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TRENDS IN OCCUPATIONAL AND COLLECTIVE DOSE IN THE CZECH REPUBLIC

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Abstract

Recent new legislation in the Czech Republic (Law on Peaceful Use of Nuclear Energy and Ionising Radiation [2]) is based on the ICRP Report 60 [3] and New International Basic Safety Standards [4]. Concerning the personal monitoring of workers, licensee will be responsible not only to designate controlled areas where specific protective measures are required for control of occupational radiation exposures (ORE) and prevention of the spread of contamination during normal working conditions, but shall also maintain exposure records for each worker for whom assessment of ORE is required. This duty of licensee is given in new Regulation on Radiation Protection No.184 adopted in August 1997 [1]. In accordance with this Regulation one duty of licensee is to send results of personal monitoring to the State Office for Nuclear Safety. The Central Registry of Occupational Exposures (CROE) was regularly established for this purpose in the State Office for Nuclear Safety and rules for handling, maintenance and protection of data were defined. The data collected in CROE were used for the evaluation of trends of occupational exposures in the Czech Republic in the period 1990 – 1994 years also for the UNSCEAR survey. Basic information about the methods used for ORE evaluation, comments for different occupational groups and general conclusions are presented. It is concluded that general trend of the occupational exposures in the Czech Republic is constant with the average value of effective dose equivalent 1.02 mSv (without workers in uranium industry). It is observed the slight increase of exposures in medicine related with the reorganisation on this field and significant decrease in uranium industry related with the suppression of uranium production.

1. INTRODUCTION

The evaluation of ORE is carried out in the Czech Republic by five approved dosimetric services - National Personal Dosimetric Service, two Dosimetric Services of Nuclear Power Plants (NPP) at Dukovany and Temelin, Dosimetric Service of Uranium Industry "DIAMO" and Dosimetric Service of Nuclear Research Institute in Řež. Recently these services control about 19,000 workers. CROE is created in the Czech Republic from 1993 year and recently is already in the stage of validation of data. The registration system of CROE allows to sort workers to different occupational groups and to evaluate dose, sex and age distribution of workers. The collection of data is managed through the special registration cards and special format for electronic transmission of data is also described. Dosimetric data are recently collecting mainly in the co-operation with dosimetric services. The structure of CROE databases and the categorisation of licensees and workers currently used in CROE were for example described in the previous work of Prouza, Petrová [5].

2. METHODOLOGY

2.1. Personal monitoring

The film dosimeter is a basic type of dosimeter used for the evaluation of ORE from external irradiation. Filtration analyse is used for the estimation of quantities $H_p(0.07)$ and $H_p(10)$. The minimum detectable level is 0.05 mSv for one month control period. Values below MDL are understood as zero values. The estimate of $H_p(10)$ is considered as acceptable estimate of the effective dose equivalent for external irradiation under normal working conditions. Further recalculations are carried out for the values of $H_p(10) > 1.25$ mSv/month.

Personal neutron dosimeters (based on plastic track detectors Maylar with the couple of fission foils, enriched uranium and natural thorium [6]) are used (recording level $H_p > 1.25$ mSv for one month as well as for one year control periods) at the selected workplaces (about 600 workers) with significant neutron sources (industrial radiographers, well-loggers, etc.).

Some workplaces, especially nuclear power plants are equipped also with additional, operational dosimeters (recently mostly TLD, but also the exchange to electronic dosimeter is prepared) for evaluation of ORE in the course of special tasks, somewhere finger TLD are used.

As far as the internal contamination is concerned, the licensees for the handling with sources of ionising radiation (SIR) are responsible for management of monitoring (in determined frequency and extent) of workers or workplaces and recording of results. When individual monitoring is inappropriate, inadequate or not feasible, ORE are assessed on the basis of the monitoring of the workplaces and information on given location and duration of exposures of the worker. The registration of ORE from internal contamination is in CROE concerned to the values of ORE exceeding the determined recording level (0.1 ALI).

After a revision of methodology (implementation of the new ICRP and ICRU recommendation) of ORE evaluation in the National Personal Dosimetric Service and Dosimetric Services of NPP during 1990-91 years, the evaluation of annual ORE and their recording in dependence of different factors (occupational group, working time, sex, age, etc.) are introduced into practise of these services. From 1998 year the effective dose instead the effective dose equivalent is evaluated and reported. The licensees perform simultaneous back checking of dosimetric values presented by the dosimetric services and afterwards these values are input into CROE.

2.2. Overexposures recording

Record keeping of overexposures is based on two systems:

- if there is suspicion on overexposure at a workplace, licensee is obliged to estimate the severity of event; an investigation shall be conducted with the aim to identify the circumstances and assess and record the relevant doses and their distribution in the body. In the case that the annual limit of the effective dose (for internal contamination - 1/10 of ALI) is exceeded, the event must be reported to the State Office for Nuclear Safety, its Regional Centres (RC SONS). For serious incident (with possible medical consequences) the National Radiation Protection Institute in Prague (NRPI) is involved in the evaluation of the incident consequences;
- the second system is based on the co-operation of CROE with dosimetric services; these services report directly to CROE immediately after the evaluation of dosimeters for given control period any excess of the E_L (or determined investigation levels). Thus identified events are investigated by RC SONS directly at the workplace where the event occurred, and the appropriate analysis of reasons and consequences of exposure is made to confirm a personal dose or false positive reading of the dosimeter.

During the years 1954 - 1994 183 persons were involved in 65 unusual events detected in the Czech Republic (and former CSSR). 102 of them were exposed by external and 82 by internal radiation. Only 14 from these events have led into health consequences (dermatitis with skin defects, cataracts). In some events surgical interventions - amputation of fingers (7 cases), removal of a local deposit were used. In 9 cases double annual limit of E (100 mSv) was exceeded. During period of 1990 - 1994 years no case of exceeding of individual dose with health consequences was detected.

In the same period (1954 - 1994) 128 dosimeter readings were reported through the second system as exceeding the value of 50 mSv (E_L). Following reinvestigation appeared that in most cases the primary evaluation was falsely positive; it was concluded that only in 45 (35 %) of indicated findings, the values of E were exceeded (22 cases from medical use of SRI, 17 in industry: 11 - radiography, 3 - well-logging, 6 cases from use of SRI for research and studding purposes); in the rest of 83 (65 %) cases, the false positive readings of the dosimeters, made by using of a personal dosimeter for research or medical irradiation, or by conscious misuse of personal dosimeters, were actually confirmed. During period 1990 - 1994 only 7 verified cases of exceeding the 50 mSv value were indicated. During 1995 - 1997 years 66 cases of exposures higher than 20 mSv (in accordance with new

legislation, new limit and investigation level) were reported by dosimetric services. 6 of them higher than 50 mSv. 35 of them were confirmed as personal doses and most of them arise from the use of SIR in medicine (interventional procedures in radiology).

3. RESULTS

The evaluation of ORE was concentrated to following main groups of workers

- nuclear fuel cycle (NPP, uranium industry),
- medical use of SIR (radiology, nuclear medicine, radiotherapy)
- industrial applications of SIR (industrial radiography, well – logging, research, services, inspection, others)

3.1. Nuclear fuel cycle

- uranium industry

Recently only one mining area (two underground mines) - DIAMO-GEAM Dolní Rožinka is working . The other important facilities - the underground and leaching mines - DIAMO Příbram and DIAMO Stráž pod Ralskem are at present under decommissioning, similar as the other surface DIAMO facilities (several deposits are flooded, in milling plant Mydlovary activity was ceased, on the other areas the decontamination is under progress). DIAMO has prepared project on inventory of old burdens from activity of the Czech uranium industry. Based on that project, a systematic removal of the survey, mining, milling, etc. remnants will commence, scheduled according with their significance. Both internal and external ORE from uranium mining and milling are not non-significant contributors to OER. In the control period from 60 to 70 - years much has been done to reduce the airborne concentration of radon and its daughters. Now, in coherency with the decrease of workers number and with the innovation of dosimetric system (application of complex individual dosimeter and method of ORE evaluation), we assume that in this occupational group will not be problems for future.

For estimate of total effective dose E in uranium industry three components are calculated - part from external irradiation, and contributions from radon, its daughters and from dust containing long-lived alpha emitting radionuclides to internal irradiation

The dependence of the contribution of internal and external parts of E values on type of work in given facility (mining, decommissioning) can be observed. In 1994 year total number of workers in underground facilities the DIAMO company was 1489 workers (collective effective dose S = 16.5 man Sv, average individual effective dose E = 11.1.mSv. The evaluation of occupational exposures for the period of 1995 – 1997 years show the stabile trend without any excess in that branch.

- nuclear power

One NPP is recently working in the Czech Republic - Dukovany. NPP was put into operation on 1985, it is based on WWER (PWR) reactors type 213 (4 blocks at 440 MW power level). ORE for reactor operation - NPP are well documented , considerable quantities of data on ORE distribution are available, the annual average individual values of dose equivalent (as well as values averaged per unit energy generated) at NPP Dukovany are lower than comparable values in the other countries. Attention is done to ORE for "critical" occupational groups on NPP (maintenance, repairs, modification) which are and will be composed mostly from outside personnel. Important trend we can see on ratio in NPP employed workers and contractors which is converted from 2 in 1990 to 0,7 in 1994. Average dose effective equivalent in 1994 was 0,56 and collective effective dose equivalent 1,4manSv. The trends of occupational exposures in NPP Dukovany is showed on the Fig.1 and Fig.2.

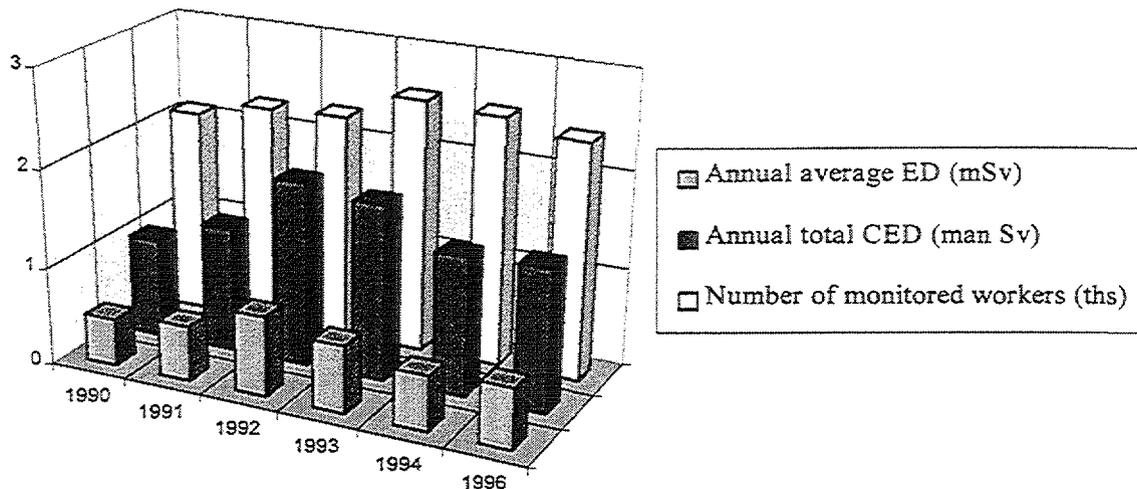


Fig. 1: Workforce and annual average and collective doses in NPP Dukovany

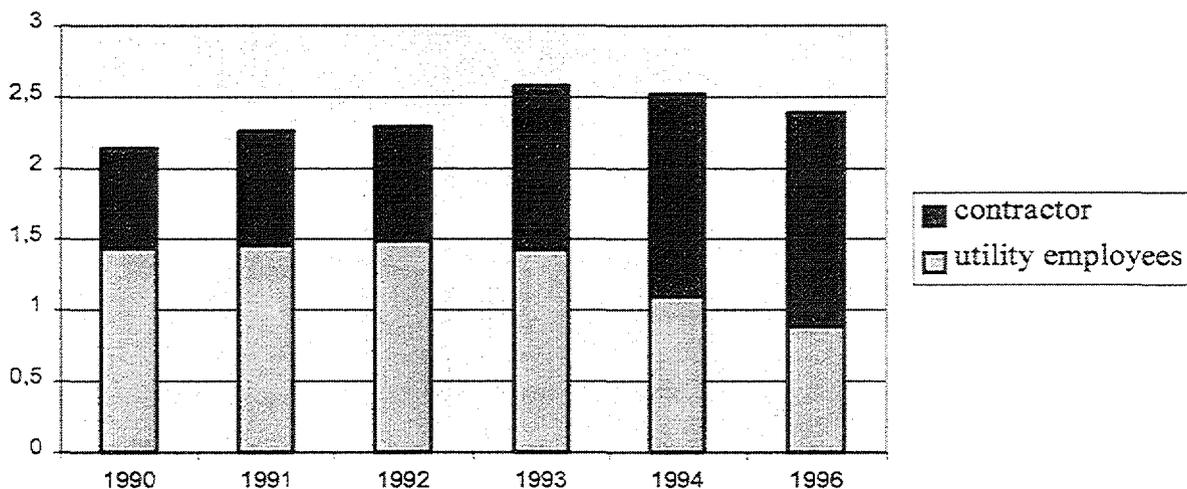


Fig. 2: Number of monitored workers in NPP Dukovany

350 workers from Nuclear Research Institute with average H_E 1mSv create specific part of „research in the nuclear fuel cycle“ (separately evaluated) group -research in the nuclear fuel cycle. The reactor LWR-15- tank type, the other SIR and laboratories in that institute are used for testing purposes, physical and radiochemical experiments.

Concerning the use of SIR in medicine and industry, the situation could be more complicated in the near future. The desegregation of state-owned companies which used SIR into small companies whose personnel and funds are rather low to assure the whole source management cycle (number of staff at one workplace for a given operation, problems related to the old sources storage and disposal, dosimetric monitoring of workplaces, procedures and local rules, records and records-keeping on ORE, etc.) might lead to a decline of the radiation protection culture and an undesirable increase in ORE. Specific attention must be given to the use of new diagnostic methods in medicine. These activities tends to non-negligible values of ORE, their use is not undoubtedly justified, the radiation protection failed to be optimised.

3.2. Medicine

Generally speaking distribution of ORE in medicine in the Czech Republic is favourable. New diagnostic (CT technique in radiology, SPECT in nuclear medicine) and therapeutic (selectors for brachytherapy) techniques were introduced into hospitals after economical changes in the country. That fact and also the origin of more private practices can be demonstrated by the increase of number of workers and of the average H_E in radiology group. In evaluated period 1990–1994 years there was observed average H_E 0,77mSv (0,59-1,12) with the collective H_E 10manSv in radiology, average H_E 0,98mSv with collective H_E 1manSv in nuclear medicine and average H_E 1,1mSv (0,91-1,28) with collective H_E 1,2manSv in radiotherapy. See Fig.3 and Fig.4

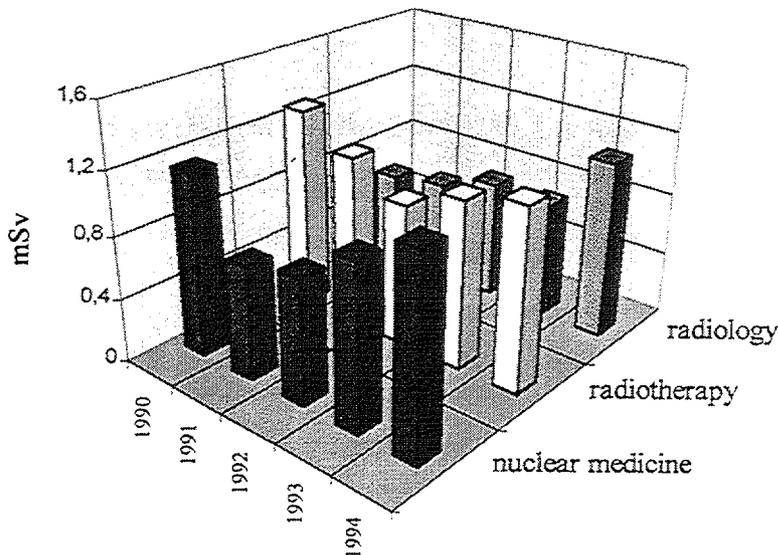


Fig. 3: Annual average effective dose in medicine

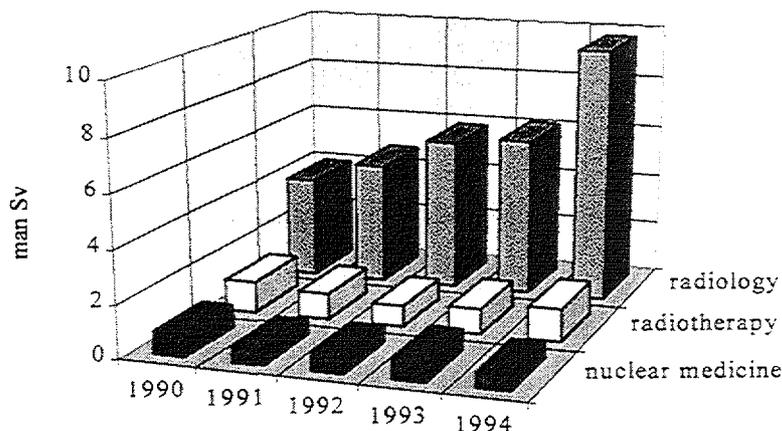


Fig. 4: Annual total collective effective dose in different medical branches

3.3. Industry

- industrial radiography

The average H_E in the evaluated period have not any significant tendency to change in comparison with previous period 1985-1990 years, the gentle increase of H_E (1,5mSv) is probably in relation with certain decrease of workers in that group (number of tests is fall down significantly). The decrease

of workers can be explained by privatisation process - new legal persons created from former great companies and involved in practice with SIR are working in the other activities now - services, testing, etc.

- well-loggers

The higher average H_E (2,25 mSv) were generally expected in that group. Similar as in radiography, number of workers in that group has tendency to decrease.

- research, education

In that group the types of SIR used are very diverse ones - from research institutes at ministries, universities, Czech Academy of Science dealing with radiology, radioecology, dosimetry to institutes, centres aiming at improvement of technological procedures. Again, the decrease of workers can be explained by privatisation process - many workers are working now in financial and business area, or in other practice with SIR - services, testing, etc. From point of view of ORE, that group is not problematical, generally is composed from qualified workers.

- other specified occupational groups

Above-mentioned process of economical changes in the Czech Republic create several specific groups from point of view of ORE evaluation:

- group of persons who are involved in service of SIR, mainly in service of X-rays diagnostic technique systems (number of workers in this group is increasing from 41 in 1991 to 555 in 1995 year),
- specific occupational group is composed from inspectors of regulatory authorities (SONS, metrology, Ministry of Environmental, etc.)

4. CONCLUSIONS

Based on the analysis and recent results of ORE evaluation, we can present that the trends in occupational exposures nevertheless the structural and economic changes occurred in the last years are stable and the unexpected changes are not observed.

We can establish, that:

- the average values, its distribution and time trends of individual effective dose are comparable with those in developed countries,
- the significant part of the annual collective dose equivalent arises from diagnostic use of SIR, but is adequate to number of investigations per habitant and practice on that area in developed countries,
- during last years the number of workers and the extent of mining in uranium industry rapidly decreased, nevertheless the contribution of ORE in that occupational group is still significant,
- average individual values of effective dose (E) in NPP Dukovany are lower or comparable with those in the other NPP's PWR - type. In period 1985-94 (operational time of NPP Dukovany) the E values have been registered [6] in the interval (0.38 - 0.87) mSv with average 0,56mSv.

The comparison of number of workers and collective effective dose equivalent (res. effective dose) for the main group of workers is showed on the Fig. 5 and 6.

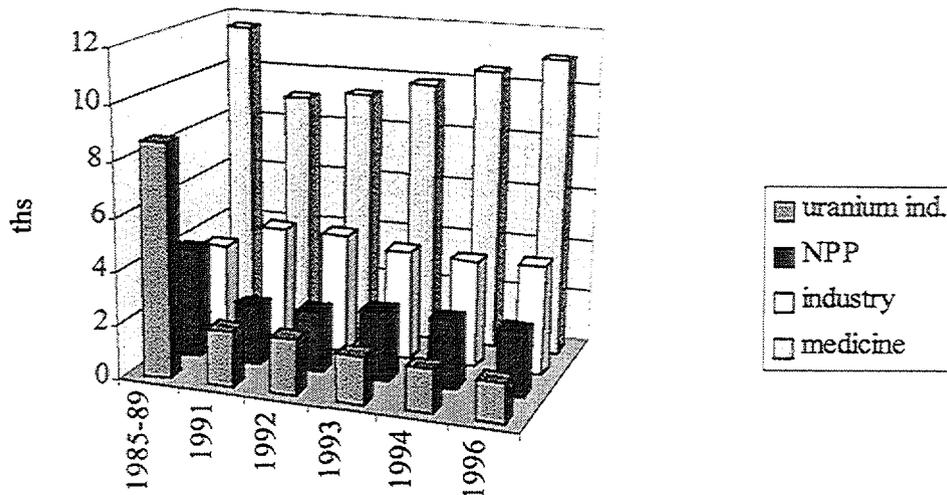


Fig. 5 Number of monitored workers in last ten years

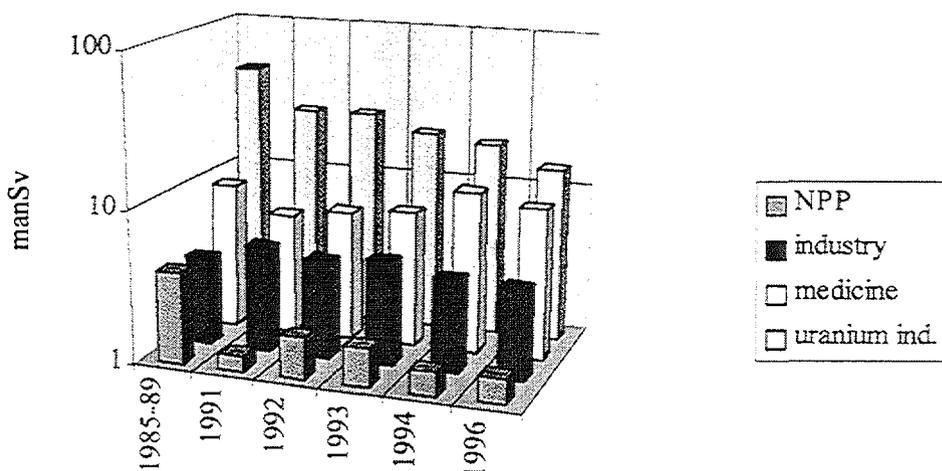


Fig. 6 Annual collective dose

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