ANALYZING AND DEVELOPING CRITERIA FOR ASSESSING OCCUPATIONAL TRAUMATISM RISKS BASING ON «BEST PRACTICE CODE»*

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A system of managing occupational risks is now being implemented in the Russian Federation; it implies developing mechanisms of their assessment. The article presents an assessment procedure for assessing occupational traumatism risks as a part of methodology for complex occupational risks assessment. Occupational traumatism risk assessment is based on such criteria as predicted traumatism frequency caused by priority risk factors for examined groups (discrete criteria of traumatism risks) and frequency diagram depending on consequences of injuries caused by priority risk factors. They are integral criteria of traumatism risks (known as F–N curves). «Best practice code» means traumatism risks levels which exist now in countries with high occupational safety.

Our research objects were cases and circumstances of traumatism occurring among such an occupational group as «drivers and operators of mobile equipment». We detected that increased risks levels occurred due to a limited number of factors from each group of variables and it, in general, corresponded to Pareto principle. We obtained a dependence of $y = c \times e^{-b x}$ type (F–N curve analogue), which described correlation between relative frequency of injuries and gravity of damage caused by them as a median of temporary disability of workers from the examined occupational group ($R^2 > 0.9$). The obtained equations for approximating curve can be criterial in assessing injuring circumstances significance and risk levels for workers from relevant occupational groups in industry and agriculture in the Russian Federation.

Assessment results and assessing priority risks and factors causing them give a possibility to make decisions related to developing strategies, programs, techniques, and activities aimed at raising workers' safety in the examined occupational group.

Key words: occupational risk, risk factor, traumatism, risk assessment criteria, Pareto principle, workers' safety, best practice code.
Occupational risks. But still a concept of occupational risks assessment in Russia hasn't been developed as a practical instrument yet.

According to the existing federal law on insurance against accidents\(^2\) and regulations on Labor Protection and Working Conditions Department and Social Insurance Fund (SIF)\(^3\) working conditions and labor protection as well as occupational risks levels are monitored in our country as per economic activity and the RF regions.

Organizations and/or private entrepreneurs (juridical persons) which are included into the statistical register are statistical observation objects in both cases. Statistical information provided by the SIF is used as a ground for fixing "occupational risk categories" as well as for choice on priority actions aimed at their elimination.

**Methodological problems.** We examined statistical data provided by the SIF Kurgan regional office for a period of 1999 to 2012; the results revealed that agricultural production was one of the most injury-prone industries both in terms of the total number of grave injuries and total number of fatalities (2160 cases). And more than 47% of all the injuries occurred in the basic occupational group 8300 "Drivers and operators of mobile equipment" [8].

The analysis results showed that causes and circumstances of injuries occurring in certain occupational groups differed significantly both from each other within a group and from those which were characteristic for agricultural production workers as a whole. This fact proves that an existing approach to occupational risks assessment basing on the information on industrial threats as per industries data is hardly relevant. And yet, analysis of reports on industrial accidents (so called H-1 forms) revealed that injuries circumstances for a specific basic occupational group are in general rather identical.

The results of traumatism analysis and screening risk assessment on the basis of criteria given in the State Standard \(51901.23-2012\) [3] showed that risks for workers from 8300 occupational group, "Drivers and operators of mobile equipment", were extremely high. It made for the necessity to perform a detailed analysis aimed at increasing risk assessment validity.

**Research goal** was to give grounds for methodology of assessment criteria creation and occupational traumatism risks assessment on the example of a basic occupational group.

**Data and methods.** We identified and ranked priority risk factors (risk indexes) which determined high traumatism level in the course of the detailed research (Table 1).

The statistical analysis results prove a hypothesis stated in works [1, 5, 6] that accidents and injuries caused by them are not casual events. They are the result of cause-effect interactions within "a worker - working environment" system and can therefore be predicted and prevented.

In this context, planning and implementing activities aimed at increasing workers' safety should be performed as per significance of injuries causes and consequences; "a worker - working environment" system is to be developed via improvement of elements which are relatively more significant.

We used **Fault Tree\(^4\)** software to assess cause-effect relations significance. We applied calculation modules system in our analysis and accomplished point estimates of probability of both the system failure as a whole (an injury itself) and intermediate events as well. We determined minimal logical expressions for calculating events probability and performed point estimates of probable emergency combinations; the paper presents the results of calculating significance of initial events and their combinations.

**Criteria choice and foundation.** Foreign practices prove that tools and methods used for calculating risk and its components should provide obtaining of such data which in their form are similar to parameters applied for describing threshold (criterial) values of ultimate, permiss-

\(^{4}\)Fault Tree Analysis (FTA) [web-source] // Wikipedia: the free encyclopedia. – URL: https://en.wikipedia.org/wiki/Fault_tree_analysis (date of visit July 18, 2016)
Risk criteria determination involves choice and foundation of parameters which determine monitoring system efficiency concerning set goals. According to our research goal and recommendations given in the State Standard 51901-2002 [2] as well, we chose the following parameters as risk assessment criteria:

### Table 1

Register of risks for "Drivers and operators of mobile equipment" occupational group (fragment)

| Accident circumstances identifier | Accident circumstances denomination and description | Circumstances occurrence probability (L)\* | Consequences of circumstances occurrence (I) | Risk assessment (IL) |
|-----------------------------------|---------------------------------------------------|------------------------------------------|------------------------------------------|---------------------|
|                                   |                                                   | Gravity | Probability** |                                   |
| **Event or impact (E)**           |                                                   |         |               |                                   |
| E1                                | Pinching by objects or between objects            | 0,27    | 0,0570        | 0,01539                             |
|                                   |                                                   |         | 0,0976        | 0,02635                             |
|                                   |                                                   |         | 0,8454        | 0,22826                             |
| E2                                | Fall of an injured                                | 0,25    | 0,0137        | 0,00343                             |
|                                   |                                                   |         | 0,0747        | 0,01868                             |
|                                   |                                                   |         | 0,9116        | 0,22790                             |
| E3                                | Contact injuries or collisions                     | 0,19    | 0,0372        | 0,00707                             |
|                                   |                                                   |         | 0,0705        | 0,01340                             |
|                                   |                                                   |         | 0,8923        | 0,16954                             |
| **Injury source (S)**             |                                                   |         |               |                                   |
| S1                                | Machines and mechanisms                           | 0,28    | 0,0427        | 0,01196                             |
|                                   |                                                   |         | 0,0843        | 0,02360                             |
|                                   |                                                   |         | 0,8730        | 0,24444                             |
| S2                                | A worker's actions or movement                    | 0,18    | 0,0192        | 0,00346                             |
|                                   |                                                   |         | 0,0652        | 0,01174                             |
|                                   |                                                   |         | 0,9156        | 0,16481                             |
| S3                                | Vehicles                                         | 0,16    | 0,0504        | 0,00806                             |
|                                   |                                                   |         | 0,0817        | 0,01307                             |
|                                   |                                                   |         | 0,8679        | 0,13886                             |
| **Injury type (T)**               |                                                   |         |               |                                   |
| T1                                | Open wounds                                       | 0,28    | 0,0327        | 0,00916                             |
|                                   |                                                   |         | 0,1176        | 0,03293                             |
|                                   |                                                   |         | 0,8497        | 0,23792                             |
| T2                                | Subcutaneous wounds and injuries (pinching)      | 0,28    | 0,0192        | 0,00346                             |
|                                   |                                                   |         | 0,0652        | 0,01174                             |
|                                   |                                                   |         | 0,9156        | 0,16481                             |
| T3                                | Fractures                                         | 0,19    | 0,0592        | 0,01125                             |
|                                   |                                                   |         | 0,2368        | 0,04499                             |
|                                   |                                                   |         | 0,7040        | 0,13376                             |
| **Body part (B)**                 |                                                   |         |               |                                   |
| B1                                | Upper extremities                                | 0,37    | 0,0036        | 0,00133                             |
|                                   |                                                   |         | 0,0357        | 0,01321                             |
|                                   |                                                   |         | 0,9607        | 0,55546                             |
| B2                                | Lower extremities                                | 0,25    | 0,0298        | 0,00214                             |
|                                   |                                                   |         | 0,0859        | 0,02285                             |
|                                   |                                                   |         | 0,9141        | 0,22853                             |
| B3                                | Head                                             | 0,12    | 0,0536        | 0,00643                             |
|                                   |                                                   |         | 0,0804        | 0,00965                             |
|                                   |                                                   |         | 0,8661        | 0,10393                             |

Note:
* – as a share of the total number of accidents with occupational group representatives;
** – as a share of the total number of accidents caused by such circumstances.
a) a predictable frequency of injuries caused by priority risk factors for workers from the examined occupational group (discrete criteria of injuries risks);

b) frequency diagrams depending on consequences of injuries caused by priority risk factors (integral criteria of injuries risks known as $F$–$N$ curves).

Risk evaluation is a process of comparing an evaluated risk with these risk criteria in order to determine its significance. Here we check if a risk in this situation is greater than an acceptable one which is considered to be permissible within the existing social values. Absence of occupational traumatism risks criteria in the RF legal regulations as well as absence of analytical tools to calculate such risks made it necessary to use relevant analogues from foreign practices as evaluation criteria.

«Best practice code» («Best practical solution») is a tool which provides practical means and relevant examples from the best domestic or foreign practices. In our context we accepted traumatism risk levels which exist now in countries with high occupational safety as a «Best practice code». "Relevance presumption" principle implies that risks which are acceptable for similar occupations, operations, production processes or activities, can be used as a standard, that is, relevant known risk values are used as criteria.

As traumatism levels in the RF are multiply higher than those existing in the EU countries and the USA, we chose traumatism parameters in the US agricultural sector as "best practice code" (Figure 1).

Our choice was determined by the fact that information resources of the US Bureau of Labor Statistics which contain more than 20 million entries are a systematized database on accidents for a period of time starting with 1992 and up to present. The data are given on the official web-site of The US National Institute for Occupational Safety and Health.

"Agricultural equipment operators" occupational subgroup 45-2091 was chosen as an analogue for our Russian "Drivers and operators of mobile equipment" occupational group. As per data provided by the US Bureau of Labor Statistics, this group consisted of 221.32 thousand workers over 2004-2013; number of non-lethal injuries over the same period amounted to 5,540. 122 people died.

![Figure 1. Non-lethal traumatism risks dynamics in agriculture](image_url)

**Analysis of injuries conditions and circumstances.** Elimination of causes which make for or directly lead to accidents is one of the most important elements of risk management. To identify dangers related to occupational activities of injured we analyzed injuries circumstances as per methodology presented in [5]. traumatism dynamics analysis revealed that over 2004-2013 fluctuations in per cent distribution (share) of injuries caused by or related to specific factors were insignificant as they were within confidence interval boundaries ($\mu \pm 2\sigma$). It provided a possibility to perform statistical analysis to determine and rank priority variables/injury circumstances for workers form this occupational group.

**Determination of injuries risks discrete criteria.** Data on number of workers in the examined occupational group and on a number of accidents made it possible to evaluate injuries risks level.

Risks were evaluated as ratio of a number of injured workers from the "Agricultural
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equipment operators’ occupational group \( (n) \) to the total number of workers in this occupational group \( (N) \):

\[
R = \frac{n}{N}.
\]

Non-lethal injuries risks analysis in the RF over 2004-2013 (see Figure 1) revealed that the observed descending trend of these parameters was within confidence interval boundaries \((\mu \pm 2\sigma)\). This regularity was detected for the whole examined set of circumstances and conditions, that is, as per injury character; as per localization of an injury on a body; as per injury source as well as per impact type (accident type). The results of the performed analysis are shown in Figure 2.

| Impact type                                      | Risk (\( \times 10^{-3} \)) |
|-------------------------------------------------|------------------------------|
| 62*hit by a moving                              | 7,14E-03                     |
| 64*pinching or crushing                         | 6,05E-03                     |
| 2*transport accidents                           | 3,93E-03                     |
| 42*falling on the same level                    | 1,76E-03                     |
| 43*falling on a lower level                     | 1,67E-03                     |
| 6*hit against an immobile object                | 1,27E-03                     |
| 711*overstrain during ascending                 | 9,40E-04                     |
| 5*hazardous substances impact                   | 6,78E-04                     |
| 41*slipping and stumbling without falling       | 4,97E-04                     |
| 999*other circumstances or impacts              | 1,08E-03                     |
| 3*mechanisms and equipment                      | 6,64E-03                     |
| 56*an injured worker                            | 5,11E-03                     |
| 8*vehicles                                      | 4,20E-03                     |
| 4*details and materials                         | 2,49E-03                     |
| 66*floors, passages and ground                  | 2,21E-03                     |
| 71*hand and power tools                         | 1,99E-03                     |
| 21*containers                                    | 8,58E-04                     |
| 1*chemicals and chemical products               | 3,61E-04                     |
| 99*other sources                                | 1,17E-03                     |
| 4*upper extremities                             | 8,31E-03                     |
| 5*lower extremities                             | 5,60E-03                     |
| 1*head                                          | 4,61E-03                     |
| 3*body                                          | 3,98E-03                     |
| 8*several body parts                            | 2,21E-03                     |
| 6*body systems                                  | 2,26E-04                     |
| 2*neck                                          | 9,04E-05                     |
| 12*injuries of muscles and tendons              | 7,00E-03                     |
| 143*hematomas, scratches                       | 5,92E-03                     |
| 1972*pains in organs / body parts               | 4,92E-03                     |
| 11*injuries of bones and nerves                 | 2,20E-03                     |
| 13*open wounds                                  | 2,17E-03                     |
| 18*multiple injuries                            | 1,40E-03                     |
| 152*thermal burns                               | 9,04E-05                     |
| 19*other injuries                               | 1,27E-03                     |

Figure 2. Non-lethal injuries risks

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2-3 factors from each group of variables are in increased risks zone which on the whole corresponds to Pareto principle: 20% means which are required to solve a problem completely, help to solve 80% of it. It seems obvious that it is those risks which are priority ones in decision-making on strategies and measures aimed at increasing safety of workers in the analyzed occupational group. Basing on traumatism levels comparison, we can state that quantitative risks values in the US agricultural sector are criterial when workers safety for analogical occupations in the RF is assessed.

Analysis of discrete traumatism risks levels allows to evaluate an injury probability without taking their consequences gravity into account. But still data on damage gravity are most significant in developing injuries prevention strategies as they most adequately highlight priority trends in increasing workers' safety.

**Determination of injuries risks integral criteria.** According to «OICS Guidelines» [19], a number of days during which a worker was temporarily disabled is one of the basic parameters indicating injury consequences gravity applied in the US. There are the following gradations: 1 day; 2 days; 3–5 days; 6–10 days; 11–20 days; 21–30 days; 31 days and longer, but not more than 3 months.

Figure 3 shows data on temporary disability duration distribution for workers from "Agricultural equipment operators" occupational group over 2004-2013. The results of statistical functions calculations are given in Table 2.

![Figure 3. Temporary disability duration distribution](image)

Table 2

| Statistical function | Disability duration distribution, % |
|----------------------|-------------------------------------|
|                      | day | 2 days | 3–5 days | 6–10 days | 11–20 days | 21–30 days | 31 days and longer |
| Median               | 14.1| 11.1   | 10.3     | 3.7       | 1.3        | 0.7        | 0.1                |
| Mean deviation       | 0.90| 1.58   | 0.78     | 0.37      | 0.19       | 0.06       | 0.01               |
| Standard deviation   | 1.10| 1.85   | 1.01     | 0.43      | 0.23       | 0.07       | 0.01               |

Data analysis revealed that over the whole observation period distribution of consequences gravity probabilities $N_i$ was within the boundaries of confidence interval $N \pm 2\sqrt{N}$. It makes for statistical research possibility assuming that injury distribution $N$ with certain consequences gravity $i$ remains unchanged, that is, $N_i = \text{const}$ with probability equal to 95%.

To obtain approximating curve equation in an analytical form and to evaluate validity of the performed approximation with Excel tools, we accomplished regression analysis of the obtained data. When fitting a trend line, Excel automatically calculates $R^2$ value which characterizes approximation validity.

$R^2$ as approximation validity value is determined as per formula

$$R^2 = 1 - \frac{\sum (y_i - \hat{y}_i)^2}{\sum (y_i - \bar{y})^2},$$

where $y_i$ are actual values; $\hat{y}_i$ are approximating functions value.

The results showed that maximum value of approximation validity $R^2 = 0.9267$ corresponded to exponential distribution

$$y = ce^{-bx}.$$

Frequency distribution median and approximating curve $y = 0.5449e^{-0.761x}$ are given on Figure 4.
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Table 3

| Injury circumstances         | Approximation curve equation | Model determination coefficient ($R^2$, $p<0.05$) |
|-----------------------------|------------------------------|-----------------------------------------------|
| **Injury character**        |                              |                                               |
| Injuries of muscles and tendons | $y = 0.4412e^{-0.744x}$     | 0.9212                                        |
| Hematomas and scratches     | $y = 1.039e^{-0.931x}$       | 0.9605                                        |
| Pains in organs and body parts | $y = 0.5408e^{-0.769x}$     | 0.9542                                        |
| **Part of a body (organ)**  |                              |                                               |
| Upper extremities injuries  | $y = 1.039e^{-0.931x}$       | 0.9600                                        |
| Lower extremities injuries  | $y = 0.3822e^{-1.081x}$      | 0.9380                                        |
| Head injuries               | $y = 1.4928e^{-1.068x}$      | 0.9785                                        |
| **Injury source**           |                              |                                               |
| Mechanisms and equipment    | $y = 0.4857e^{-0.732x}$      | 0.9427                                        |
| Injured worker              | $y = 0.540e^{-0.763x}$       | 0.9540                                        |
| Vehicles                    | $y = 0.3915e^{-0.689x}$      | 0.9421                                        |
| **Event or impact**         |                              |                                               |
| Hit by a moving object      | $y = 0.7288e^{-0.835x}$      | 0.9623                                        |
| Pinching or crushing        | $y = 1.1683e^{-0.909x}$      | 0.9575                                        |
| Transport accidents         | $y = 0.3701e^{-0.679x}$      | 0.9410                                        |
The obtained dependence is in its essence an analogue of a well-known $F$–$N$-curve, which represents a graphic interpretation of correlation between an event probability and gravity. In this case the curve shows correlation between relative injuries frequency (as a % of total number of cases) and gravity of damage caused by them (as disability duration median / period) for workers from "Agricultural equipment operators" occupational group.

Injuries risks level ($R$) can be given as:

$$R = f(F, N),$$

where $F$ are discrete frequencies of accidents which caused disability days, $N$ is gravity of the given accidents consequences.

We obtained similar dependences for all detected priority risk factors during our research. Integral risk levels as per most significant injury circumstances are given in Table 3.

So, allowing for multiply higher injury risks for workers employed at the RF agricultural enterprises (see Figure 2), we can state that $y = ce^{-b}$ curves based on the long-term statistical observation of workers from relevant occupational groups in the USA can be used as criterial ones in evaluating acceptability of relevant injury circumstances and risk levels (Figure 5).

Conclusions. According to our research goal we took predictable frequency of injuries caused by priority risk factors for workers from the examined occupational group (discrete injuries risks criteria) and frequency diagrams depending on consequences of injuries caused by priority risk factors (integral injuries risks criteria known as $F$–$N$ curves) as criteria of occupational traumatism risks evaluation.

We detected that increased risks levels were caused by a limited number of factors from each group of variables which in general corresponded to Pareto principle: 20 % means which are required to solve a problem completely, help to solve 80 % of it.

"Relevance presumption" principle implies that risks which are acceptable for similar occupations, operations, production processes or activities, can be used as a standard, that is, relevant known risk values are used as criteria. As traumatism levels in the RF are multiply higher than those existing in the EU countries and the USA, and there aren't any standard values for occupational traumatism risks existing in the RF, we chose traumatism parameters in the US agricultural sector as a standard value.

The $y = ce^{-bx}$ dependence obtained in the course of our research is an analogue of a well-known $F$–$N$-curve which shows correlation between an accident probability and gravity. In our case the curve shows correlation between relative injuries frequency and gravity of damage caused by them as a disability duration median for workers from the examined occupational group.

The research results and the approximation validity values $R^2 > 0.9$ which we obtained via regression analysis prove that the detected $y = ce^{-bx}$ dependence adequately reflects the essence of cause and effect relations between injury circumstances and consequences they have. Hence, the obtained approximating curve equations can be criterial in evaluating injury circumstances significance and risks for workers from relevant occupational groups in the RF industry and agriculture.

Results of priority risks evaluation as well as assessment of factors which determine them make it possible to take decisions related to development of strategies, programs, methods and means for increasing safety of workers from an analyzed occupational group.

References

1. Lomov O.P., Akhmetzyanov I.M., Greben'kov S.V., Levashov S.P., Terent'ev L.P. Gigienicheskie normativy. Fizicheskie faktory okruzhayushchei i proizvodstvennoi sredy: Kollektivnaya monografiya [Hygienic standards. Physical factors of the environment and occupational environment: Collective monograph]. In: O.P. Lomov ed. St. Petersburg, Professional Publ., 2013, 796 p. (in Russian).
2. Менеджмент риска. Анализ риска технологических систем: Государственный стандарт Российской Федерации [Risk management. Risk analysis of technological systems: The RF State Standard 51901.1-2002.]. Available at: http://docs.cntd.ru/document/1200030153 (22.03.2016) (in Russian).

3. Менеджмент риска. Реестр риска. Руководство по оценке риска опасных событий для включения в реестр риска [Risk management. Risk register. Guide on assessment of hazards risk for inclusion in risk register: The RF National Standard 51901.23-2012]. Available at: http://docs.cntd.ru/document/1200100076 (22.03.2016) (in Russian).

4. Артемьев В.Б., Килин А.Б., Шаповаленко Г.Н., Ошаров А.В., Радионов С.Н., Кравчук И.Л. Концепция опережающего контроля как средства существенного снижения травматизма [Predictive control concept as a means of substantial traumatism lowering]. Ugol’, 2013, no. 5, pp. 82–85 (in Russian).

5. Левашов С.П., Манило И.И. Оценка рисков профессионального травматизма [Occupational traumatism risk assessment]. Chelovek i trud, 2013, no. 11–12, pp. 62–70 (in Russian).

6. Левашов С.П., Шкрабак В.С. Профессиональный риск: методология мониторинга и анализа [Occupational risk: Monitoring and analysis methodology]. In: В.С. Шкрабак ed. Kurgan, Izdatel'stvo Kurganskogo gosudarstvennogo universiteta Publ., 2015, 308 p. (in Russian).

7. Лисовский В.В., Гршин В.Ю., Кравчук И.Л., Галкин А.В. Об оперативном управленении рисками травмируемого персонала: удержание опасной производственной ситуации на приемлемом уровне риска [On operative managing risks of workers’ traumatism: keeping a dangerous production situation at an acceptable risk level]. Ugol’, 2013, no. 1, pp. 46–52 (in Russian).

8. Общероссийский классификатор занимаемых должностей [Russian Classification of Occupations 010-2014 (MSKZ-08)]. Available at: URL: http://docs.cntd.ru/document/1200121893 (24.04.2016) (in Russian).

9. Пустовит А.Е., Козлов В.И. Прогнозирование травматизма с использованием метода анализа рисков травмируемого [Miners traumatism forecasting by means of injury risk analysis]. Sibbezopasnost’-Spassib, 2013, no. 1, pp. 234–238 (in Russian).

10. Севастяновов В.В., Шадрин Р.О. Прогнозирование рисков травмируемого работника на рабочих местах [Structuring risks of traumatizing at working places]. Izvestiya vysshikh uchebnykh zavedenii. Tekhnologiya tekstil'noi promyshlennosti, 2012, vol. 338, no. 2, pp. 137–144 (in Russian).

11. Селеванов Л.К. Оценка риска травмируемого в Российской Федерации и федеральных округах [Assessment of the risk of injury in the Russian Federation and federal districts]. Aktual'nye problemy aviatsii i kosmonavтики, 2016, vol. 1, no. 12, pp. 975–977 (in Russian).

12. Суворов С.Б. Структурирование рисков травмируемого на рабочих местах [Structuring risks of traumatizing at working places]. Izvestiya vysshikh uchebnykh zavedenii. Gornyi zhurnal, 2007, no. 5, pp. 42–44 (in Russian).

13. Сусеева И.В., Букалова Г.К., Репин В.М. Метод оценки риска травмируемого с учетом ущерба на текстильном предприятии [The Method of Estimation of Traumatizing Risks Taking into Account Damages at Textile Enterprises]. Izvestiya vysshikh uchebnykh zavedenii. Tekhnologiya tekstil'nogo promyshlennosti, 2012, vol. 338, no. 2, pp. 137–141 (in Russian).

14. Фейер А., Уильямсон А.В. Классификация причин производственных травм для использования в стратегиях предотвращения рисков [A Classification System for Causes of Occupational Accidents for Use In Preventive Strategies]. Scand. J. Work Environ. Health, 1997, vol. 17, pp. 302–311.

15. Йованович Д., Бацич С., Митрович И. Риск молодых водителей в дорожно-транспортном движении на территории Республики Сербия [Prediction of injury risks to workers employed in municipalities of the Udmurt Republic]. Problemy prognozirovaniya, 2012, no. 1, pp. 152–157 (in Russian).

16. Лишовский В.В., Гришин В.Ю., Кравчук И.Л., Галкин А.В. Об оперативном управлении рисками травмируемого персонала: удержание опасной производственной ситуации на приемлемом уровне риска [On operative managing risks of workers’ traumatism: keeping a dangerous production situation at an acceptable risk level]. Ugol’, 2013, no. 1, pp. 46–52 (in Russian).

17. Mitropoulos P., Namboodiri M. New method for measuring the safety risk of construction activities: task demand assessment. Journal of Construction Engineering and Management, 2011, vol. 137, no. 1, pp. 30–38.

18. Mosher G.A., Keren N. Analysis of safety decision-making data using event tree analysis. The Association of Technology, Management, and Applied Engineering: Conference Proceedings Papers, 2011, pp. 137–142.
19. Occupational Injury and Illness Classification System. Centers for Disease Control and Prevention. Available at: http://wwwn.cdc.gov/wisards/oiics/Trees/MultiTree.aspx?Year=2012 (12.02.2016).

20. Schaufler D.H., Yoder A.M., Murphy D.J., Schwab C.V., Dehart A.F. Safety and health in on-farm biomass production and processing. Journal of Agricultural Safety and Health, 2014, vol. 20, no. 4, pp. 283–299.

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