ASSESSMENT OF COLLECTIVE DOSE FOR TRAVELLERS BY WATERS*

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ABSTRACT

People travelling by air will receive more exposure dose and by water will receive less one. According to statistic data from the Ministry of Communications in 1988, the turnover in that year was about 2×10^{10} man·km. The total number of fishermen for inshore fishing was nearly two million reported by Ministry of Agriculture, Animal Husbandry and Fishery. Based on measured data on 212 points in six typical shipping lines of inshore lines and inland rivers, and the total voyage is 5625 km, the average natural radiation dose rate received by travellers was calculated. From that assessment of collective effective dose for passengers by water and fishermen was derived. The value is 32.7 man·Sv for passengers and 265.3 man·Sv for fishermen.

Keywords Passengers by water, Assessment, Collective effective dose

1 INTRODUCTION

Radiation dose received by mankind mainly comes from natural radiation[1]. Natural radiation for external exposure includes cosmic rays (ionizing components and neutron components) and natural γ rays. Some environmental changes caused by human being and some activities of mankind may decrease or increase the radiation dose level from natural radiation[2,3], people travelling by water and working on the water will receive less exposure dose. There are about 18000 km coast line in China and also the inland water transportation is very flourishing. According to statistic data from the Ministry of Communications in 1988, the turnover of water transportation in that year was about 2×10^{10} man·km and the total number of fishermen for inshore fishing was nearly two million. In this paper, on the bases of statistic data of the Ministry of Communications; the Ministry of Agriculture, Animal Husbandry and Fishery and the exposure dose level measured on several shipping lines, the assessment of colloective effective dose for the travellers by water and fishermen is done.

2 METHOD OF MEASUREMENT AND CONCLUSION

First, six typical shipping lines of inshore lines and inland rivers are chosen, the total voyage is 5625 km. Then high pressure chamber is used to measure the dose rate (including cosmic rays and natural γ rays) in cabin of the passenger ship every hour. Totally, 212 points are measured, then the average dose rate of each shipping line calculated. The average latitude and altitude are looked out in topography map.

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Table 1

Natural radiation dose rate in ship on each shipping line in China

Date of measure	Shipping lines	Average latitude /°N	Average elevation height/m	Voyage /km	Time of navigation /h	Measure times	Measure result /10^{-8} Gy·h^{-1}
19890210—0211	Fuzhou—Shanghai	28.73	0	874	28	25	3.80±0.38
19890222—0224	Shanghai—Dalian	35.13	0	1033	37	28	3.73±0.24
19900506—0508	Chongqing—Hankou	30.13	125	1370	54	46	3.57±0.15
19900511—0513	Hankou—Shanghai	31.02	30	1130	48	48	4.49±0.09
19900808—0809	Ha'erbin—Jiamusi	46.29	60	445	24	23	3.76±0.14
19900826—0828	Nanning—Wuzhou	23.16	50	623	31	27	3.43±0.23
19900927—0928	Suzhou—Hangzhou	30.83	38	150	13	15	3.35±1.10

Table 1 shows that the exposure levels for Fuzhou to Shanghai is similar to that for Shanghai to Dalian. They also are similar to the other papers'[4,5] results. In the inland river shipping lines, the exposure level mainly concerned with the ionizing components of cosmic rays except the individual section of shipping line. The average exposure level for Hankou to Shanghai of Yangtse River is higher than the other inland river shipping lines about thirty percent, 1.3 times as much as cosmic rays' exposure level in the same place. The exposure level for Ha'erbin to Jiamusi of Heilongjiang River and Songhuajiang River was rather high because of the latitude effect of cosmic rays.

3 DOSE ESTIMATION

According to the data in Table 1 and the statistic data from the Transportation Management Department of Ministry of Communication in 1988, the turnover of the travellers by waters in that year was 1905191×10^4 man·km. So the annual collective effective doses of five shipping lines are estimated (see Table 2).

Table 2

Annual collective effective doses for China travellers by waters in 1988

Shipping lines	Exposure level /10^{-8} Gy·h^{-1}	Speed of ship /km·h^{-1}	Turnover of travellers /10^4 man·km	Collective effective dose /man·Sv
Inshore	3.76	30	445916	5.59
Yangtse River Chongqing–Hankou	3.57	25	438181	6.26
Yangtse River Hankou–Shanghai	4.49	25	361419	6.49
Heilongjiang River, Songhuajiang River	3.76	24	956	0.02
Other inland river	3.45	20	628456	10.84
Oceangoing voyage	3.76	30	30263	0.38
Total			1905191	29.58

Notes: not include the dose contribution of neutron components of cosmic rays

Just the consideration same as UNSCEAR report 1990, effective dose equavelent rate caused by ionizing components of cosmic rays is chosen to equal the air absorbed dose equivalent rate and it is taken account into the dose rate value measured on the water with high pressure chamber from ionizing components of cosmic rays. From Table 2 one knows, caused by ionizing components of cosmic rays and natural γ rays, the collective effective dose received by the passengers by waters in China was 29.58 man·Sv in 1988.

From Ref.[6] one knows, in mainland areas of China, the average annual effective dose of external exposure from cosmic rays is 278 μSv, in which for ionizing components is 252 μSv, for neutron components is 26 μSv. So one gets that ionizing components is 9.69 times as much as neutron components. Therefore, one gets that the collective effective dose for the travellers by waters who received from cosmic rays (ionizing components and neutron components) and the natural γ rays of external exposure is 32.7 man·Sv.

As we know, the people working on the sea receive external exposure dose mainly from the cosmic rays. For the ionizing components of cosmic rays and a little natural γ rays, the exposure level was taken as 3.76×10^{-8} Gy·h^{-1}. In this case, for three different work conditions we did assessment of collective effective dose for the fishermen (see Table 3). The collective effective dose received by the fishermen (from ionizing components of cosmic rays and natural γ rays) was 240.5 man·Sv. If we took account into neutron components of cosmic rays the result would be 265.3 man·Sv.

Table 3

Annual collective effective doses for China fishermen working on the sea

Work condition	Population /men	Time /months	CED /man·Sv
Sea fishing	1029856	5	141.72
Sea farming	277418	3	22.91
Part-time	688860	4	75.84
Total	1996134	-	240.47

Notes: CED-Collective effective dose not including the dose contribution of neutron components of cosmic rays; Time-Staying time on the sea

Table 4

Effect of technical developments on annual collective effective dose of population in China mainland

Classification	Effective dose rate^1 /10^{-8} Sv·h^{-1}	Normalized result	Change of annual collective dose^2 /man·Sv
Land (indoor, outdoor)	9.38	1	0
Passenger ship	4.03	0.43	−43.3
Air flight	98.25[8]	10.47	+22.8
Fishing ship	4.06	0.43	−351.7
Nuclear industry	–	–	+23[12]

1. normalized by the effective dose of natural external exposure for the inland.
2. Annual collective effective doses for travelling by air, water and the fishermen including the external exposure dose from cosmic rays (ionizing components and neutron components) and a little natural γ rays. The change of annual collective effective dose is compared with natural external exposure in the inland.

Based on the natural radiation dose received by the population[6,10], one can evaluate the effect of the technical developments on annual collective effective dose of population in China mainland (see Table 4).

4 CONCLUSION

The UNSCEAR has been working for collecting, sorting out and evaluating all the scientific information of radiation level and effects from every country in the world since it was founded in 1955. In these years, in China the department concerned has also done this kinds of work[7~10]. This paper and Ref.[6] give the assessment of increasing and decreasing the exposure level of the passengers travelling by air or working on the water. In the world there was almost no information about the activities of mankind decreasing the radiation dose level from natural radiation except Japanese report[11] of people working on the water decreasing the collective effective dose. In the Table 4, we took the average external exposure effective dose of the China population in the inland as the normalized factor. The collective effective dose of the passengers by water is just less than a half of it, but by air it is more than ten times of it. Travelling by water and working on the sea can make the collective effective dose decrease about 400 man·Sv and travelling by air make it increase about 23 man·Sv. it just the same as it comes from nuclear industry[12].

During the measuring we found that the dose rate level of the shipping line from Hankou to Shanghai was higher, we thought it came from the passengers ship itself. For estimation of dose for neutron components of cosmic rays we adopted the data from Ref.[6], and the difference for edge effect of neutron on the water or earth is neglected.

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