INVESTIGATIONS ON THE MOVEMENT AND DISTRIBUTION OF RADIOACTIVITY IN THE COASTAL ENVIRONMENT OF KALPAKKAM

ABSTRACT

The presence of radioactivity in the environment is due to both natural and man-made sources. Our earth's crust contain several naturally occurring radionuclides such as U-238, Th-232, K-40, C-14, etc.. The concentration of these radionuclides vary from place to place. The radionuclides such as Cs-137, Sr-90, H-3, etc. are added to the environment due to nuclear detonations. The levels of these man-made radionuclides are decreasing due to their short half-life and the ban on atmospheric nuclear detonations. The concentration of these radionuclides in the environment can be measured by means of various chemical as well as instrumental methods. It has been reported that persons who are resident in the vicinity of nuclear establishments or nuclear power plants or installations that provide fuel for the power plants are exposed to reportedly minute quantities of radionuclides discharged into the environment (Hemming and Clarke, 1984). It is, therefore of interest to monitor the levels of these radionuclides in various food items, air, water, etc. in the environs of nuclear reactors in order to find out the radiation dose contributed to man through these sources. In the present work the radioactivity measurements were carried out by collecting samples in the environment around Madras Atomic Power Station, Kalpakkam. In this study more attention was given to the measurement of H-3 as it has been suggested by ICRP that a part of H-3, which is bound to the organic matter, stays for a longer duration in the body compared to that of free H-3. Therefore, it was of interest to study the level of free and organically bound H-3 in the vegetation around the nuclear power plant which contributes H-3 to the environment as this reactor uses heavy water as moderator and primary
coolant. In addition to H-3, other radionuclides such as I-131, Cs-137, Sr-90, etc. of reactor origin have been measured during various time periods. The results obtained from these studies are given in this thesis which is divided into six chapters.

The introductory chapter brings out the various sources of radiation exposure. It also discusses the distribution of various natural and man-made radionuclides in the environment. The amount of radiation dose received by the public from natural sources at global level and also by the people living in high natural background radiation areas have been brought out in this chapter. This chapter describes the area covered under this study. It brings out the concept of apportionment of dose permitted to members of public from different installations at the site through various routes of exposure.

The second chapter discusses the methods involved in the collection of air, water and various biological samples. The different methods to process these samples and the measurement of radioactivity are described.

The third chapter brings out the details of monitoring and observed concentration levels of H-3 in the Kalpakkam environment and the estimation of doses to members of the public due to exposures from H-3 and Ar-41. Among the radioactivity discharged from MAPS, Ar-41 and H-3 are two important radionuclides from the consideration of dose to members of the public. During the normal operation of the reactors, H-3 and Ar-41 are released to the environment in a controlled manner through atmospheric and aquatic routes. Present study tries to assess the impact of such release on the environment and to evaluate the concentration of H-3 in coastal seawater, backwater, freshwater and in the atmospheric environment. The total dose due to internal and external exposures at fence post
(1.6 Km from plant site) ranged from 21.8 to 50.9 μSv/y compared to the permitted limit of 270 μSv/y apportioned to MAPS operations.

The fourth chapter brings out the amount of H-3 present in vegetation as tissue free water tritium (TFWT) and organically bound tritium (OBT). A study has been carried out on the amount of tritiated water present in air, vegetation and soil in the vicinity of nuclear facility that have routinely released small amounts of H-3 into the environment. Measurements of TFWT and OBT carried out in vegetation growing in soil at site were compared to those obtained in potted plants. The ratio of TFWT in vegetation of potted plants to that present in atmospheric moisture was about 0.7. The specific activity ratio (OBT/TFWT) in the samples obtained from the tree grown in soil was between 0.4 and 1.1 with an average of 0.74 compared to that of potted plants ranging between 0.1 and 0.5 with an average of 0.26. Although a small variation in the SAR was observed, both potted plants and the trees grown in soil showed reasonably good correlation between TFWT and OBT (r values were 0.78 and 0.62). This study indicated that tree leaves can provide both atmospheric and ground water contamination due to H-3.

The fifth chapter discusses the concentration of major fission products and activation products in the effluent being discharged into the sea. The major contribution to the total radioactivity was from Cs-137 and Cs-134. The concentration of Cs-137 and Sr-90 in samples of seawater, seafood (fish, crab, prawn, etc), salt, seaweed and sediment were studied. The mean doses received by the members of the public due to Cs-137 and Sr-90, as a result of the consumption of seafood have been evaluated which ranged from 0.21 to 0.28 μSv/y.
The concluding chapter has brought out the salient points of the thesis:

(i) the mean dose received by the members of the public at exclusion boundary was very much below the apportioned dose to the member of the public,

(ii) the study of TFWT and QBT has shown that trees are very good indicators of both atmospheric and ground water contamination of H-3 in the environment,

(iii) the SAR of "bound" to "loose" H-3 in vegetation growing in enhanced H-3 atmosphere is at unity or less suggesting that there is no discrimination or enrichment of H-3 in the organic fraction and

(iv) the controlled discharges of radioactivity into atmospheric and aquatic environments has not significantly altered the levels of radioactivity in any of the environmental matrices, indicating the negligible impact of MAPS operations on the coastal environment.