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Benchmarking Initiatives in the Field of Occupational Safety and Health in the Context of Development of the Coal Industry of Russia.

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ABSTRACT

Modern trends in occupational safety are associated with the zero accident paradigm, especially in high-risk sectors. The key objective of the research is to attain a better understanding of the factors that contribute to successes with implementing a 'Zero Accident Vision' in coal companies. The paper deals with analytical survey on the status of working conditions and occupational safety and health (OSH) issues at coal mining enterprises of the Russian Federation, European Union and Australia. Absolute and relative figures of occupational fatal injury rate are given, as well as dynamics of accident and injury rate at the coal mining enterprises of Russia. Importance to possess information about stress-strain condition of the rock mass (at a design stage) and its changes in process of multiple seam mining is shown. The OSH measures taken throughout Russia (implementation of modern systems of control over occupational safety and health and environmental protection, supervisory measures, improvement of OSH culture, Zero Accident Vision corporate programs etc.) made it possible to decrease fatal injury rates in coal mining industry – in 2014 specific fatal injury rate was equal to 0,07 fatalities per 1 mln. tons of produced coal, i.e. it was consistent with the figures of the EU member states. Since a zero-accident corporate programme is the element of long-term planning, the role of the top management of organization is especially important in promotion of the concept (vision) of potential preventability of occupational accidents. There is an apparent danger of discrediting the concept among the employees if it is not supported by real (though gradual) results. Thus, at the first stage of implementation of the program it is reasonable either to focus on gradual decrease of relative figures of fatal injury rate per 1 mln. worked hours (per 1 mln. tons of produced coal), or on decrease of Lost Time Injury Frequency Rate (LTIFR). The results may be used when developing and/or improving the OSH strategy of coal mining enterprises, as well as in training programmes on OSH issues in coal mining sector.

Keywords: coal mining, occupational safety and health, 'zero accident vision', coal seam, multiple seam.

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INTRODUCTION

As noted in series of publications in the last years, there are the following main strategic goals of development in the coal industry of Russia for the period until 2030^{1,2}:

- Sufficient and reliable response to the growing domestic demand for coal of the necessary quality and coal derivatives;
- Further consolidation of positions on the foreign markets without sacrificing and, possibly, with increase of coal export by 20% and reorientation up to 60% of its volume to the Asian market;
- Provision of the coal production competitiveness under conditions of foreign and domestic market saturation and availability of traditional and alternative power supplies;
- Essential increase in labour productivity and coal mining safety level with decrease in harmful environmental impact.

Occupational safety and health issues at coal mining enterprises have always been sufficiently acute in Russia. Despite the evident tendency towards the decrease in the number of industrial accidents and their victims, occupational safety level in the Russian coal mining industry still causes great anxiety.

The present paper, which is of polemical character, reviews the working conditions and occupational safety in the coal mining enterprises of various countries as well as considers and analyzes the possibility of implementing “Zero Accident Vision” for coal mining enterprises. It is notable that due to relative “youth” of the concept there is a significant deficiency in legal and regulatory documents on this issue, that’s why this paper generally deals with the results of benchmarking researches.

MATERIALS AND METHODS

According to the figures of the Federal Service for Environmental, Technological, and Nuclear Supervision (Rostekhnadzor) there were 8 incidents at the coal mining enterprises in 2014: among them were 2 accidents with group casualties and one group casualty without accident. 10 people were injured at the incidents; 5 of them received fatal injuries. Total number of workers received fatal injuries was 26³.

Unfavorable labor conditions are the main reason of occupational diseases for the coal mining workers. Thus, in Russia in 2014 the highest level of occupational illness was observed in companies representing the coal mining sector (19,3 people per 10 thousand of the employees, including coal mining, lignite mining and peat digging – 79,7, underground coal mining – 130,0), while among the reasons of occupational pathology the leading role is played by unsatisfactory labor conditions – at the coal mining, lignite mining and peat digging enterprises 80,2% of the employees are occupied at the working places with harmful and (or) hazardous labor conditions⁴.

In 2014 exactly coal mining, lignite mining and peat digging enterprises had the greatest number of employees who were paid at least one kind of compensation for working under harmful or hazardous conditions, equal to 84,3%.

Economic losses for enterprises, caused by unfavorable labor conditions and industrial accidents, are rather detrimental to the coal mining cost and eventually to the compatibility of the coal products on the domestic and foreign markets. In the current context the focus of financial resources on the activity areas of the company, which are characterized by the maximum value of decrease in the injury rate and occupational diseases per cost unit, should be deemed the primary way of minimizing the influence of unfavorable economic tendencies on the occupational safety at the enterprises of mineral resources sector. These are the following areas: development of scientifically based methods for analysis of consequences of occupational diseases and accidents; increase in the effectiveness of the system of control over the condition of occupational safety and health and environmental protection; active involvement of the enterprise personnel into the functioning of the system of control over occupational safety and health and environmental protection; organization of executive cooperation of peripheral staff and line management with the top management; improvement of quality of training the safety provision methods by means of implementation of innovative technologies⁵.

The research completed in 2015 conducted under the aegis of the European Agency for Safety and Health and devoted to the benchmarking initiatives in the field of occupational safety and health for the European Union Member States, served the purposes of solution of the above mentioned tasks⁶.

Among the basic 11 initiatives, stated in the research, 3 relate to the approach, which is called Zero Accident Vision (ZAV) in modern scientific publications:

- Zero Accident Forum, Finland
- Zero Accidents Network, the Netherlands
- Initiatives of ArcelorMittal metals company, Luxembourg holding in its strategy to the principle of a 'journey to zero accidents'.

The Zero Accident Vision suggests that ideally all occupational accidents are considered as preventable and thus, modern systems of control over occupational safety and health and environmental protection created at the enterprises, focus exactly on prevention of accidents and casualties.

Exactly this approach (Vision Zero) is currently considered as the basis for formation of strategies and goals in the context of development of safety culture at production site⁷.

The importance of implementation of this approach for enterprises within the territory of Russia is confirmed by the fact that the measures of the standard government program of a constituent entity of the Russian Federation aimed at improvement of labor conditions and safety for the period from 2015 till 2017 provide development and implementation in the enterprises of a constituent entity of the Russian Federation the programs of "Zero Injury" based on the principles of responsibility of the management and each employee for safety, observance of all mandatory labour protection requirements, involvement of employees into the occupational safety and health engineering, provision of detected hazards, estimation and control over the occupational risks, conduction of regular safety audits, ongoing training and informing the personal regarding occupational safety⁸.

RESULTS AND DISCUSSION

Nevertheless, for coal mining enterprises (both in Russia and abroad) the Zero Accident Vision though can be proclaimed, but should be implemented carefully and consistently considering the peculiarities and hazards of coal mining operation. Consider some examples on this thesis.

1. According to the figures of researches carried out by the BP company⁹ about a half of the world coal mining – 46,9% is accounted for by China (the rest of the world has significantly less percent in this rating: USA – 12,9%, Indonesia – 7,2%, Australia – 7,1%, EU member states – 6,6%, India – 6,2%, Russia – 4,3%). However there is currently no information on the results of implementation of the corporate programs of "Zero Injury" at the coal mining enterprises of China, and moreover there are significant difficulties in acquisition of objective evidence of the number of accidents at the coal mining enterprises of China (e.g., there is no such information in the database of the International Labor Organization (LABORSTA)¹⁰).

2. In late 2015 under the aegis of the Partnership for European Research in Occupational Safety and Health (PEROSH) the project on the factors contributing to successful implementation of "Zero Injury" programs was carried out¹¹. During 2013-2015 the experience of 27 European companies releasing corporate programs of "Zero Injury" and working in such economic sectors as construction and manufacture was studied. It is characteristic that among the investigated organization there was no one working in the field of mineral production.

3. The data on occupational accidents at the coal mining enterprises of the statistical services of the European Union (Eurostat) can indirectly witness the difficulties of quick and successful implementation of Zero Injury programs at the coal mining enterprises (Table 1, Table 2)^{12, 13}:

Table 1: Dynamics of the number of accidents (without fatalities) at the organizations of coal mining sector in the EU member states

Countries/years	2009	2010	2011	2012	2013
Poland	2 266	2 201	1 930	1 766	1 571
Spain	2 624	2 256	1 798	1 690	1 372
Germany	558	520	430	272	297
Slovakia	7	0	1	0	203
Great Britain	290	224	282	271	157
Romania	281	241	182	159	111
Slovenia	117	115	78	110	89
Hungary	2	3	2	1	84
Bulgaria	61	62	68	59	63
Italy	42	45	25	39	34
Finland	0	0	18	0	32
Norway	128	28	140	100	24
Czech Republic	543	449	516	17	0

Table 2: Dynamics of the accidents with fatalities at the organizations of coal mining sector in the EU member states

Countries/years	2009	2010	2011	2012	2013
Poland	36	15	18	16	8
Spain	2	1	6	1	6
Germany	0	0	1	2	1
Slovakia	0	0	0	0	1
Great Britain	3	1	6	0	0
Romania	4	1	7	3	0
Slovenia	0	0	0	0	0
Hungary	0	0	0	0	0
Bulgaria	3	1	1	1	7
Italy	0	0	0	0	0
Finland	0	0	0	0	0
Norway	0	0	0	0	2
Czech Republic	1	2	7	5	0

Table 3 shows the common figures of the occupational fatal injury rate at the organizations of coal mining sector in several EU member states during 2013. The table is based on information sources^{9, 13}.

Table 3: Absolute and relative figures of occupational fatal injury rate at the organizations of coal mining sector in several EU member states for the period from 2012 till 2013.

Country/figure	Number of accidents with fatal injuries (2012/2013)	Output, mln. tons* (2012/2013)	Specific figure of fatality, people./mln. t (2012/2013)
Poland	16/8	58,8 /57,6	0,27 / 0,14
Spain	1/6	2,5 /1,8	0,40 /3,33
Germany	2/1	47,8 /44,7	0,04 /0,02
Bulgaria	1/7	5,5 /4,7	0,18 /1,49

* million tons of oil equivalent

Based on the tables above, alongside with the absolute figures of occupational injury rate, relative figures per 1 mln. tons of produced coal are rather informative. The last figure is characterized by significant inconsistency within the EU member states; notably that in 2012-2013 it was minimal for Germany.

4. The data of the Australian government agency Safe Work Australia also give evidence of rather gradual and inconsistent decrease in the figures of occupational injury rate and occupational illness at coal mining enterprises (Table 4)^{14, 15}. It is notable that for the recent decade in Australia strong measures have been taken in order to prevent occupational injuries and increase the safety level in industries. For example, the Towards Zero Strategy of the Western Australia province is being successfully implemented; it is aimed at preventing road traffic incidents¹⁶. There is also Zero Harm at Work Leadership Program developed in Queensland.

Table 4: Figures of occupational safety for coal mining enterprises of Australia

Figure/years*	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014
The number of occupational injuries and occupational diseases per 1 million of man-hours of work (not including fatalities)	7,4	7,0	7,4	9,1	6,7
The number of occupational injuries and occupational illnesses per 1000 workers (not including fatalities)	16,2	15,6	16,4	20,1	14,3

* The periods under review: from 1 July of the previous year till 30 June of the current year

Considering the state of occupational safety and health and environmental protection at coal mining enterprises of the Russian Federation it is notable that recently the series of leading enterprises implement corporate programs which are close in their concept to the Zero Injury. The most distinctive examples of them are the following:

1. The policy in the sphere of occupational safety and health and environmental protection of the “Vorkutaugol” joint-stock company, which is an affiliate of the “Severstal” group, sets the strategic goal of the company development – to perform consistent work without fatalities since 2015 on the basis of implementation of the best international practice in the sphere of occupational safety and health and environmental protection¹⁷.

2. Joint Coal Company “Yuzhkuzbassugol”, OJSC joining the “Evraz” company, establishes the goal “Zero Fatalities and Severe Injuries”. In 2014 one might observe quarterly increase in LTIFR¹⁸ (Lost Time Injury Frequency Rate), which resulted in decrease by 18% at the end of that year to the figures of the previous 2013, which corresponds to the established goal to ensure long-term tendency towards the decrease of this figure¹⁹. In general the measures taken throughout the Russian Federation (implementation of modern systems of control over occupational safety and health and environmental protection, supervisory measures, improvement of labor protection culture, Zero Accident Vision corporate programs etc.) allow decreasing accident and fatal injury rates in coal mining industry. Table 5 shows the dynamics of fatal injury rates both in absolute values and per 1 mln. tons of produced coal for the period from 2005 till 2014³. It is notable that during 2014 specific fatal injury rate in this area was equal to 0,07 man/mln. t. (in 2005 this figure was 0,36 people/mln. t., in 2010 – 0,41 people/mln. t.), i.e. it is consistent with the figures of the EU member states.

Table 5: Dynamics of Accident and Injury Rate at the coal mining sites of Russia

Years	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Number of Accidents	27	23	21	12	9	22	13	16	11	8
Number of Fatalities	107	68	232	53	48	135	46	36	63	26
Specific Figure of Fatal Injury Rate, people / mln.t	0,36	0,23	0,73	0,16	0,15	0,41	0,13	0,10	0,17	0,07

CONCLUSIONS

Summarizing the factors of successful implementation of Zero Injury corporate programs^{6, 7, 11, 20, 21, 22, 23} one may make the following preliminary conclusions regarding applicability of these programs at the coal mining enterprises of Russia.

1. Speaking about interconnection of the Zero Injury programs and the system of control over occupational safety and health and environmental protection at the organizations, then such programs are usually a part of the control system, while the measures aimed at solution of this task are included in the long-term agenda on decrease and elimination of risks of occupational injuries²⁴. In this regard the role of the top management of organization is especially important in promotion of the concept (vision) of potential preventability of occupational accidents. Therewith there is an apparent danger of discrediting the concept among the employees if it is not supported by real (though gradual) results. Thus, at the first stage of implementation of the program it is reasonable either to focus on gradual decrease of relative figures of fatal injury rate per 1 mln. worked hours (per 1 mln. tons of produced coal), or on decrease of LTIFR. For example, in the last five years LTIFR at the enterprises of the SUEK-Kuzbass company has decreased from 2,66 to 1,50.

2. Another important factor is interconnection of provision of the employees with the information about Zero Accident Vision and the representation form of this program for the peripheral staff (underground miners, breakage face miners etc.), i.e. for the groups of employees who constantly face with the risks of occupational injuries. Often the safety requirements are accompanied with the pictures, showing right and wrong behavior in various situations, as well as educational video films, simulation exercises and the other forms. An important factor of success is company's own logo for the program and its recognizable motto.

3. Organization of audits of employees' safe behavior, carried out by the audit functions together with the representatives of the employees' authorities (labor union). The main goal of these audits is not in the imposition of disciplinary penalties on the violators, but in the revelation of the core reasons inducing employees to ignore the safety requirements.

4. If necessary, to reconsider the corporate policy in the sphere of occupational safety and health and environmental protection focusing on the aspect of involvement of the employees in the managerial activities, including – through the activities of the committees (labour protection commissions). Experience has proven that the employees participating, for example, in the work of risk assessment teams, begin considering the occupational safety issues not only as the set of instructions to be signed, but as a real process which they can influence and bear responsibilities for its results.

Taking measures for active involvement of employees into the process of safety control it should be noted that these measures cannot bring immediate effect. As a rule, real decrease in the figures of occupational injury rates, including microtraumas, is shown in 2-3 years after the initial involvement of the employees.

5. It is notable to underline the importance of the Zero Injury program implementation in the context of influence of coal seam development flow diagrams on the mine safety. For example, the factors complicating operations in the areas of overburden stress are danger of mine bumps (sudden bursts) formation, destabilization of openings and their interfacing with longwalls, formation of breakouts and coal spill in the longwall face space. Negative influence of the factors can be complex; at this the most complicated conditions are formed at intense development of gas seams prone to spontaneous ignition. Provision of high loads at mining faces at necessary safety level of mining operations in such conditions, especially at implementation of "mine-longwall" structure, imposes special requirements to the quality of the projects on development of the seams.

A series of researches on the influence of flow diagrams' parameters of development of the flat gas seams formations on the effectiveness and safety of mining operations, allowed developing the set of recommendations for the provision of effectiveness and safety of the seams development under conditions of their mutual influence²⁵⁻²⁷.

6. With the purpose of current acquaintance with the best practices in the sphere of occupational safety and health and environmental protection, including benchmarking, we recommend using the following information resources on a regular basis (Table 6):

Table 6: Zero Accident Vision Internet Resources

Source	Link
Finnish Zero Accident Forum	http://www.ttl.fi/en/safety/occupational_accidents/zero_accident_forum/pages/default.aspx
Zero Accidents Network in the Netherlands	http://www.zeroaccidents.nl/over-het-netwerk/about/
German Zero Accident Forum	http://www.dguv.de/webcode/d664972
Polish Safety Leadership Forum	http://www.ciop.pl/CIOPPortalWAR/appmanager/ciop/pl?nfpb=true&_pageLabel=P30002831335688236754
The Zero Harm at Work Leadership Programme by the Workplace Health and Safety Queensland	http://www.safeworkaustralia.gov.au/sites/swa/australian-strategy/case-studies/pages/zero-harm-at-work
Zero Accident Campaign (ZAC) by the Korea Occupational Safety and Health Agency (KOSHA)	http://english.kosha.or.kr/english/content.do?menuId=6150

REFERENCES

- [1] Session of the Government of the Russian Federation “On the Long-Term Program of Development of the Coal Industry of Russia for the Period till 2030. <http://www.ugolinfo.ru/Free/052014.pdf>. Date accessed: 12/06/2015.
- [2] Plakitkina LS. Coal industry in Russia: State-of-the-Art and growth prediction through 2035. *Mining Journal*. 2015; 7(1), 59-65.
- [3] Annual Report on the activities of Federal Service for Environmental, Technological, and Nuclear Oversight in 2014. http://www.gosnadzor.ru/public/annual_reports/%D0%93%D0%94%202014.pdf. Date accessed: 05/01/2016.
- [4] Report on Implementation of Government Policy in the Area of Labor Conditions and Safety in the Russian Federation in 2014. <http://www.rosmintrud.ru/docs/mintrud/salary/24>. Date accessed: 05/01/2016.
- [5] Gendler SG, Rudakov ML, Samarov LY. Experience and prospects of occupational and industrial safety control in mineral mining and processing. *Mining Journal*. 2015; 5(1), 84-87.
- [6] Review of successful occupational safety and health benchmarking initiatives. <https://osha.europa.eu/en/tools-and-publications/publications/report-eu-osha-review-successful-occupational-safety-and-health/view>. Date accessed: 07/01/2016.
- [7] Five pillars for a culture of prevention in business and society – Strategies on safety and health at work 2nd International. <http://www.dguv.de/iag/veranstaltungen/strategiekonferenz/2011/index-2.jsp>. Date accessed: 07/01/2016.
- [8] Letter of the Ministry of labour and social security of Russia No.15-3/10/П-4574 dated 14 August 2014 “On Development of Draft of Government Program of a Constituent Entity of the Russian Federation (Sub-Program of the Government Program) on Improvement of Labor Conditions and Safety for the period from 2015 till 2017. <http://www.rosmintrud.ru/docs/mintrud/salary/16>. Date accessed: 05/01/2016.
- [9] BP statistical review of world energy. <http://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/coal-review-by-energy-type/coal-production.html>. Date accessed: 06/01/2016.
- [10] LABORSTA, an International Labour Office database on labour. <http://laborsta.ilo.org/STP/guest>. Date accessed: 11/01/2016.
- [11] Success Factors for the implementation of a Zero Accident Vision (ZAV). <http://www.zeroaccidents.nl/publicatie-onderzoek-succes-factors-for-the-implementation-of-a-zero-accidents-vision-zav/>. Date accessed: 09/01/2016.
- [12] European statistics on accidents at work (ESAW) 2012 edition Summary methodology. <http://ec.europa.eu/eurostat/en/web/products-statistical-working-papers/-/KS-RA-12-002>. Date accessed: 09/01/2016.
- [13] European Commission. <http://ec.europa.eu/eurostat/data/database>. Date accessed: 02/01/2016.
- [14] Work-Related traumatic injury fatalities. <http://www.safeworkaustralia.gov.au/sites/swa/about/publications/pages/work-related-traumatic-injury-fatalities-australia-2014>. Date accessed: 11/01/2016.
- [15] National data set for compensation-based statistics (NDS). <http://www.safeworkaustralia.gov.au/sites/swa/statistics/pages/statistics>. Date accessed: 02/01/2016.
- [16] Towards Zero: Western Australia’s Road Safety Strategy for 2008-2020. <http://rsc.wa.gov.au/Towards-Zero>. Date accessed: 02/01/2016.
- [17] Health, safety and environmental policy of the “Severstal” company. <http://www.vorkutaugol.ru/rus/csr/politics/index.phtml>. Date accessed: 09/01/2016.
- [18] Lost time injury frequency rates. <http://www.safeworkaustralia.gov.au/sites/swa/statistics/ltifr/pages/lost-time-injury-frequency-rates>. Date accessed: 09/01/2016.
- [19] Health and Safety: EVRAZ. http://www.evraz.com/ru/sustainability/health_and_safety/health_and_safety/?print=Y. Date accessed: 09/01/2016.
- [20] Policy statement of the SUEK-Kuzbass, OJSC in the Sphere of Occupational Safety. <http://www.suek.ru/assets-operations/industrial-safety-and-health/>. Date accessed: 09/01/2016.



- [21] Cudworth A. The positive impact of communication on safety at Shell. *Strategic communication management*. 2009; 14(1), 16-19.
- [22] Drupsteen L, Groeneweg J, Zwetsloot GIJM. Identifying critical steps in learning from incidents. *Journal of Occupational Safety and Ergonomics*. 2013; 19(1), 63-77.
- [23] Zwetsloot GIJM, Aaltonen M, Wybo JL, Saari J, Kines P, Op de Beeck R. The case for research into the zero accident vision. *Safety Science*. 2013; 58(1), 41-48.
- [24] Occupational health and safety management systems – Requirements. <http://www.bsigroup.com/en-GB/ohsas-18001-occupational-health-and-safety/>. Date accessed: 09/01/2016.
- [25] Kazanin OI. Foundation of longwall panels parameters for multiple seam longwall mining. *Mining Informational and Analytical Bulletin*. 2014; 10(1), 12.
- [26] Kazanin OI. Underground multiple gassy coal seam mining design features. *Proceedings of the Mining Institute*. 2015; 215(1), 38-45.
- [27] Ahmadzadeh TR, Pourbakhshian S, Pouraminian M. Admixing PET for the safety of Earth dams. *Indian Journal of Science and Technology*. 2014; 7(12), 1950-1955.