OCCUPATIONAL EXPOSURE TO IONISING RADIATION IN THE REGION OF ANATOLIA, TURKEY FOR THE PERIOD 1995 – 1999

H. Gündüz, C. T. Zeyrek, L. Aksu and S. Işak

Turkish Atomic Energy Agency, Ankara Nuclear Research and Training Center,

Department of Dosimetry

06100, Beşevler, Ankara, Turkey.

Contact author E-mail: zeyrek@taek.gov.tr

OCCUPATIONAL EXPOSURE TO IONISING RADIATION IN THE REGION OF ANATOLIA, TURKEY FOR THE PERIOD 1995 – 1999

H. Gündüz, C. T. Zeyrek, L. Aksu and S. Işak
Turkish Atomic Energy Agency, Ankara Nuclear Research and Training Center,
Department of Dosimetry
06100, Beşevler, Ankara, Turkey.

Abstract

For this study, the individual annual dose information on classified workers who occupational exposure due to extended radiation sources in Anatolia region of Turkey was assessed and analysed by the Ankara Nuclear Research and Training Centre dosimetry service (ANAEM) at the Turkish Atomic Energy Authority (TAEA) for the years 1995-1999. The monitored radiation workers are divided into three main work sectors: conventional industry (8.24%), medicine (90.20%) and research-education (1.56%). The average annual dose for all workers in each particular sector was 0.14 mSv , 0.38 mSv and 0.08 mSv, respectively, in 1995 to 1999. This paper contains the detailed analysis of occupational exposure. The statistical analysis provided includes the mean annual dose, the collective dose, distributions of the dose over the different sectors and the number of workers that have exceed any the established dose levels.

INTRODUCTION

Radiation accidents over the last several years have increased a general awareness of the risks of exposure to ionizing radiation. The International Commission on Radiological Protection (ICRP) and International Atomic Energy Agency (IAEA) are committed to the promotion of the principle of optimizations, effeciall through applications of the Basic Safety Standards (BSS-115) for radiation protection[1,2]. In ICRP publication 60, the quantities recommended to dose limitation are the effective dose for whole-body

exposure, the equivalent dose for exposure of certain tissues or organs and the committed effective dose for intake of radionuclides.

All radiation workers in Turkey are regulated and supervised by the Turkish Atomic Energy Authority (TAEA). The TAEA is responsible for monitoring workers in all radiation facilities [3]. The TAEA has charged the two national dosimetry services to preside the necessary monitoring. One is the Ankara Nuclear Research and Training Centre (ANAEM) dosimetry service, the other is the Çekmece Nuclear Research and Training Centre (ÇNAEM) dosimetry service. The ANAEM dosimetry service has been in operation since 1963. The ANAEM dosimetry service is responsible for monitor personal working in the large Anatolia region of Turkey. The ÇNAEM dosimetry service is responsible to monitor radiation workers who are working in Istanbul and a part of west region in Turkey.

Occupational exposure due to external radiation sources in Turkey arises from three different fields of activity, namely: conventional industry (industrial radiography, industrial irradiation and others), medicine (diagnostic radiology, radiotheraphy, nuclear medicine, dental radiology and others) and research-education. There are no nuclear power plants in the country. However, there are two research reactors in Istanbul and the persons monitored have been included in the ÇNAEM dosimetry service.

At present, individual monitoring for external radiation is performed at the ANAEM dosimetry service using a film dosimetry. Approximately 10000 radiation workers in 1575 institutions throughout Turkey are monitored. Over 70000 whole-body dosimeters are processed per year. Also, there are new automatic and manual thermoluminescence dosimetry (TLD) systems for whole-body and extremity monitoring available since 2000. There will be a gradual transfer from film dosimetry to TLD in the near future.

This study presents initial statistics on personal dose equivalent to ionising radiation of Turkish radiation workers in different occupations, evaluates the occupational doses for

external radiation in workers 1995-1999, and provides a source of data for epidemiological investigation and studies of dose trends [4].

METHODOLOGY

Radiation workers have been monitored by the ANAEM dosimetry service since 1963. Dosimeters are issued monthly in the Ankara region and bi-monthly outside Ankara. The database of the dose records has been continuously renewed and updated during recent years. The registry contains dose information on 20621 workers for the years 1995 to 1999.

The personal dosimeter is based on the AGFA-Geavart personal monitoring films and used by a holder of the Physikalisch-Technische Werkstätten (PTW) type (see Fig. 1). Each badge contains two films in a single film pocket, one having a high sensitivity, the other low sensitivity. The film badge has five filters: open window and windows with 0.05 mm Cu, 0.3 mm Cu, 1.2 mm Cu and 0.8 mm Pb filters. The dosimeters construction offer the possibility of a detailed analysis using the multiple filters. Energy calibrations of film dosimeters are performed at the Secondary Standard Dosimetry Laboratory (SSDL) at ÇNAEM. Routine calibration of dosimeters is performed at ANAEM dosimetry laboratory.

The film dosimeters are processed manually the optical densities are measured manually and transferred automatically to the computer program for dose calculation. Up to 1987, dose records were kept on hard copy. Since then, the dose records are kept on floppy and compact disks. This system relied heavily on manual labour for both film processing and data transfer. The new dose records keeping system is designed to make use of modern hardware and software technologies to provide a very reliable and efficient system. The ÇNAEM dosimetry service (SSDL) participated to intercomparison of International Atomic Energy Agency (IAEA) for individual monitoring of radiological measurement for monitoring proposes in 1999.[5] The methods of dose evaluation in the ANAEM dosimetry

service is same with methods of the ÇNAEM dosimetry service. Occupational exposure data from 1995 to 1999 for radiation workers presented quantity of the personal dose equivalent $H_p(d)$ strongly and weakly penetrating radiation[6,7] in the present work.

The ANAEM dosimetry service has established a thermoluminescence dosimetry laboratory in 2000. There are two new thermoluminescence dosimetry readers, Panasonic automatic UD-716AGL and Panasonic manual UD-513A readers. The thermoluminescence personal dosimeters are based on the Panasonic UD-802 and UD-809 dosemeter card and holder which contains $^{7}Li_2{}^{11}B_4O_7$:Cu, $^{6}Li_2{}^{10}B_4O_7$:Cu, $^{n}Li_2$ $^{n}B_4O_7$:Cu and $CaSO_4$:Tm thermoluminescence phosphor elements. The TL dosimeter allows the measurement of the operational quantities $H_p(d)$ the personal dose equivalent, respectively.

RESULTS AND DISCUSSION

In this study, mean of the radiation workers is all monitored persons in Turkey. Exposed workers are radiation workers who may be exposed to doses exceeding 0.1 mSv. Minimum detectable dose level, MDL is 0.1 mSv for our dosimetry service. The results accepted non-exposed workers who have effective dose less than 0.1 mSv (MDL). Therefore, account is taken of doses occurring below MDL and recorded as zero.

The occupational monitoring areas of ANAEM and ÇNAEM dosimetry services in Turkey represented Figure 2. A total of 20621 radiation workers were monitored between the years of 1995 and 1999. The monitored radiation workers are divided into three main work sectors: conventional industry sector (8.25%) (industrial radiography 4.48%, industrial irradiation 0.66% and others 3.11%), medical sector (90.84%) (diagnostic radiology 73.75%, radiotheraphy 4.71%, nuclear medicine 9.86%, dental radiology 2.04% and others 0.48%) and research-education sector (0.90%) as shown Figure 3.

In Table 1, the numbers of monitored, percentage of exposed workers with numbers of exposed range effective dose (E) MDL<to<1 mSv, 1≤to<20 mSv, 20≤to≤30 mSv and E>30 mSv for during this period. Doses higher than 30 mSv were received by three operators of medical and two operators of industry in this period. The percentage of the exposed radiation workers is 6578 (31.9 %.) The majority of occupational group and occupationally exposed workers 6471 (about 35 %) have activities in medical uses of radiation. As the Table 1 shows, 2037 workers received exposures between 1 ≤ to < 20 mSv and 11 workers received effective doses equal to above 20 mSv in medical uses of radiation. In the conventional industry and research-education establishment, the number and percentage of exposed workers is 96 persons (5.6 %) and 11 persons (5.9 %). In those sectors, 40 persons are exposed between 1 ≤ to < 20 mSv and 6 persons are exposed E ≥ 20 mSv. Only 17 persons exceeded an effective dose of 20 mSv per year average over five consecutive years (1995-1999).

The collective effective dose was determined according to the expressions (equ.1) mentioned on UNSCEAR 2000 Report[4] , ICRP Publication 60[1] and on the Safety Series No. 115 [2] in each working field and presented in Tables 2, 3 and 4 for the years 1995 to 1999. The collective effective dose, S is given by

$$S = \sum_{i=1}^{N} E_i \qquad (1)$$

where E_i is the annual effective dose received by the i^{th} worker and N is the total number of workers. The average annual effective dose, $\overline{E}$ is equal to S/N.

Diagnostic radiology applications involve the largest number of persons monitored in the medical field. The annual total average effective dose in medicine is shown to range from 0.04 to 0.80 mSv. The largest annual average effective dose was found in nuclear medicine (0.80 mSv) in the year 1997 **as** shown Table 2.

Radiography involves the largest number of persons both monitored and exposed in the industrial sector. All persons of irradiation application are exposed under MDL in the field of industrial uses of radiation. Therefore, account is taken of doses occurring below MDL and recorded as zero shown Table 3.

The research-education has the smallest number of radiation workers as composed to the other sectors as shown Table 4. The average effective dose showed the largest value in 1995.

The results of the collective and average effective doses are schematically presented in Figure 4. In 1995, the average effective dose is the largest value in the medical sector. However, the collective effective dose is the highest value in 1998. The average effective dose of industrial sector is the largest value in 1997. In 1997 and 1999, the collective effective dose is the same largest value in industrial sector. The collective and average effective doses are the largest value in 1995 for research-education sector while the lowest value in 1996-1997.

Table 5 shows the collective dose (manSv) from workers in effective dose intervals in 1995-1999. Table 6 shows the number of workers in effective dose intervals in 1995-1999. It can be seen that most annual doses were distributed less than MDL 14043 persons and MDL-0.99 mSv of 4483 persons. The total collective dose is 3.062 manSv in this dose interval. But, total collective dose of 1726 persons is 5.062 manSv between 1.0 and 4.99 mSv.

In conclusion, the statistical analysis was carried out in order to understand better the occupational radiation doses in Anatolia region of Turkey. In the future, there is a plan to carry out an epidemiological study in order to evaluate radiation effects on radiation workers based on radiation dose data.

ACKNOWLEDGMENTS

In this study, all of the occupational dose database (1995-1999) presented by permission of directorate of Ankara Nuclear Research and Training Center (ANAEM), Turkish Atomic Energy Agency. Also, the authors wish to thank all personals of the ANAEM personnel dosimetry department for their contributions towards the development of the occupational dose database.

REFERENCES

1. International Commission on Radiological Protection. *1990 Recommendations of the International Commission on Radiological Protectio*n. ICRP Publication 60. Ann. ICRP **21**(1–3) (Oxford: Pergamon Press) (1991).
2. International Basic Safety Standarts for Protection Against Ionizing Radiation and for the Safety of Radiation Sources - Safety Series: **115**, International Atomic Energy Agency, IAEA (1996).
3. Law of Turkish Atomic Energy Agency (TAEA), law No. 2690, Turkish Government Official Gazette No 17753, 13 July 1982.
4. United Nations Scientific Committee on the Effects of Atomic Radiation UNSCEAR 2000 Report to the General Assembly. *Sources and effects of ionizing radiation.* UNSCEAR 2000 Report Vol **1**.
5. Results of the 1999 Intercomparasion for Individual Monitoring of Radiological Measurement for Monitoring Proposes, R. Cruz-Suarez, K. Mrabit, H. Stadtmann, International Atomic Energy Agency, IAEA (1999).
6. Measurement of Dose Equivalents from External Photon and Electron Radiations, ICRU report **47**, International Commission on Radiation Units and Measurements, ICRU(1992).
7. Quantities and Units in Radiation Protection Dosimetry, ICRU report **51**, International Commission on Radiation Units and Measurements, ICRU(1993).