

BARC
HIGHLIGHTS

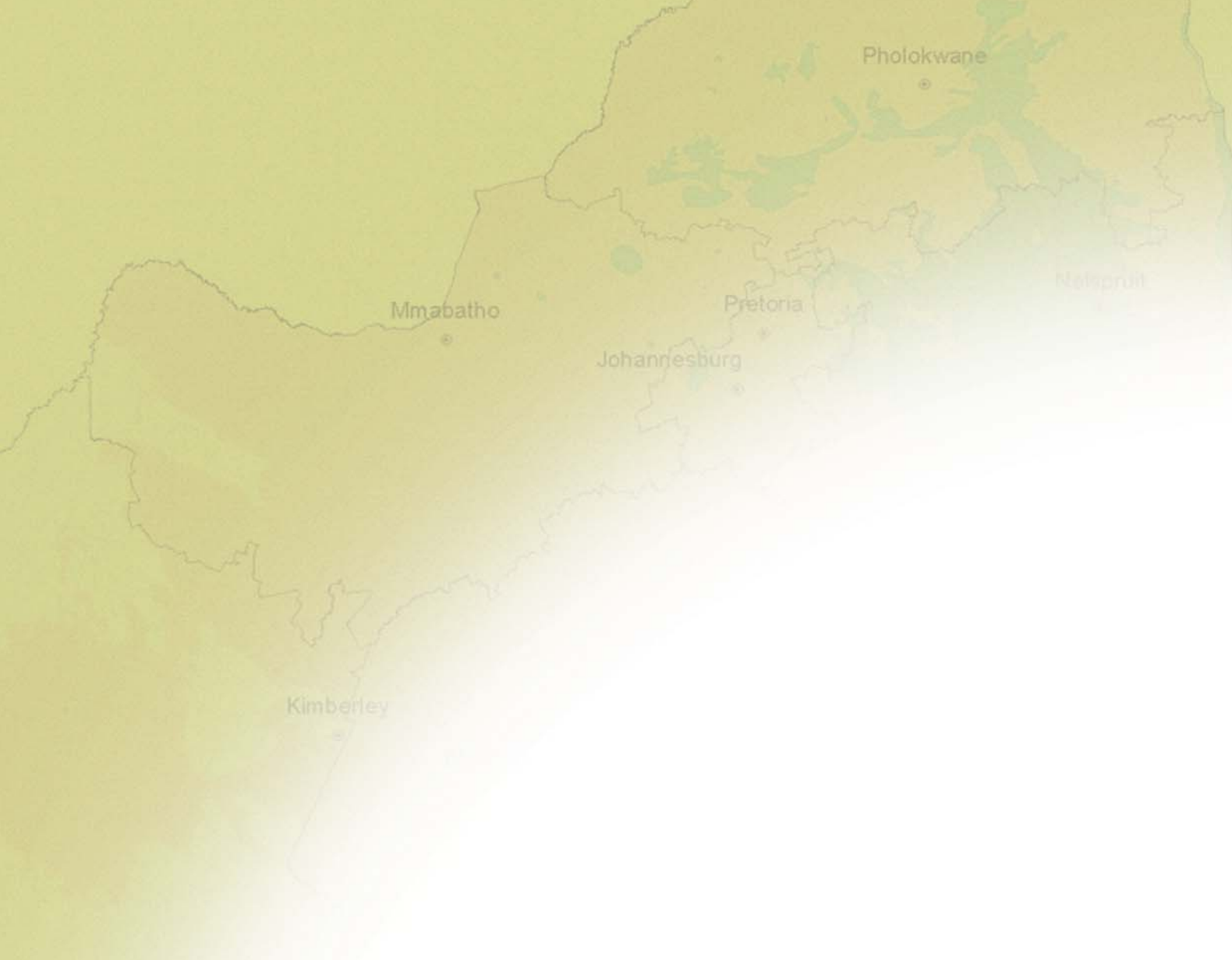
ENVIRONMENTAL
SCIENCES
AND
ENGINEERING



भारत सरकार
Government of India

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BHABHA ATOMIC RESEARCH CENTRE

स्वर्ण जयंती वर्ष
GOLDEN JUBILEE YEAR
2006-2007



For further details contact:

Dr. Y. S. Mayya

Head, Aerosol, Monitoring and Simulation Section
Environmental Assessment Division
Bhabha Atomic Research Centre, Trombay, Mumbai - 400 085, India.

E mail: mayyays@barc.gov.in

Published by :

Dr. Vijai Kumar

Associate Director, Knowledge Management Group and
Head, Scientific Information Resource Division,
Bhabha Atomic Research Centre, Trombay, Mumbai - 400 085, India.

E mail: vijai@barc.gov.in

FOREWORD

Bhabha Atomic Research Centre (BARC) is celebrating its golden jubilee year during 2006-07. On 20th January, 1956, Pandit Jawaharlal Nehru formally inaugurated the Atomic Energy Establishment Trombay (AEET), which was renamed Bhabha Atomic Research Centre (BARC) on January 22, 1967. As a premier R&D centre of the Department of Atomic Energy (DAE), BARC has a mandate to provide R&D support to the nuclear power programme, to pursue all activities related to nuclear fuel cycle, to operate research reactors for supporting neutron beam research and supplying radioisotopes for various applications, to conduct frontline basic research in physical, chemical, biological and engineering sciences all of which lead towards improving quality of life of our people. The achievements BARC has made over the last 50 years are well known not only to the scientific community in the country but also to our people at large. Scientific achievements made by this premier research centre are well documented in various publications of DAE including the series "BARC Highlights". During this golden jubilee year, we have made an effort to bring out some glimpses of recent research and development accomplishments in the form of 8 volumes, highlighting the following areas:


1. Nuclear Fuel Cycle
2. Physical Sciences
3. Chemical Science and Engineering
4. Materials Science and Engineering
5. Life Sciences
6. Reactor Technology and Engineering
7. Electronics, Instrumentation and Computers
8. Environmental Science and Engineering

These volumes will showcase the latest work in the aforementioned areas and will demonstrate how each of these is directed towards achieving the overall goal of using nuclear energy for the benefit of our people.

Nuclear energy programme in India has now reached a level of maturity. Today, India is self-sufficient in building nuclear power stations of 540 MWe capacities and has gained sufficient mastery over the entire fuel cycle. We are at the threshold of entering the second stage of nuclear power programme, in which a rapid growth in installed capacity is expected through the fast reactor programme. In the area of basic research in science and engineering, BARC has been maintaining a lead position both in national and international scenarios. One of the strongest points of basic research in BARC lies in its capability in building in-house sophisticated research facilities. The core competence of the scientists and engineers in our centre covers a very wide range as is reflected in the 8 companion volumes released on the occasion of the golden jubilee year.

This volume highlights the achievements made during the last few years in the area of Environmental Sciences and Engineering. Measurement of radiation levels and of concentration of pollutants constitutes the most important component of environmental assessment. The techniques employed depend upon the type of parameters monitored and the objective behind monitoring. BARC scientists posted in a number of environmental survey laboratories located at nuclear power stations, reprocessing units and uranium mines, maintained a constant vigil on the environment in and around the areas where atomic activities are being pursued. The laboratories in association with the central unit at Trombay begin their work for collecting the lease line environmental data even before an activity starts in a new location and keep monitoring the impact of our activities on the environment. Study of long term impact also requires study of natural radiation environment in different regions of the country through large scale surveys. BARC's programme in Health, Safety & Environment has evolved in a unified risk assessment methodology through studies on radiation and conventional pollutants in an integrated manner.

BARC has adopted computational methods based on the atmospheric and aquatic dispersion models for estimating the environmental impact. These models requiring a host of meteorological parameters as input variables can map the spread of radioactivity and pollutants on real time basis.



Radiations and radioisotopes find important applications in industrial radiography, cancer treatment and medical diagnostics. In order to minimise unwanted exposures either to patients, their family members or to personnel handling these sources, appropriate shielding designs and dosimetric plans are evolved and these services are provided to the organisations to handle such radioactive sources.

Preparedness for the scenarios of probable nuclear and radiological emergencies in the country constitutes an important activity of the environmental safety programmes of BARC. As a first step, it is required to obtain online information on the radiation levels at various parts of the country through a well connected network of online radiation monitoring systems. It is also necessary to have an integrated decision support system and mobile monitoring facility to take countermeasures in case of nuclear and radiological emergency in the public domain. Safety assessment of Nuclear Power Reactors calls for laboratory scale studies for validating the computer codes used for source term prediction to the environment in the event of accidents. Apart from these, constant efforts are made in BARC to develop systems and techniques for scientific studies related to the assessment of the environment and application of nuclear techniques in other areas such as geological dating.

The present volume will provide an outline of the varied activities of BARC in Environmental Sciences and Engineering.

Srikumar Banerjee
Director

PREFACE

In recent years, environmental issues are playing an increasing role in considering the options available for energy production, a prerequisite for steering the course of national development. In the context of nuclear power, environmental protection and safeguards are inextricably linked to the setting up, operation and decommissioning of the entire fuel cycle facilities. Broadly speaking, these pertain to the protection of occupational workers, general public and the environment at large. In the occupational domain, the radiation exposures to workers should be controlled so as to meet the rigorous standards stipulated by regulatory agencies. This is achieved both at the level of design and at the level of operations. In the same manner, discharges from nuclear facilities to the public domain need to be controlled to within specified international standards. It is mandatory to ensure compliance to these standards by conducting regular environmental surveys, which in their totality, include studies on natural background radiation. In addition, one needs to address issues pertaining to the environmental consequences of extremely low probability reactor accidents as well as possible radiological emergencies. All these call for the setting up of elaborate programmes on field monitoring, predictive modeling, laboratory studies and emergency preparedness. These in essence form the activities being pursued in BARC in the area of environmental science and engineering.

The collection of articles in this "Highlights Volume" brings out the progress made in BARC in the areas mentioned above, over the last few years. The volume essentially intends to provide a flavour of the different facets of environmental studies, rather than present individual activities being carried out in various divisions. Keeping this in mind, the articles are arranged into four broad sections, namely,

- I. Environmental assessment methodologies,
- II. Modeling pollutant dispersion in the environment,
- III. Safety in industrial and medical applications of radiation,
- IV. Development of facilities, systems and techniques.

The first section deals with the methodologies used for monitoring radiation, radioactivity and other pollutants in the environment for carrying out impact assessment. The second section contains articles on the development of mathematical models and computer codes for understanding the processes and strengthening the prediction capabilities of pollutant behaviour in the environment. The third section deals with radiological safety aspects pertaining to the use of radiation sources in hospitals and in industries. The last section deals with the development of online systems as well as various other techniques for environmental applications. On the whole, the articles are written in a style that informs the reader on the motivation behind the studies and give essentially a glimpse of the depth involved in the subject. The references listed at the end of each article are intended to guide the interested reader to additional details.

I wish to thank all the contributors for their efforts in condensing their work in the form of short articles without compromising on the essence of the subject matter. I also acknowledge the help received from Dr. B.K. Sapra, EAD, in compiling this volume. I am grateful to Mr. H.S.Kushwaha, Director, Health, Safety and Environment Group for his guidance in bringing out this volume.

Y.S. Mayya



ENVIRONMENTAL SCIENCES AND ENGINEERING

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