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COMPARATIVE ANALYSIS OF RADIATION BURDEN OF STEPNOGORSK MINING AND CHEMICAL COMBINE URANIUM WORKERS

Aumalikova M.N[1,2]., Ibrayeva D.S[1,2]., BakhtinM.M[1].
abulmalik.md@gmail.com
[1]PhD student of International department of nuclear physics, new materials and technologies
L.N. Gumilyov Eurasian national university
[2]Institute of radiobiology and radiation protection nCJSC Astana medical university
Research adviser – K.Zhumadilov

Uranium is a naturally occurring element with an average concentration of 2.8 parts per million in the Earth's crust. With the modern interest in nuclear power, there has been an increase in uranium mining and processing facilities in many countries. The uranium production occurred in 16 different countries at nearly 50 various mining and processing facilities. Since 2007 uranium production has increased by 50%. Therefore of this increased demand, the numbers of workers in the uranium mining and processing industry is set to increase substantially within a few years [1]. Objects of study is comparative analyze of radiation situation on workplace of Kazakhstan and other uranium mining countries uranium workers.

Materials and methods. Annual effective dose, dose of radon decay products (RDP), dose of long lived radionuclides (LLR) for uranium workers of Stepnogorsk mining and chemical combine (SMCC) for last 35 years were analized. Also for comparison annual effective doses of according to UNSCER reports of world uranium workers and workplace situation were analyzed. Archival data were taken from the industry register of the Institute of Radiobiology and Radiation Protection from 1985 to 2015. Also, the latest data on the average effective dose for workers from the Toxic and Radiation Safety Service for 2020. UNSCEAR data on occupational radiation exposure were available from 1985 to 2002 for a number of world leaders in uranium mining and reserves, such as Australia, Canada, the United States, etc.

Results. Average annual effective dose for last 35 years for uranium workers of SMCC illustrated on Figure 1 and constituted 8.19 mSv/year. According to UNSCEAR [2] average annual effective dose of uranium worldwide workers decreased from 6.27 to 2.30 mSv/year. For SMCC uranium workers this trend not observed.

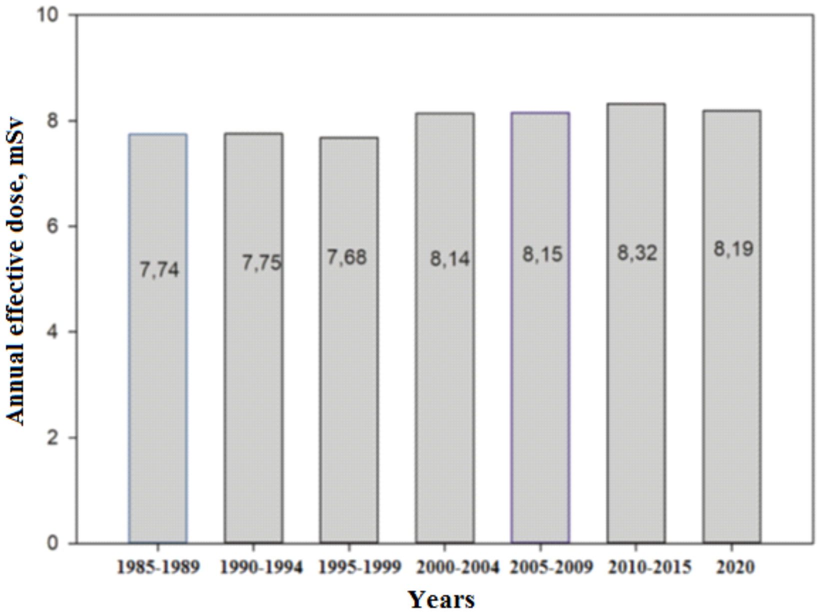

Figure 1- Average annual effective dose of SMCC workers.

First reason of this is malfunction technology on workplaces (Aumalikova et al), second is Uranium processing workers ~ 5-10% of ~ 500,000 nuclear fuel cycle workers have an average annual effective radiation dose of 10 mSv compared to <5 mSv for other workers. Recent studies show that workers working with uranium were exposed to higher external exposure to gamma radiation compared to workers working in nuclear reactors and uranium mines. [2,3]. Uranium processing workers constitute a very separate group, because their cumulative occupational gamma irradiation throughout their lives is 4-5 times higher than the external exposure of nuclear workers (100 mSv versus 20 mSv). Workers of SMCC is uranium processing workers and their major occupational exposure pathways: external radiation, inhalation of long-lived radionulides (LLR) and inhalation of radon decay products (RDP) (Figure 2).

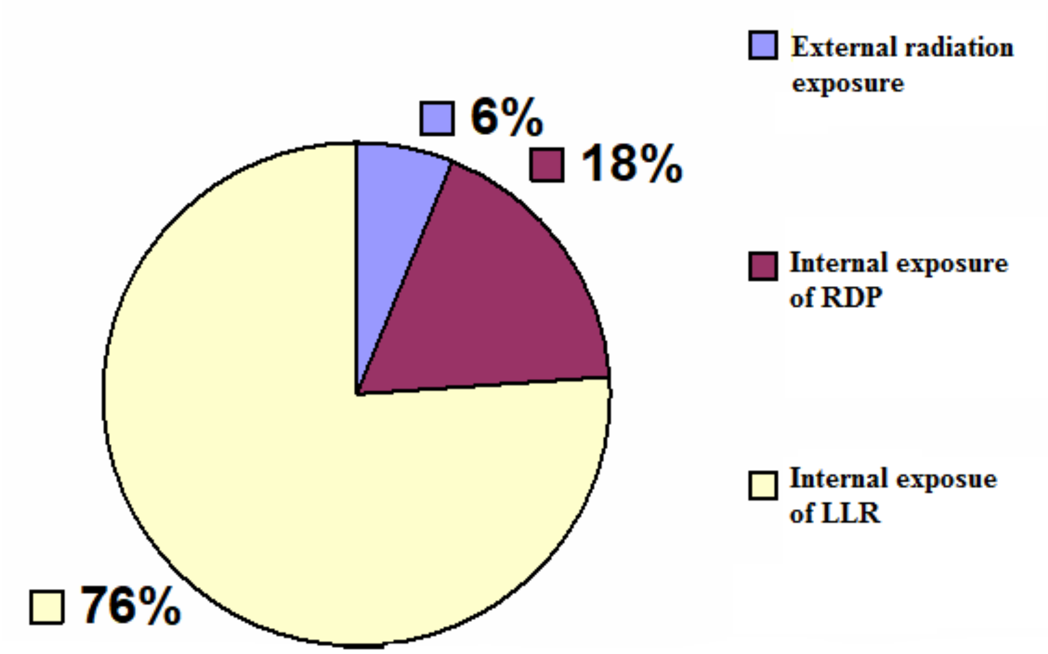

Figure 2 - Major occupational exposure pathways of SMCC uranium processing workers

Analyze dose of LLR and RDP for SMCC uranium processing workers showed that average dose of LLR is 5.61 mSv, average dose of RDP is 1.85 mSv (Figure 3a,b). These doses do not exceed the permissible level of 20 mS per year, however, they are an order of magnitude higher than the world values of uranium mining workers, which dose of RDP exposure is 0.42 mSv and dose of LLR exposure is 3.08 mSv. Thus, the exposure of workers working with uranium is significantly different from that of underground uranium miners or working nuclear reactors, and that workers working with uranium must be carefully assessed in separate studies.

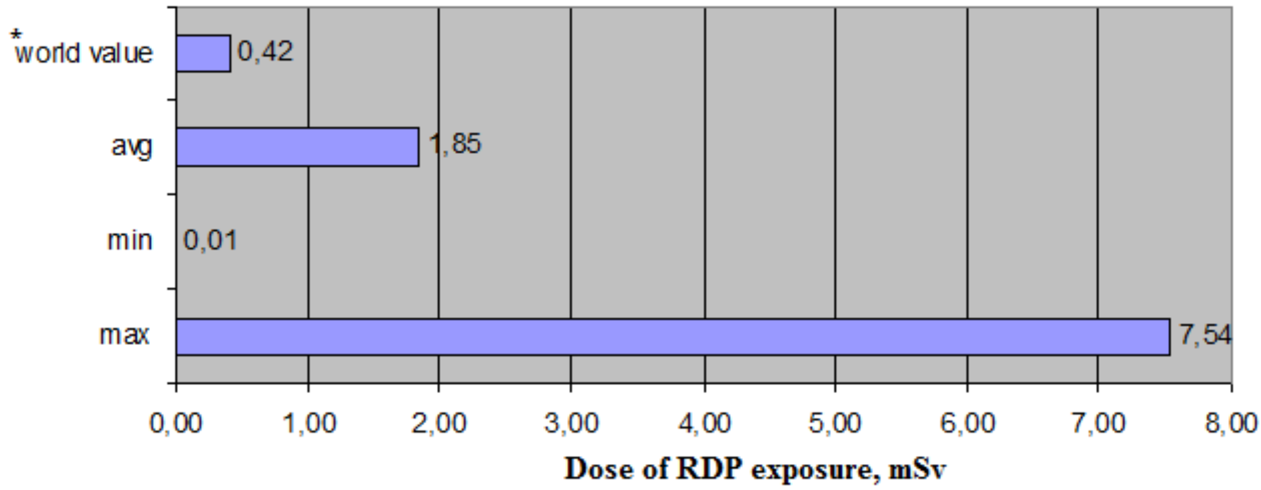

Figure 3a - Dose of RDP exposure of SMCC uranium processing workers with world value comparison

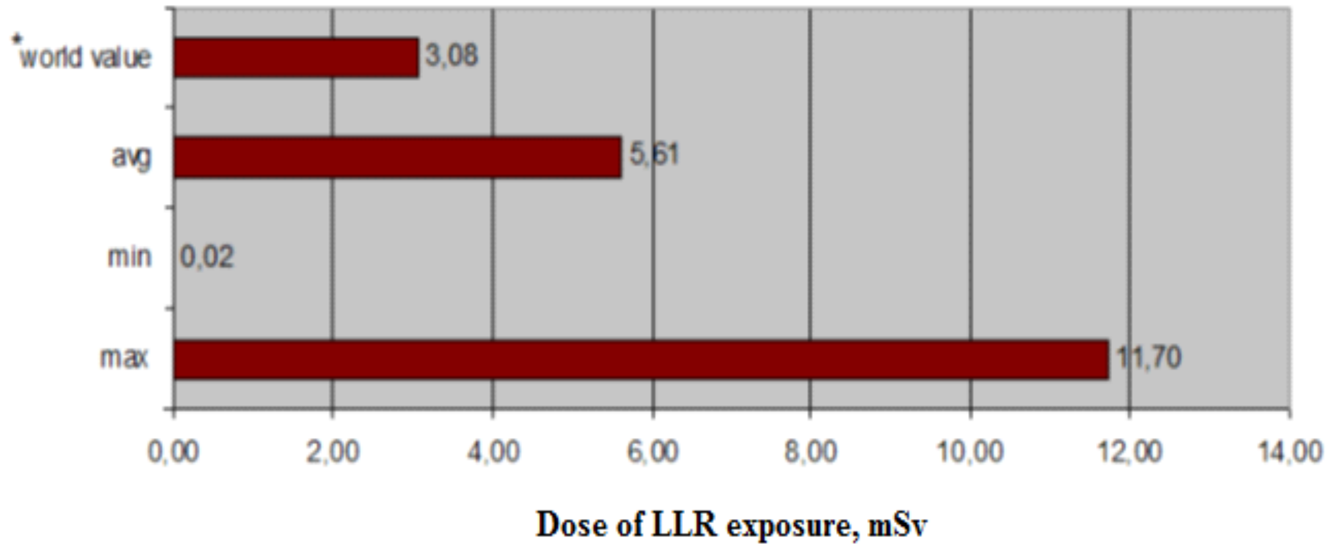

Figure 3b - Dose of LLR exposure of SMCC uranium processing workers with world value comparison

A number of published studies have assessed the health effects of both external radiation exposure of nuclear reactor workers and internal radiation exposure of uranium miners in underground mines. Recent studies show that workers working with uranium were exposed to higher external exposure to gamma radiation compared to workers working in nuclear reactors and uranium miners [2]. Thus, the exposure of uranium workers is significantly different from that of underground uranium miners or working nuclear reactors, and that workers working with uranium must be carefully assessed in separate studies.

Conclusion. Uranium processing workers should be treated as a separate group, since the doses received during work are different from other workers in the uranium industry. Subsequently, the potential health consequences of chronic exposure to uranium is currently being widely discussed [4-7] and there is a need to increase the cohort of workers at the uranium processing plant. Workers of a uranium processing plant in Kazakhstan may be included in the study cohort (i.e. Canada, Germany, France). A joint international cohort can provide valuable information on the risks associated with occupational exposure to uranium and gamma radiation doses, as well as perceived differences in risk with other groups of workers involved in the nuclear fuel cycle.

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