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भारत सरकार
GOVERNMENT OF INDIA
परमाणु ऊर्जा आयोग
ATOMIC ENERGY COMMISSION

RADIOLOGICAL PROTECTION DOSIMETRY SECTION
REPORT OF WORK DONE & LIST OF PUBLICATIONS
DURING 1981 and 1982

Compiled by

D. Krishnan and G. Venkataraman
Division of Radiological Protection

भाभा परमाणु अनुसंधान केन्द्र
BHABHA ATOMIC RESEARCH CENTRE

बंबई, भारत

BOMBAY, INDIA

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FOREWORD

The Division of Radiological Protection is entrusted with countrywide radiation protection programmes. The main responsibility of the Division is to assess and control radiation exposure from all radiation sources, including the use of radiations in diagnosis and therapy, general environmental radioactivity and fallout. The work of the Division is divided into six major sections with each section having 6 - 8 groups working on different aspects of the overall programme. These sections are :

- (a) Radiological Monitoring and Research Section
- (b) Industrial & Medical Advisory and Control Section
- (c) Radiation Metrology Section
- (d) Radiological Protection Dosimetry Section
- (e) Radiation Protection Instrumentation Section
- (f) Air Monitoring Section

A progress report of the first five sections was brought out in 1978 (B.A.R.C. - 962) and that of Air Monitoring Section as a separate report, (B.A.R.C. - 961). A list of publications of the Division for the period 1975-1980 was also brought out in the form of a Report (B.A.R.C. - 1130) in 1981. The present report is a very brief summary of the progress during 1981-82 of the Radiological Protection Dosimetry Section alongwith list of publications during this period.

U Madhvanath

(U. Madhvanath)

29.6.83

Head, Radiological Protection Dosimetry Section.

June 1983.

ABSTRACT

Radiological Protection Dosimetry Section has as its objective development of dosimetric techniques, theoretical as well as experimental. To this end in view research and development work on chemical and neutron dosimetry systems, computational dosimetry and dosimetry associated with protection problems is being done. Work is also carried out on radiobiological investigations at cellular level to understand radiation damage and interpret the basis of radiation exposure limits and attendant safety standards.

These topics are covered by five groups in the section viz.

Neutron Dosimetry

Chemical Dosimetry

Radiation Biophysics

Radium Hazards Evaluation and Control

Theoretical studies

A brief outline of the activities of each of the above groups is given along with a list of publications for the last two years.

NEUTRON DOSIMETRY (G. VENKATARAMAN, O.P. MASSAND, H.K. KUNDU,
M.P. SHAIRYAWAN)

1. The technique of fast neutron personnel monitoring with nuclear track emulsions (NTA) is continuously being improved for its accuracy and sensitivity of detection. Studies connected with the second stage of its improvement, for extending the monitoring period to 3 months (currently monthly intervals are used) were just completed and will be introduced from early 1983 onwards. This has been made possible by evolving a procedure of desiccating the NTA films in nitrogen atmosphere, sealing them in aluminised polyester pouches which has prevented the fading in emulsions to more than a period of 4 months. This would reduce cost (in ₹) of film procurement and labour involved in processing and evaluation to a third.

2. In order to improve on the energy threshold for the neutron monitoring and avoid completely the costly photographic emulsions, studies with polycarbonate and CR-39 polymer foils are in progress. With the electrochemical etching method developed so far, dose equivalent lower than 30 mrem cannot be measured. With improvements anticipated for CR-39, its sensitivity of detection is expected to increase by 30 fold with a background track level about 4 mrem. It is hoped to develop this within a year.

A limited number of active pocket type neutron monitors based on silicon surface barrier detectors and albedo principle are being fabricated, for use by the radiological protection survey teams of the Division. Detection limits are a fraction of one mrem of thermal neutrons, one mrem of intermediate energy and 30 mrems of fast neutrons.

Gamma fields of 10 R/hr cannot affect the neutron readings. These small devices would be of immense use in maintenance work involving high mixed fields and emergency situations.

CHEMICAL DOSIMETRY (B.L. GUPTA, U.R. KINI, R.M. BHAT, R.N. GOMATHY,
Rm. S. RAMASWAMY)

3. The irradiation verification indicator labels (yellow to red) developed earlier for use at ISOMED for the radiation sterilization of medical products, are being produced in large scale to meet the demand of customers. Technique of coating, adhesive paper, method of cutting etc. are being standardized. Nearly two lakh labels have been supplied to a dozen companies during 1982.

4. In the mega-rad range, a chemical read-out technique using alanine and glutamine as dosimeters, is being developed under an IAEA research contract. Irradiated alanine or glutamine powder is dissolved in a special solution developed by the Division and the resultant absorbance is measured spectrophotometrically. This technique avoids the requirement of costly ESR detection equipment with which currently assay is made for free radicals. With successful intercomparison results at plants of ISOMED, Institute of Isotopes, Budapest and Risø National Laboratory, Denmark, it is hoped that this system may be recommended for use for calibration of high-dose irradiation facilities.

5. The FBX Chemical dosimeter developed by the Division for low dose measurements has been perfected for its use as a secondary standard

dosimeter. Its utility for output measurements of teletherapy Co-60 beams and electron/photon beams from accelerators has been demonstrated. It was also found superior when compared to ionization chamber method for dose measurements at large depth in phantoms where proportion of degraded low energy components predominate. Extensive studies for obtaining depth dose data for clinical use for cobalt-60 and accelerator beams will be taken up to improve upon the existing tables published in 1971.

THEORETICAL STUDIES (P.S. NAGARAJAN, M.A. PRASAD, D.P. BHATIA,
S. SACHIDANANDAN, DAYASHANKAR, D. ARORA,
C.P. RAGHAVENDRAN AND APUNKUMAR)

6. Theoretical studies are aimed to obtain microdosimetric parameters and problems associated with radiation transport. Studies include determination of atom-atom collision cross sections, W values, Fano factors, probability distributions of ionization yields etc. Radiation transport studies are mainly concerned with comparing the efficiency of different computational techniques and methods of reducing statistical errors in the various Monte Carlo methods.

7. Theoretical studies with fast neutrons included development of computer codes for the response of cavity chambers to neutrons and gamma rays (different sizes & shapes of cavities), evaluation of effective dose equivalent following exposure to fast neutrons of different energies, evaluation of energy distribution in charged particle secondaries for purpose of dose average and track average LET values.

A computer code was also developed to calculate energy deposition in human respiratory tissue from alphas (from radon and its daughter products) which can be used for other alpha sources as well.

RADIATION BIOPHYSICS (M.S.S. MUPTHY, P. SUBRAHMANYAM, D. KRISHNAN,
B.S. RAO, G. UNNIKRISHNAN, K. GOPAKUMAR,
D.R. SINGH & N. SANKARANARAYANAN)

8. Under an IAEA contract, geno-toxic effects of chemicals (drugs, pollutants associated with energy production) and their radiation equivalence were obtained by using diploid yeast as a test system. Some of the chemicals studied are cyclophosphamide (a drug), sodium nitrate (a food preservative), ethylmethane sulfonate (a standard mutagen), benzo (a) pyrene and sulphur dioxide (pollutants released during fossil fuel burning). The results provide a proper perspective of the hazards of ionizing radiation vis-avis other human activities including energy production.

9. Many chemicals in the general environment and in the work place are known to act as inducers and promoters of cancer. Studies have been initiated at the cellular level in diploid yeast to investigate the combined effects (synergistic or otherwise) of some of these chemicals and ionising radiations. These studies have an important bearing in the analysis of carcinogenic hazard at low-dose levels. Interaction studies were also carried out with inhibitors of cancer. Investigations are also being carried out to study in detail alkylation

of DNA and its association with the lethal and mutagenic action of alkylating agents.

10. Results of several radiobiological investigations relevant to improvement in cancer radiotherapy, such as hyperthermia combined with radiation, hypoxic cell sensitizers, conducted earlier can be applied in cancer treatment. Attempts are being made to start new clinical trials in major radiotherapy centres in the country.

11. Several studies are in progress to understand, at molecular level, mainly with DNA and nucleotides, the mechanism of radiation sensitization and protection by dose modifying chemicals. Specific studies covered the determination of G values under O_2 and N_2 irradiation conditions using base damage and phosphate release as the end points of assay, their modification by radical scavengers, effect of flagyl, misonidazole and NEM on the radiolysis of DNA and bases.

12. In collaboration with Biochemistry and Food Technology Division, studies were also carried out with rats on the radiation sensitization aspects of misonidazole using DNA strand break and tumour growth delay as end points.

RADIUM HAZARDS EVALUATION & CONTROL (K.S. PARTHASARATHY AND K.

UNNIKRISHNAN)

13. About 65 hospitals in the country use radium needles and tubes for cancer brachytherapy. In order to help them detect any leakage of radium or radon, triafol and cellulose nitrate foils were standardised.

These are mailed periodically to these institutions. A radon-in-breath analyser for estimating radium body burden is kept in go-condition in the Division. A compact portable instrument kit based on electrostatic collection of radon and its daughter products for use in routine surveys is being fabricated. Leakage determination by activated charcoal method is also being standardised.

SERVICES

14. Members of the Section participated in several radiological protection surveys in medical and industrial institutions. They have also participated in the teaching programmes of several short term courses conducted in the Division and at locations outside Trombay. A substantial portion of the teaching load in the one-year diploma course is also borne by the officers of this Section. Experience gathered by all members are shared and discussed at regular technical sessions arranged by the Section.

PUBLICATIONS FROM THE R.P. DOSIMETRY SECTION,
FOR THE TWO YEAR PERIOD (1981 AND 1982)

NEUTRON DOSIMETRY

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