.
  - Sub channel analysis in two-phase situations under critical break Loss of Coolant Accident.
  - Analysis of events involving steam line / feedline break in the secondary coolant system.
  - Analysis of the effectiveness of the suppression pool in a loss of coolant accident scenario in PHWR.
- Heat transfer analyses applicable to post dry out period.
- Heat transfer analysis under Station Black Out situation.
- Behaviour of PHWR core under severe accident conditions.
- Modelling of underground mine ventilation system.
- Pump behaviour under two-phase flow conditions.
- Studies on vortex formation in emergency core cooling system accumulators.
  - Evaluation of necessary and sufficient conditions for explosive thermal interactions between molten fuel materials and liquids.

- Theoretical model studies on propagation of pressure waves through fluid media and determination of effect on structures.
- Molten Fuel and Clad Relocation Models in nuclear reactors.
- Post Accident Heat Removal Studies.
- Air thermo-hydraulics in Multiple Compartments of a Building.
- Core catcher modeling studies in Light Water and Fast Reactors.
- Studies on incidents in different type of heat exchanger.
  - To establish the basis for the strike zone and distance up to which its effect is to be considered for safety in layout depending upon potential for generation of primary and secondary missiles.
  - Core-catcher modeling and analysis for VVER and FBR type reactors.
  - Methods to find residual stress in components, which have undergone physical and thermal stresses during operation of NPP.
  - Development of Algorithm and computer codes for computational fluid dynamics.

## **11. Civil and Structural Engineering**

- Safety assessment of containment structure against aircraft crash, internal pressure loading, and impact of internal missiles generated by turbine failure.
- Soil-structure interaction in seismic response analysis of nuclear island connected building.
- Assessment of seismic potential of capable faults.
- Probabilistic seismic hazard analysis.
- Establishment of constitutive laws of concrete with mineral and mixtures.
- Study of heat hydration, shrinkage and creep of concrete with mineral admixtures.
- Bacterial concrete.
- Development of liquid metal resistant concrete.

## **12. Safety Evaluation Methodology**

- Generation of failure data for mechanical, electrical, electronic, computer based system including softwares and process system components for the purpose of reliability assessment.
- Model development for applications to Probabilistic Safety Assessment (PSA), like analysis of aircraft impact on the reactor and its potential for affecting the safety related systems and structures.
- Development of models for Human Reliability Analysis (HRA) for integration with Probabilistic Assessment, characterization of operator errors of commission and omission arising from misdiagnosis and other relevant factors for the purpose of HRA, supporting data based on accidents that have occurred in large facilities. Studies on common cause failures.
- Development of Common Cause Failure (CCF) with specific model applications for some reference plants.
- Risk monitor at plant site with regulators interface.
- Fire Hazard Analysis for fuel cycle plant.

## **13. Applications of Computers and Appliances**

- Development of expert systems as operator aids in safety surveillance and operation of Reactors and Nuclear Plants.
- Development of robotic techniques for a variety of unmanned operations such as inspection of structures, material welding, radiation survey, application of protective coatings, chemical decontamination, etc.

## **14. High Energy Particle Accelerator**

- Radiation Source Term calculations (Neutron Yields).
- Attenuation characteristics of High Energy Neutron through shields ( $>20\text{MeV}$ ).

## **15. LINAC ( $<25\text{MeV}$ Accelerator)**

- Bremsstrahlung Source Term detailed calculations and Empirical Fits in LINAC.
- Beam Flattening Designs and Development of suitable Algorithms.
- High Energy Standard Photon Dose Rate Estimations for medical dosimetry

## **16. Environmental Impact Assessment (EIA)**

- Theoretical and field studies on atmospheric dispersion and ground deposition of aerosols under different weather conditions, in diverse terrain, development of models for prediction of atmospheric concentrations and extent of ground deposition.
- Hydrological investigations.
- Marine dispersion studies.