

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

NATIONAL TECHNICAL UNIVERSITY
«KHARKIV POLYTECHNIC INSTITUTE»

GUIDELINES
for practical work on the topic “Quantitative risk assessment”
for the course “Fundamentals of Occupational Safety and Health”
for students of all specialties, all forms study

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The goal of the work

Learn to quantify the degree of risk of realization of the danger of the conditioned class.

General provisions

Potential danger is a universal property of the process of human interaction with the environment at all stages of the life cycle.

The axiom of potential danger is a fundamental postulate of Life Safety.

It determines that all human actions and all components of the environment, especially technical means and technologies, in addition to other positive properties and results, have the ability to generate dangerous and harmful factors.

In this case, any positive action or result is inevitably accompanied by the emergence of a new potential hazard or group of hazards.

In each case, the occurrence of danger in the technical system is multi-causal, and its development passes through a chain of events. Variants of the reasons and the following purpose of events can be foreseen if to create system on the basis of the analysis of its structural structure and possible actions of the person at service or management of technical system. In-depth analysis of failures of technical systems and possible erroneous human actions contributes to increased safety (reduced risk of danger) through the introduction of protective and restrictive means, as well as by increasing the training requirements of engineers and employees.

The presence of potential danger in the system is not always accompanied by its negative impact on humans. To implement such an action, you must meet three conditions: the danger (harm) actually works; the person is in the danger zone; the person does not have sufficient means of protection and the necessary level of training.

Relatively complete safety is guaranteed only by the first option (I) of the mutual position of danger zones 2 and the stay of a person 3 - this is remote control, surveillance, etc. (Fig. 1)

In the second option (II), the danger exists only in the case of a combination of zones 2 and 3. Since the person is in this common zone for a short time (inspection, minor repairs, etc.), the danger exists only in this period; in the third option (III) the danger can be realized at any time, and in the fourth option (IV) - only if the functional integrity of the means of protection is violated.

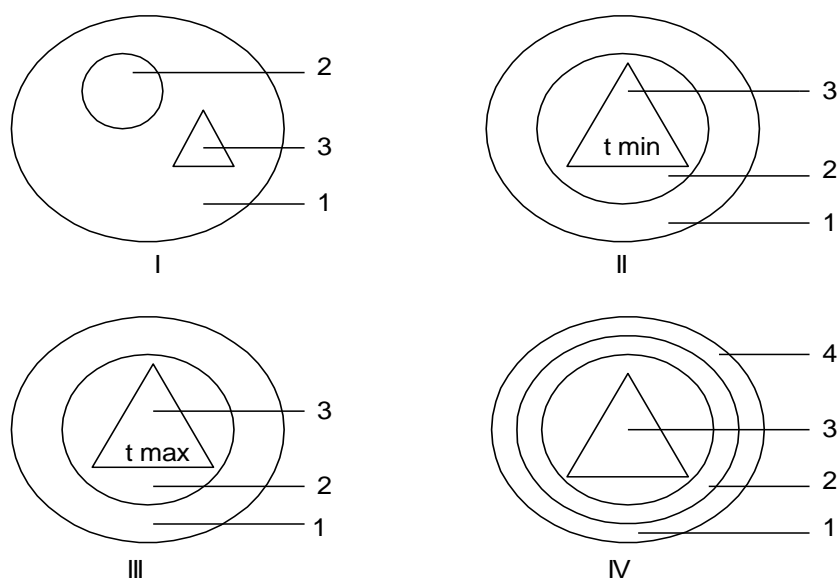


Fig. 1 - Variants of the mutual position of the habitat (1), danger zone (2), human zone (3) and zone of action of protective equipment (4): I - safe situation; II - situation of short-term or local danger; III - dangerous situation, IV - conditionally safe situation.

The criterion for assessing human actions and deeds in the presence of danger * is the risk, which is determined by the probability of manifestation

(realization) of danger in the area of human presence and the probability of human presence in the area of danger (danger zone).

***DANGER** is a negative property of the “human-habitat” system that can cause damage due to the energy state of the environment and human actions.

Relatively low (zero) risk indicates the absence of real danger in the system, and vice versa, the higher the risk, the higher the reality of the danger to humans.

However, it is impossible to provide zero risk in existing technical systems.

The concept of acceptable (acceptable) risk has gained worldwide recognition. The meaning of this concept is in the pursuit of low safety.

Acceptable risk is the degree of risk that can be realized by available technical means on the one hand, and economically justified on the other. According to statistics of foreign authors, the allowable risk is $n \cdot 10^{-6} \div n \cdot 10^{-8}$.

To develop effective safety measures, it is necessary to quantify the degree of risk.

Quantitative risk assessment

Risk R – frequency of realization of danger of a certain type (class).

Risk can be defined as the frequency (dimension - the inverse of time 1 / sec) or the probability of event A (dimensionless value lying within 0-1).

Safety experts offer the most general definition: risk is a quantitative assessment of danger.

Quantitative assessment is the ratio of the number of certain adverse effects to their possible number over a period of time.

There are: Individual risk; Social risk.

Individual risk – the frequency of occurrence of influences of a certain type, which affect the occurrence of certain hazards at a certain point in space (where the individual may be).

The concept of social risk is introduced to assess the scale of catastrophic detection (realization) of danger.

Social risk – the frequency of events, which consists in the defeat of a certain number of people who are exposed to certain types of influences, which affect the realization of certain dangers.

A person working in an enterprise or living in an area that may be in a zone of destruction or hazard during an accident is at risk. The level of risk depends on many factors, including from the location of the person and time.

As a rule, the fact of danger impact on a person is a random variable and is determined by the probability of finding the person in a certain place in case of danger.

The probability of event A can be determined from the expression:

$$R(A) = \frac{M}{n} \quad (1)$$

where M is the number of favorable factors (cases);

n is the total number of cases.

The analysis of individual risk should take into account the nature of the accident, the proportion of time spent in the risk zone and the place of residence of the risk taker.

The individual risk of death for resident A can be determined from the expression

$$R_n = \frac{N_n \cdot D \cdot t}{T \cdot N_o \cdot d \cdot t_d} \quad (2)$$

where N_n is the number of inhabitants killed per year;

d is the number of weeks in the year;

D – the number of weeks of stay of resident A in the investigated or dangerous area (city or village);

t_d – number of hours per week;

t – the number of hours per week when the resident is at risk (in the investigated or dangerous area);

T – time interval of statistical data accounting;

N_o – the number of inhabitants in the investigated or dangerous area (in the city or village) per year.

The individual risk of being the victim of an accident of any severity can be determined for resident A from the expression:

$$R_{\text{ж}} = \frac{(N_n + N_{\text{тп}}) \cdot D \cdot t}{T \cdot N_o \cdot d \cdot t_d} \quad (3)$$

where $N_{\text{тп}}$ - the number of injured residents

The order of work

Using these guidelines, to get acquainted with the nature of the origin of hazards, the conditions of the negative impact of danger on humans, quantitative assessment of the degree of risk.

Get an individual task from the teacher to calculate individual risk.

After completing the task and checking it by the teacher to discuss the work done and summarize.

Test questions

1. Define the concepts of "danger", "risk".
2. Axiom of potential threat.
3. Give examples of the negative effects of danger (harm) on humans and the conditions for its implementation.
4. Quantitative risk assessment.
5. Qualitative risk assessment.
6. Individual risk.
7. Social risk.
8. Permissible risk.

Sources of information

1. Problems of occupational injuries and ways of its reduction on example of Ukraine / I. Mezentseva [et al.] // Diversity: disease preventive of research integrity. – 2024. – Vol. 4, Issue 2. – P. 54-62.
2. Kuzmenko, O., I. Mezentseva, S. Vambol, and S. Mezentsev. “Reduction of Occupational Injuries As a Way to Solve the Problem of the Shortage of Personnel to Reduce Risks in the Energy Industry”. Bulletin of the National Technical University "KhPI". Series: Energy: Reliability and Energy Efficiency, no. 1 (8), July 2024, pp. 55-63.

TASKS

for calculating individual risk

Calculate two tasks according to the variant. The variant corresponds to your number in the group journal.

Table 1

Variant (your number in the group journal)	Number of tasks according to methodical instructions
1	1, 28
2	2, 29
3	3, 30
4	4, 31
5	5, 32
6	6, 33
7	7, 34
8	8, 35
9	9, 36
10	10, 28
11	11, 29
12	12, 30
13	13, 31
14	14, 32
15	15, 33
16	16, 34
17	17, 35
18	18, 36
19	19, 32
20	20, 33

TASK 1

Determine the risk of injury of people at production in Ukraine in 1996, if it is known that in general in the national economy were injured 65 000 people, and the number of employees is 15 million people.

TASK 2

Determine the risk of death at production in Ukraine, if it is known that in 1996 as a result of accidents at production 1 900 people died. The number of employees is 15 million people.

TASK 3

Every year in Ukraine about 127 500 people die as a result of various hazards. Taking the country's population of 50 million determine the risk of living in the country.

Compare the obtained data with the risk of human habitation in the former USSR, if it is known that as a result of various hazards about 500 000 people died with a population of 300 million people.

TASK 4

Identify the trend in the risk of human habitation in the Kharkiv region, if it is known that in 1997 as a result of non-production injuries 5 279 people were fatally injured, and in 1998 – 4 742 people, with a total population of 3 million people in the region.

TASK 5

Determine the individual risk associated with traffic accidents in the Kharkiv region in 1998, if it is known that 359 people died in road accidents with a total population of 3 million people in the region.

TASK 6

Compare the individual risk of electric shock injuries among residents in the Kharkiv region, taking into account the population of the region of 3 million people, if we know that in 1997 97 people died, and in 1998 – 46 people.

TASK 7

Determine the risk of death from accidents per a year related to the exploitation of vehicles, if every year in the former Soviet Union 63 000 people died. The population of the USSR was 300 million people.

TASK 8

Determine the risk of death from accidents at production per a year, if every year in the former Soviet Union from forced deaths 287 000 people died. The population of the USSR was 300 million people.

TASK 9

Determine the risk of death from accidents at production in the Russian Federation in 1990 per a year, if it is known that 8 200 people died. The number of employees at production is 25 million people.

TASK 10

Determine the risk of death at production in the world per a year, if it is known that every year 200 000 people dies in the world. The number of people working in production is 2,4 billion people.

TASK 11

Determine the individual risk caused by poisoning, if it is known that in 1996 in the Kharkiv region as a result of poisoning 1 120 people were injured with a total population of 2 997 900 people.

TASK 12

Determine the individual risk of injury in Kharkiv due to a fall, taking into account that 10 000 people are injured annually with a total of 1 510 000 people.

TASK 13

Determine the risk of death at production in 1989 in the former USSR, if it is known that 14 500 people died and the number of workers at production is 138 million people.

TASK 14

Determine the risk of death at production in mechanical engineering in 1990 per a year, if it is known that 400 people died with a total of 2,3 million people working.

TASK 15

Determine the individual risk of injury at production in the former Soviet Union in 1990, if it is known that 677 000 people were injured, and the number of workers at production is 138 million people.

TASK 16

Determine the individual risk of injury at production in mechanical engineering in 1990, if it is known that 58 600 people were injured with a total of 2,3 million people.

TASK 17

Determine the risk of personal injury in the former USSR during the exploitation of vehicles in 1990, if it is known that 350 000 people were injured with a total population of 300 million people.

TASK 18

Determine the individual risk due to the acquisition of occupational diseases in 1991 in the United States, taking into account that 400 000 people received occupational diseases with a total number of 120 million people.

TASK 19

Determine the individual risk of becoming disabled at work in the former USSR in 1990, if it is known that about 25 000 workers became disabled at work. The number of workers in production is 138 million people.

TASK 20

Determine the risk of death from environmental diseases, if it is known that 1,6 million people die annually from environmental diseases on the globe with a total population of 4,8 billion people.

TASK 21

Determine the individual risk caused by poisoning in the former Soviet Union in 1990, if it is known that the number of fatal poisonings at production and at home reached 50 000 people with a total population of 300 million people.

TASK 22

Determine the risk of death and injury in a fire in the former USSR in 1990, if it is known that fires killed 8 500 people, and more than 10 000 people were injured, with a total population of 300 million people.

TASK 23

Determine the risk of death and injury from natural disasters in 1991, if it is known that natural disasters killed 250,000 people and endangered the lives of about 25 million people with a total population of 4,8 billion people.

TASK 24

Determine the risk of death from earthquakes in the world in 1990, if it is known that earthquakes in the world killed more than 52 000 people with a total population of 4,8 billion people.

TASK 25

Determine the risk of death in a fire in Ukraine and in the Kharkiv region in 1996, if it is known that 1 200 people died in fires in Ukraine and 149 people – In the Kharkiv region, with a population of 49,3 million people in Ukraine and 2 997 900 people in the Kharkiv region.

TASK 26

Determine the individual risk of injury due to fires in Kharkiv in 1998, if it is known that 85 people were injured with a total population of 1,51 million people.

TASK 27

Determine the risk of injury in the Kharkiv region in 1998, if it is known that 1 388 people were injured with a total of 1 million employees.

TASK 28

Determine the individual risk for resident A, who lives in city N with a population of 1,51 million people. Statistics for T=10 years show that during this time 60 000 residents of the city died and 120 000 residents were injured.

A resident of the city N 40 hours a week works in the city, 4 weeks a year goes on vacation, 3 weeks each year is on business trips, 56 days a year working in the country, and the rest of the time is in the city.

TASK 29

Determine the individual risk for resident A, who lives in a village with 200 residents. Among the villagers in 10 years 5 people died and 50 people were injured.

Resident A works 40 hours a week in the nearest town N, 4 weeks a year he leaves the village for a rest, 2 weeks every year he goes on business trips, 56 days a year he works in the country, and the rest of the time he is in the village.

TASK 30

Determine the individual risk for resident A, who lives in city N with a population of 2,3 million people. Statistics for 10 years show that during this time 58 000 residents of the city died and 134 000 residents were injured.

A resident of the city N **40 hours** a week works in the city, **4 weeks** a year goes on vacation, **3 weeks** each year is on business trips, **56 days** a year working in the country, and the rest of the time is in the city.

TASK 31

Determine the individual risk for resident A, who lives in a village with 560 inhabitants. Among the villagers in 10 years 12 people died and 69 people were injured.

Resident A works **40 hours** a week in the nearest town N, **4 weeks** a year he leaves the village for a rest, **2 weeks** every year he goes on business trips, **56 days** a year he works in the country, and the rest of the time he is in the village.

TASK 32

Determine the individual risk for resident A, who lives in city N with a population of 2,41 million people. Statistics for 10 years show that during this time 76 000 people died and 201 000 people were injured.

A resident of the city N **40 hours** a week works in the city, **4 weeks** a year goes on vacation, **3 weeks** each year is on business trips, **56 days** a year working in the country, and the rest of the time is in the city.

TASK 33

Determine the individual risk for resident **A**, who lives in a village of 768 residents. Among the villagers in 10 years 12 people died and 83 people were injured.

Resident **A** works **40 hours** a week in the nearest town **N**, **4 weeks** a year he leaves the village for a rest, **2 weeks** every year he goes on business trips, **56 days** a year he works in the country, and the rest of the time he is in the village.

TASK 34

Determine the individual risk for resident **A**, who lives in city **N** with a population of 1,22 million people. Statistics for 10 years show that during this time 73 000 residents of the city died and 134 000 residents were injured.

A resident of the city **N** **40 hours** a week works in the city, **4 weeks** a year goes on vacation, **3 weeks** each year is on business trips, **56 days** a year working in the country, and the rest of the time is in the city.

TASK 35

Determine the individual risk for resident **A**, who lives in a village of 870 inhabitants. Among the villagers in 10 years 13 people died and 96 people were injured.

Resident **A** works **40 hours** a week in the nearest town **N**, **4 weeks** a year he leaves the village for a rest, **2 weeks** every year he goes on business trips, **56 days** a year he works in the country, and the rest of the time he is in the village.

TASK 36

Determine the individual risk for resident **A**, who lives in city **N** with a population of 3,23 million people. Statistics for 10 years show that during this time 89 000 residents of the city died and 214 000 residents were injured.

A resident of the city **N** **40 hours** a week works in the city, **4 weeks** a year goes on vacation, **3 weeks** each year is on business trips, **56 days** a year working in the country, and the rest of the time is in the city.

For notes

Educational Edition

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