OCCUPATIONAL HEALTH EXPERIENCE IN THE PRODUCTION AND DISTRIBUTION OF RADIONUCLIDES USED IN MEDICINE

GABURO, Janete C.(SBPR); SANCHES, Matias P.(SBPR) & SORDI, Gian M. A. A.(HPS)
Instituto de Pesquisas Energéticas e Nucleares - CNEN/SP, C.P. 11049, CEP 05422-970 - São Paulo-SP,Brazil

ABSTRACT

A brief description of the main operations performed in the Radioisotope Production Facility at IPEN-CNEN/SP is presented. This facility is provided with hot cells which must be periodically replaced due to deterioration by reagent processing and hard treatment to which they are submitted. When the lifetime of these hot cells are at their limit, leaking of airbone materials arises bringing forth incorporation by workers. As a safe control, a series of procedures have been implemented in a program of internal monitoring by urine sampling and external monitoring by film badge. From this program it became possible to evaluate the radiation dose received by workers. The results obtained within the last 10 years where analyzed against the lifetime of the hot cells and studies were made to verify possible explicit or implicit relations between doses and the natural stress of these hot cells. In the distribution of the effective dose equivalent among 304 workers submitted for individual monitoring of internal exposure by urine samples, some significant exposures higher than 1.5 mSv, in 126 cases were presented. From these cases, 64 had an effective dose higher than 4.5 mSv. The sum of effective doses and doses from external exposures can lead to levels close to regulatory limits. The internal effective dose equivalent is small when compared with whole body external dose equivalent, however it is not negligible.

1. INTRODUCTION

The workers exposed to ionizing radiation at the controlled area in the Radioisotope Production Facility at Instituto de Pesquisas Energéticas e Nucleares - GP-IPEN-CNEN/SP are submitted to personnel monitoring. Individual radiation exposures consist of external exposure from radiation sources outside the body and of internal exposure due to the intake of radioactive material. The radioisotope production is based upon targets irradiated either in a research reactor or in a cyclotron unit available in the IPEN-CNEN/SP facilities. The main targets irradiated in the reactor are tellurium, sodium, samallium and rhenium. The targets irradiated in the cyclotron are tellurium and zinc.

In the IPEN-CNEN/SP, the maximum activity level is limited on the basis of available processing containments. This facility not only produce radioactive materials and labelled compounds but also use them for research purposes. The main part of the radioisotope production is used in medicine. Therefore, a great part of the job is done in workplaces that may easily become contaminated as during the maintenance and other procedures. Due to the possibility of internal contamination the workers are monitored by urine sampling that are sent to the radiotoxicological laboratory at periodic intervals. Presently there are approximately 62 employees for operating, mantaining and managing the facilities. During the whole operation, workers radiation doses have been monitored and assessed to ensure that they remain well controlled.

2. METHODS AND PROCEDURES

Presently the project involves sixty two (62) workers of the GP-IPEN-CNEN/SP that cross two processing plant sites. Urine samples was collected during the work period i.e. 8 hours per day, using rigorous collection protocols to minimise the possibility of contamination. The measurement method for internal monitoring of the Iodine-131 by urine sampling is based on the use of silver chloride with the aim of separating iodine by precipitation from the sample. The detection is carried out in a NaI(Tl) scintillator counter.

The urine samples analysis frequency for the iodine-131 is twice a month or 25 analysis per person per year.It was assumed that the worker exposure to radiation is continuous during the work period and that the worker always has collected 25 urine samples per year although there may be some missing. In this case the values in the Table I are always the medium value over 25 analyses per person per year.

The external monitoring is perfomed by film badge. The measurement frequency is once a month or 12 per year.

3. RESULTS AND DISCUSSION

3.1 Urine Sampling

The Table I shows the results of Iodine-131 internal contamination monitoring by urinalysis measurements. From 1984 to 1993, 304 persons were monitored, giving a medium value of 30.4 persons per year. The reference levels, recording, investigation and intervention are annual and they are based on the ALI value for ^{131}I and taking into account 25 urinalysis per year. These reference levels were calculated considering the limit for deterministic effects on the thyroid.

Table I - Result of Urinalysis - Distribution of Internal Contamination

^{131}I in urine (Bq/L) per year	year									
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Recording Level <150	18	21	13	22	17	23	8	19	12	25
151 - 450	6	4	6	10	9	8	2	7	5	5
451 - 1500	3	1	4	2	9	2	7	7	2	3
> 1500	1	1	3	0	1	0	15	2	1	0
Persons Monitored	28	27	26	34	36	33	32	35	20	33
Average Intake (Bq/L) per year	250.0	397.5	468.5	152.5	355.0	165.0	1866.0	1195.0	292.5	152.5

The Table II, shows the collective committed effective dose equivalent, considering the thyroid as deposition organ.and the ratio between the number of individual monitored and the effective dose equivalent ranges.

Table II - Collective Committed Effective Dose Equivalent and Annual Effective Dose Equivalent for Internal Exposure

Year	Collective dose person x mSv	Number of Workers		
		H_e=0	1.5<H_e<4.5 mSv	4.5<H_e<50 mSv
1984	47.00	18	6	4
1985	72.71	21	4	2
1986	83.14	13	6	7
1987	35.25	22	10	2
1988	86.90	17	9	10
1989	37.02	23	8	2
1990	406.08	8	2	22
1991	284.41	19	7	9
1992	39.78	12	5	3
1993	34.22	25	5	3

From the Table II it can be seen that there were 126 cases with effective dose equivalent above the recording level, that is 1.5 mSv/y and 64 cases above the investigation level, that is 4.5 mSv/y.

The results show that 58% of the persons monitored had an effective dose equivalent lower than the recording level and therefore considered without internal exposure.

3.2 External Exposure

The Table III presents the results of external exposure monitoring for the same exposure period considered in the urinalysis samples. From 1984 to 1993, 451 persons were monitored, giving a medium value of 45.1 persons per year. The Table III shows that there are 103 cases with whole body external exposure above the recording level, that is 5 mSv/y and 32 cases above the investigation level, That is 15 mSv/y.

Table III - External Radiation Exposure - Whole Body

Annual Equivalent Dose mSv/y	year									
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Recording Level < 5	26	29	32	31	33	31	33	45	43	45
5 - 15	7	2	4	6	6	9	8	5	12	13
15.1 - 50	1	4	3	5	5	3	2	2	3	4
> 50	0	0	0	0	0	0	0	0	0	0
Number of Workers Monitored	34	35	39	42	43	43	43	52	58	62
Average Annual Dose (mSv/y)	4.24	4.15	4.49	4.79	5.37	5.15	4.05	3.80	4.83	5.00
Collective Dose (Person x mSv)	144.16	146.25	175.11	201.18	230.91	221.45	174.15	197.60	280.14	310.00

The results show that 89% of the persons monitored had a whole body external exposure lower than the recording level an therefore were considered without external exposure.

3.3 General Discussion

The table I shows that only a few persons has individual effective committed dose equivalent over 15 mSv/y and the Table III shows that the same occurs for external exposure. If it is considered the internal effective dose equivalent added to the external whole body dose equivalent for each individual worker no one exceeds the annual limit of 50 mSv for stochastic effects.

The Tables II and III show that both the internal and external annual collective effective dose equivalent are extremely low.

4. CONCLUSION

Internal exposure does not represent a problem on the individual committed effective dose equivalent in Radioisotope Production Facility for stochastics effects, however it is not negligible for the doses. The same, is not possible to state for the dose limits for deterministics effects in the thyroid organ.

The assessments presented in this paper demonstrate that the radiation protection mechanisms are adequate for the control of the employee exposure, considering the ICRP dose limit.

According to the results presented in Table I, in 1986 there was a dose peak.In That year the filters of the hot cells were replaced due deterioration, and the internal contamination level in 1987 became lower than 1986. In 1990 and 1991, appeared several problems in the hot cells. The safe containment, due deterioration by hard treatment that they are submitted presented failure and required maintenance. In 1992 the internal contamination level was higher than 1993 due to a small influence of the 1991 problems.

As final conclusion of this work, is possible to observe that with the increasing difficulty in the operations and in the activity level, it is more important to improve the intrinsic containment safety, instead of providing radiation protection control equipment.

5. REFERENCES

Limits for Intakes of Radionuclides by Workes. International Commission on Radiological Protection - Publication 30, 1979.

Recommendations of the International Commission on Radiological Protection - Publication 26, 1977.

Duarte, C. L; Gaburo, J. C; Rangel, E.P. Interpretação dos Dados de Análises de Iodo 131 na Urina segundo o ICRP - 35 - São Paulo, Instituto de Pesquisas Energéticas e Nucleares, 1988 - Publicação IPEN 213.