Practical work №1 «Calculation of individual risk»

The objectives of the work:

- to calculate the individual risk from different causes in domestic and production activities;
- to compare individual risks from different causes depending on the type of activity in regions, countries;
- to assess individual risk in terms of statistic data on emergencies of natural and technogenic origin on the territory of Russia;
- to perform comparative characteristic of individual risk.

Individual risk is a frequency of the affections of a single individual as a result of the danger factors investigated: $\boldsymbol{R_{ind.} = N_{lo}/N,}$ where N_{lo} - number of lethal outcomes in a group of a number N which is subjected to an influence.

Collective (integral) risk determines the scale of expected consequences of potential accidents for people $\mathbf{R_{col.}} = \boldsymbol{R_{ind}} \times \boldsymbol{N_R,}$ where N_R – number of people subjected to a risk

If it is known for what definite cause $R_{ind} = 10^{-6}$, it means then that one person out of a million subjected to this cause would die of this impact. Usually all risk assessments are given per a unit of time – a year.

In this case individual risk is calculated not for each person, but individual risk for the groups of people characterized by approximately the same time of being in different unfavorable zones is estimated. It commonly takes into account the individual risk for working people and population of adjacent regions or smaller groups, e.g. workers of different profiles. Numerical value of individual risk is a quantitative characteristic of the risk level. Individual risk is characterized by one numerical value – a probability of deaths in terms of per one person a year. It is a universal feature of hazard for a man that makes it a basis for standardization of acceptable risk level. At the same time one should bear in mind that this value is far from being sufficient for complete characteristic of an event with undesirable consequences.

The level of acceptable individual risk is standardized only in some countries. In Netherland in 1985 the concept of "acceptable risk" became a basis for the state legislation. According to this law the death probability connected with hazards in technosphere more than 10^{-6} is considered unacceptable, less than 10^{-8} - acceptable (probability of dam destruction separating the most part of the country from the sea). At the risk level 10^{-6} — 10^{-8} decisions are made taking into account economical and social aspects.

In Russia the value of unacceptable risk accounts > 10^{-4}, but acceptable one is < 10^{-6}. At the risk value 10^{-6} - 10^{-4} all decisions ate taken taking into account economical and social conditions.

Group risk (or integral) determines the scale of expected consequences of different hazard factors for people $R_{col.} = R_{ind} N_R$, where N_R is the number of people subjected to risk.

Examples of **Solutions**

1. The annual number of victims in road accidents all over the world amounts to 1.2 million a year. Estimate an individual risk of loss of life in road accidents in the world. Assume the population number is 6.5 billion according to 2006.

$$R_{ind.} = N_d/N = 1{,}2 \cdot 1000000 / 6{,}5 \cdot 1000000000 = 0.185 \cdot 10^{-3} = 1{,}85 \cdot 10^{-4}$$

This number means that approximately 2 men die out of 10000 due to road accidents in the world annually.

2. Estimate the probability of death (Personal risk, year $^{-1}$) caused by the events listed below.

- Calculate the number of expected fatal outcomes for 1 million human beings.
- Arrange the causes listed below in column 1 in the sequence according to descent of the degree of danger.

Take the population of the USA in 1973 equal to 219 mln.

Estimation of the number of sudden death events in USA in 1973

The cause of an accident	Total number of deaths	Personal risk, year $^{-1}$	Number of expected fatal outcomes for 1 million human beings
Background (natural) radiation e.g. solar radiation	7200	$3{,}3 \cdot 10^{-5}$	33

Solution:

$$R_{ind.} = N_{lo}/N = 7200/218000000 = 3{,}3 \cdot 10^{-5}$$

$$R_{кол.} = R_{ind} N_R = 3{,}3 \cdot 10^{-5} \times 1000000 = 33$$

3. Calculate K_d – the coefficient of accident frequency in mines, if the number of death is 27 accidents per 1000 of workers at 40-hour working week during 50 weeks a year during 50 years.

Solution:

When it is assessed the risk of some people group of definite occupation or profession, it is preferable to refer their risks to one hour of work or a technologic cycle. Individual risks of professional activity are expressed in $K_л$ – coefficient of accident frequency. It expresses the number of deaths per 1 person during 1 hour of work (d/per.hour.).

27 accidents happen per 1000 of employers at 40-hour working week during 50 weeks a year during 50 years, hence, per a person during an hour of work is

$$K_л = 27/1000 \times 40 \times 50 \times 50 = 27 \cdot 10^{-8} \text{ d/per.hour}$$

4. Analyze the data in the Figure. Calculate the death individual risk from natural disasters taking into account the average statistical data for 1965-1999. Take the population of the world is equal to 6,5 billion.

Solution: The general number of people died in the world from seven types of accidents during 35 years is 3.8 mln. people. If one analyzes the dynamics of changes in the number of people died within 5-year intervals, it turns out that the number of victims changes unevenly from year to year: from 25 to 359 000 people a year. The maximum was in 1970-1974, when draughts in Africa resulted in the deaths of 1793 thous. people. One more death peak connected with the draught in some countries of Asia was in 1980-1984. At the end of the 80's and beginning of the 90's the number of victims from natural disasters remained approximately at the same level (52-58 000 people a year), but within the last 5-year period (1995-1999) it decreased up to 33 000 people a year. There was the growth in the number of victims due to floods, whereas the distribution of victims from other types of accidents over the years was not regular.

Calculate the average number of deaths from natural disasters per year within the period from 1965 to 1999

N_{lo} = 25+359+71+107+58+52+33/7 =705/7=100,1 peoples

Calculate the individual risk of the death from natural accidents

R ind.= N_{lo}/N== 100,1/6,5 $\cdot 10^{9}$ = $15{,}5 \cdot 10^{-9}$ = $1{,}55 \cdot 10^{-8}$

Fig. The number of people died in the world from different natural disasters within the period from 1965 to 1999, thous. people

VARIANT 3

1. Calculate the personal risk of lethal outcomes and the personal risk of injury in emergency cases of all kinds in different federal districts of Russia in 2012 year. Analyze and compare the data.

	federal district	Number of emergency cases of all kinds	Number of death	Number of people injured	Population of district,thousand people	R_{ind} of death	R_{ind} of injury
1	Far Eastern	25	40	99	**7 169 400**		
2	Siberian	112	98	227	**20 792 500**		
3	Ural	23	81	153	**12 603 200**		
4	Privolgski	84	128	39282	**32 017 800**		
5	Northern-west	24	43	93	**14 515 000**		
6	Central	48	106	269	**37 142 300**		
7	South	86	221	53314	**13 856 700**		
8	Northern Caucasus	35	102	1668	**9 496 800**		
9	Russian Federation	437	819	95105	**142 856 536**		

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Estimation of the number of sudden death events in USA in 1973

The cause of an accident	Total number of deaths	Personal risk, year $^{-1}$	Number of expected fatal outcomes for 1 million human beings
Medicine radiodiagnosis and radiotherapy	3300		
Nuclear industry	3		
Other causes not connected with radiation	398500		
Air pollution	20000		

Aviation accident	1778		
Rail disaster, train crash	798		

3. When it is assessed the risk of some people group of definite occupation or profession, it is preferable to refer their risks to one hour of work or a technologic cycle. The following data allow for comparison of professional risks which are expressed by $К_л$ – the coefficient of accident frequency. It expresses the number of deaths per 1 person during 1 hour of work (d/per.hour.). Calculate $К_л$ different professional activities in terms of the number of deaths given below, if 1000 people work 40 hours a week during 50 weeks a year during 50 years.

Type of activity	Number of deaths	Type of activity	Number of deaths
Building	20	Electrical engineering, mechanics, optics	4
Metallurgy	6	Textile, leather industry	3
Food industry	6	Health protection	2

4. On the basis of statistical data on Russia for 2009– 2012 calculate the personal risk of death in technogenic and natural accidents separately and as a whole.