

# Technique of an Assessment of Industrial Safety of Paint and Varnish Productions

E V Omelchenko<sup>1</sup>, E A Trushkova<sup>1</sup>, S L Pushenko<sup>1</sup>, S V Sitnik<sup>2</sup>, V A Firsov<sup>1</sup>

<sup>1</sup>Architectural and construction academy of the Don State technical university  
st. Socialisticheskaya, 162, Rostov-on-Don, Russian Federation, 344000

<sup>2</sup>Rostov State transport university  
sq.Rostov Rifle Regiment of the National Militia, 2, Rostov-on-Don, Russian Federation, 344038

E-mail: ayurvedaom@mail.ru

**Abstract.** In article the technique of an assessment and the analysis of industrial safety of paint and varnish productions is described, the main measures of prevention, the main reasons for traumatism and action for decrease in risks of influence of dangerous and harmful production factors on workers are given.

## 1. Introduction

Industrial traumatism, now, despite introduction of technologies, more modern and safe for the person, represent a considerable problem in all industries. The organization of work in the sphere of ensuring industrial safety of a production activity consists in a choice and formation of such structure of management at the enterprise which in the best way would correspond to performance of the main task - to creation of safe and healthy working conditions for the working personnel.

## 2. Technique

We developed a technique of an assessment of fire safety of paint and varnish productions on the example of the paint and varnish enterprise JSC “Empils” of Sochi of Krasnodar area, the analysis of a security status and labor protection of this paint and varnish production was made.

The technique includes the following stages: an assessment of number of the personnel of the enterprise for a group sign, the analysis of the reasons of operational injuries, an assessment of influence of harmful and dangerous production factors, definition of degree of professional risk, a quantitative assessment of conditions of activity on factors of harm and injury risk, an assessment of security of means of individual protection (MIP), development of measures of prevention for ensuring industrial safety.

According to investigation phases by us it was established that the number of the personnel in 2014-2016 years. I increased on 48 people in connection with increase in production. The analysis of personnel structure showed that the greatest number of the personnel – workers, men, at the age of 30-40 years. At the enterprise workers with an experience of 10-20 years and prevail over 20 years. Presence of the skilled personnel promotes increase not only prestige of the enterprise, but also affects the level of safety of production.



The analysis of a condition of industrial safety and labor protection of the organization is carried out according to statistical and accounting reports for 2014 - 2016 years. Were the main reasons for traumatism in JSC "Empils": the organizational; the operational; design violations. The analysis of a condition of working conditions was carried out according to certification of workplaces on the basis of an assessment of influence of harmful and dangerous production factors. The major factors influencing workers of JSC Empils were: chemical factor; microclimatic conditions; noise; radiations; illumination; weight and intensity of work [1-10].

Distribution of workplaces of painters on classes of working conditions on JSC "Empils" following: optimum and admissible working conditions fall on 38% of workplaces; for 34% - harmful to the first degree; for 28% - harmful to the second degree. The greatest contribution on increase of a class of working conditions on workplaces is made by such production factor as weight of work. Working conditions with a class 3.1 and 3.2 are established for 62% of workplaces.

The analysis of results of certification of workplaces which is carried out on JSC "Empils" allowed to define concrete workplaces which are subject to influence of harmful production factors, these factors have the prevailing value and are shown more that gives the grounds further properly to control observance of requirements of labor protection, in those productions which have most a high risk [2]. A measure of the actual danger of each operation is the frequency of emergence of a dangerous situation of traumatizing workers.

The method of arrangement of priorities allows to define degree of professional risk [3]. At calculation of risk of influence of harmful and dangerous production factors, depending on a class of working conditions on workplaces of painters with high risk, the major factor introducing this risk is revealed, it is weight of work. On the offered strategy of management the risk with high is reduced to an average [2].

It is established that working at the paint and varnish enterprises organize the work according to employment policies and procedures. The persons which passed preliminary medical examination, induction and primary instructing in labor protection on a workplace and who passed examination in the profession are allowed to these works. Persons under 18, pregnant women and nursing mothers aren't allowed to works with the paints and varnishes containing toxic substances, solvents and lead connections. The quantitative assessment of conditions of activity on factors of harm and injury risk on life expectancy of the painter showed reduction of life expectancy for 5,5 years. The maximum (maximum permissible) mass of combustible liquids, safe for people, vapors of easily flammable liquids (EFL), kg, at explosion of explosive mix in JSC "Empils" is determined by a formula:

$$m_p^e = \frac{150 V_f \rho_a (t_a + 273)}{Q_L^p z} \quad (1)$$

where  $V_f$  - the free volume of the room,  $m^3$ ;  $\rho_a$  - air density indoors before explosion at a temperature of  $t_a$ ,  $kg/m^3$ ;  $Q_L^p$  - the lowest warmth of combustion of substance,  $J/kg$ ;  $z$  - the fuel share in explosion accepted for the painting camera - 0.3; for shop - 0.5.

Recognizing that the operator of production of JSC "Empils" works in electrowire footwear at a floor with an electrowire covering, the persons having the III qualification group on electrical safety, instructed about strict observance of measures of fire safety, acquainted with ways of a call of fire protection and able to apply practically available fire extinguishing means to elimination of the fires and fire are allowed to work on service of installation of manual [11].

All works connected with preparation of paint and varnish mixes, and also with dilution by their solvents are carried out strictly according to technological instructions in the special, well ventilated room. It is forbidden to apply paints and varnishes and solvents of unknown structure, to replace one solvents with another, not provided technical processes in compliance with Safety Rules "A safety rule of paint and varnish productions".

Apply materials which fire-dangerous characteristics - flash temperature, temperature limits of ignition, spontaneous ignition temperature, tendency to self-ignition, weight or volume area of ignition, toxic properties and precautionary measures at their application - are specified in standardly - technical documentation (Set of Rules 2.13130.2009) to painting works. The analytical passports attached to each consignment of paints and varnishes, powder polymeric paints, solvents, hardeners, semi-finished products for preparation of the washing, degreasing and polishing structures, contain data on percentage of extremely dangerous substances and flying part on separate components. Painting sites and platforms are equipped with effective local ventilation and have protections of an explosive zone. Coloring is made only in the rooms equipped stitched - exhaust ventilation according to the Set of Rules 7.13130.2009. All painting equipment (sprays, tanks) is grounded. As dangerous factors of the fire at the paint and varnish enterprises are: explosion - and fire danger of vapors of solvents and paints; compressed air; toxic components of paints and varnishes, lighting in preparatory and painting offices it is carried out in fire and explosion safe execution. Manual electropainting installations have so that possibility of mechanical damage of a cable for tension supply to a spray of paint supply and air hoses was excluded. The delivery tank with paint have out of the painting camera. Surfaces of the high-voltage equipment are kept clean. In the presence on its surface of dust and impurity installation isn't included. Cleaning is made by the electrotechnical personnel. Giving of a high voltage on the electropainting camera is followed by simultaneous automatic signals: the shining banners with inscriptions light up located at an entrance door, at an aperture and near the control panel: "The high voltage is included", "Not to enter". All works connected with repair of the painting equipment are made at the removed stress. The working zone is provided with fire-prevention posters and inscriptions. In case of the fire or its signs (emergence of a smoke, characteristic smell) it is immediately reported about fire or the fire in fire protection and start fire extinguishing. Fire extinguishing is made carbon dioxide fire extinguishers, the small centers of a flame liquidate use of sand or covered from nonflammable materials. At emergence of situations, according to the Set of Rules 1.13130.2009 which can lead to accident and accidents, stop work, disconnect supply of electricity, bring out of a dangerous zone of people, delete explosive and flammable materials and the equipment and report about the arisen situation to the master or the foreman [12-15].

High degree of protective efficiency and convenience at operation are provided by means of protection (overalls cotton; boots leather; mittens with slips; the headdress (takes); when coloring by an dip method an apron rubberized; rubber gloves; a gas mask, a jacket cotton on the warming laying; trousers cotton on the warming laying).

As the assessment of fire safety of the enterprise is part of system approach to decision-making, procedures and practical measures in the solution of problems of management of process of safety, a basis of a technique were the physical and mathematical modeling of the most technical system and its working processes including interactions of the main components of system, operators, the personnel with environment in regular and emergency situations. In the analysis of fire safety by the developed technique scenarios of emergence and development of accidents and accidents with application of the main defining equations and criteria of mechanics, physics with implementation of a complex of works on safety at all stages of life cycle of technical systems are formed and described:

- development of measures of protection from the fires, accidents and accidents;
- monitoring of danger of functioning in the field of industrial safety;
- extension of a resource of safe operation;
- modernization in process of increase of safety requirements;
- a safe conclusion from operation, storage and utilization of elements of the technological scheme.

Information on fire risk received during research of paint and varnish production is a basis for management of risk – development and optimization of organizational and technical actions for decrease in risk up to the set size (table 1). A problem of management of risk is development of plans of action for decrease and control of risk, an operating time of alternative options, and also an assessment of efficiency of these plans and development of recommendations for adoption of administrative decisions, up to refusal of the planned activity. The results are shown in Table 1.

**Table 1** – Main types of accidents, factors of danger and a consequence of accidents on dangerous components of JSC "Empils"

Type of accident	Dangerous factors	Consequences of accidents
1. Dangerous components of this object on which turn out, used, processed, are stored, transported, destroyed dangerous substances		
<ul style="list-style-type: none"> <li>– the destruction of gas pipelines, failure of the gas equipment which caused emission of natural gas with its subsequent fire (jet burning, explosion of air-gas mix);</li> <li>– the explosions of gas in fire chambers and gas flues of coppers, devices which caused them local destructions or shutdowns;</li> <li>– destruction of tanks, pipelines, devices with flammable and (or) combustible liquids, failure of the equipment about EFL and combustible liquids (CL), which caused emission of combustible substances, formation of a zone of flood with its subsequent ignition, explosion of air-gas mix</li> </ul>	<ul style="list-style-type: none"> <li>– dangerous factor of mechanical influence (fragments and splinters of the equipment, communications, excessive pressure);</li> <li>– dangerous thermal factor (burns);</li> <li>– dangerous toxic factor (emissions of dangerous substances, formation of toxic products of incomplete combustion)</li> </ul>	<ul style="list-style-type: none"> <li>– infliction of harm to health of the personnel;</li> <li>– death of the personnel;</li> <li>– material damage – infliction of harm and (or) destruction of property of natural and legal entities;</li> <li>– ecological damage</li> </ul>
2. Dangerous components of this object on which the equipment working under excessive pressure more than 0.07 MPas is used		
<ul style="list-style-type: none"> <li>– destruction or damage (gap) of devices, units, the pipelines working under pressure;</li> <li>– explosion of the vessels working under pressure</li> </ul>	<ul style="list-style-type: none"> <li>– dangerous factor of mechanical influence (fragments and splinters of the equipment, communications; excessive pressure);</li> <li>– dangerous thermal factor (burns, frostbites)</li> </ul>	<ul style="list-style-type: none"> <li>– infliction of harm to health of the personnel;</li> <li>– death of the personnel;</li> <li>– material damage – infliction of harm and (or) destruction of property of natural and legal entities;</li> <li>– ecological damage</li> </ul>
3. Dangerous components of this object on which permanently installed load-lifting mechanisms are used		
<ul style="list-style-type: none"> <li>– destruction or damage (deformation) of a metalwork of load-lifting cars or their elements;</li> <li>– falling of load-lifting cars;</li> <li>– falling of freight</li> </ul>	<ul style="list-style-type: none"> <li>– dangerous factor of mechanical influence (fragments of the equipment, designs, communications);</li> <li>– dangerous electric factor (defeat by electric current)</li> </ul>	<ul style="list-style-type: none"> <li>– infliction of harm to health of the personnel;</li> <li>– death of the personnel;</li> <li>– material damage – infliction of harm and (or) destruction of property of natural and legal entities</li> </ul>

On the basis of the developed technique the analysis of engineering calculations is carried out and the complex of organizational, sanitary and household, treatment-and-prophylactic and technical actions for improvement of working conditions in the construction organization is offered [4,16,17].

The shown technique is a fundamental element of a basis of insurance protection, and assessment of fire safety is not a casual event, but legally reasonable condition here. The general logical sequence of steps (actions) to methodologies consists of performance of the following stages:

1. Justification of the purposes and tasks of the analysis of industrial safety.
2. Planning and organization of works.
3. Analysis of technological features of production object.
4. Identification of sources of risk and conditions under which they can make negative impact.
5. Determination of frequency (or probabilities) emergence of undesirable events.
6. Definition of characteristics of sources of influence of dangerous factors (totals, intensity and duration: emissions, drains, energy allocation) for all range of undesirable events.
7. Justification of models and calculation of existential transfer and distribution of initial factors of danger in environment.
8. Creation of fields of potential risk round each of the allocated danger sources.
9. Calculation of straight lines and indirect consequences (damages) of negative impact of sources of danger on various subjects (recipients) or groups of risk.
10. Estimation of fire risk. Calculation of indicators.
11. Comparison with criteria of the acceptability and assessment of the importance of a technique.

The assessment of sizes of the specified factors was carried out on the basis of the analysis of the physical phenomena proceeding at fire-dangerous situations, the fires, explosions (table 2). The results are shown in Table 2.

**Table 2** – Results of calculation of areas of coverage of the major striking factors at jet burning of the expiring compressed gas (a horizontal torch)

Pressure in the device, MPa	Diameter of an opening, mm	Mass expense of the expiration of gas G, kg/s	Torch length at jet burning	Torch width d, m	Area of defeat of the person in a horizontal torch, area of impact of a horizontal torch on the next equipment (30° the sector limited to the radius equal to $LF$ ), m	The zone sizes with intensity of thermal radiation from a horizontal torch of 10 kW/sq.m	Area of possible impact of the fire flash (30° the sector limited to the radius equal $LF$ ), m
до 0,03	100	1.237	13.61	2.04	13.61	20.41	13.61
	50	0.309	7.81	1.17	7.81	11.72	7.81

Thus the following processes arising at realization of accidents or being their consequences were considered (depending on type of the equipment and combustible substances addressing on object):

- the expiration of liquid from an opening at destruction of the equipment;
- spreading of liquid and formation of a zone of flood;
- evaporation of liquid from the passage;
- emission of superheated liquid at destruction of the equipment;

- formation of a gas-steam-air cloud (gases and vapors it is heavier than air);
- combustion of gas-steam-air mix in open space;
- combustion of gas-steam-air mix in processing equipment or the room;
- thermal radiation at the fire of the device, transport capacity, the passage;
- fire indoors (building).

Decisions on the prevention of emergence of accidents on components of this object as a result of possible dangerous thermal influences of a hard frost and a strong heat provided passive and active ways of protection [7,18,19].

Passive ways include use of the equipment, designs of the buildings and constructions capable to provide the functions in the conditions of the possible temperature range of environment.

Active ways include use of systems of heating, the ventilation and conditioning providing a necessary microclimate in rooms of these buildings.

### 3. Result

The analysis of risk factors, conditions of emergence of accidents and their scenarios on other objects around placement of this object of object showed – accidents on nearby the located existing objects of JSC "Empils" don't make impact on the condition of this object exceeding similar indicators at possible accidents on components of the most this object. For this object the main consequence of accidents on nearby the located existing objects of JSC "Empils" which are followed by the fires, explosions will be need of a stop of functioning of shop of varnishes for the period before the end of suppression of the fires, carrying out rescue, emergency and recovery, repair work in the territory of the enterprise and completion of investigation of the reasons of accidents. The main action for ensuring industrial safety and the prevention of accidents on this object as a result of accidents on other objects around placement of this object will be observance of gaps between the buildings, constructions established by normative documents in the field of fire and industrial safety.

### 4. Conclusions

Application of a technique of an assessment of fire safety of paint and varnish productions on the basis of data of accounting and statistical reports, allows to create the systematized complex of the actions directed on improvement of quality and working conditions to reduce risk of influence of dangerous and harmful production factors, to reduce material, social and economic production losses.

### References

- [1] Chernoplekov A.N, etc. The analysis of traumatism in construction and suggestions for improvement of working conditions.// Health and safety, 2005, No. 8. p.126-130.
- [2] Staseva E.V., Pushenko S. L., Strakhova N. A.. Improvement and increase of efficiency of the organization of labor protection in construction on the basis of a control system of risks: Monograph. Rostov-on-Don, 2012. 240 p.
- [3] Professional risk for health of workers (The management under the editorship of N. F. Izmerov and E. I. Denisov. M.: Trovant. 2003. 196 p.
- [4] Omelchenko E.V., Trushkova E.A., Sidelnikov M.V., Pushenko S.L., Staseva E. V. Algorithm research exposure dust emissions enterprises of building production on the environment //IOP Conference Series: Earth and Environmental Science. 2017 Vol. 50, Article number 012018. p. 1-5
- [5] Andreeva E E 2016 K ocenke riskov dlja zdorov'ja rabotnikov pri klassifikacii ob#ektov sanitarno-jepidemiologicheskogo nadzora i planirovanii proverok (na primere g. moskvy) Analiz riska zdorov'ju ed E.E. Andreeva 84-92 № 2 (14)

- [6] Habibulina V M 2015 Zdravoohranitel'naja politika: pragmatichnost' na osnove otkrytyh dannyh medicinskoj statistiki Materialy Mezhdunarodnoj mezhdisciplinarnoj konferencii ed V.M. Habibulina 380-390
- [7] Trushkova E.A. Harmful factors of production environment. Part I: tutorial. / E.A. Trushkova, E.V. Staseva, N.Y Volkova Rostov-on-Don: Rostov State Civil Engineering University, 2014. 103 p.
- [8] Kannel W B 1991 Left ventricular hypertrophy as a risk factor: the Framingham experience J. of hypertension 9. P. 3-9
- [9] Pushenko S.L. Health and Safety. Part 2 Production Sanitation and health: Textbook. S.L. Pushenko, D.V. Deundyak, E.V. Omelchenko, A.V. Nihaeva , A.S. Pushenko, E.A. Trushkova, E.V. Staseva, E.V. Fedina, E.S. Fil - Rostov n / D: Height. state. building. University Press, 2014. 94 p.
- [10] Denisov Je I 2013 Problema real'noj jeffektivnosti individual'noj zashhity i privnosimyj risk dlja zdorov'ja rabotnikov Medicina truda i promyshlennaja jekologija ed Je.I. Denisov, T.V. Morozova, E.E. Adeninskaja and N.N. Kur'erov 18-25 4.
- [11] Trushkova E.A. Development of measures on preventing injures and occupational diseaseson JSC 'Rostvertol' / E.A. Trushkova, N.Y. Volkova // Scientific review. 2014. 10. S. 550-553.
- [12] Zaharenkov V V 2013 Ocenka professional'nogo riska dlja zdorov'ja rabotnikov promyshlennyh predpriyatij na osnove medicinskoj tehnologii Akademicheskij zhurnal Zapadnoj Sibiri 9 ed V.V. Zaharenkov, A.M. Oleshhenko, I.P. Danilov, D.V. Surzhikov, V.V. Kislicyna and T.G. Korsakova 8. 2 (45)
- [13] Zaharenkov V V 2013 Primenenie novej medicinskoj tehnologii dlja ocenki professional'nogo riska zdorov'ju rabotnikov promyshlennyh predpriyatij Vestnik Kuzbasskogo nauchnogo centra ed V V Zaharenkov, A M Oleshhenko, I P Danilov, D V Surzhikov, V V Kislicyna, T G Korsakova and I Ju Motuz 28-30. 17
- [14] Resnik L M 1993 Ionic basis of hypertension, insulin resistance, vascular disease and related disorders Am.J Hypertens. 6. P. 123-134
- [15] Zeljaeva N V 2014 Ocenka zaboлеваemosti rabotnikov promyshlennyh predpriyatij i puti ee snizhenija (na primere predpriyatij otrasli mashinostroenija g. Nizhnego Novgoroda) Fundamental'nye issledovanija ed N V Zeljaeva 698-705. 7-4
- [16] Kislicyna O A 2015 Nezashhishhennost' v sfere truda rabotnikov v Rossii kak faktor riska plohogo zdorov'ja i povedenija s riskom dlja zdorov'ja: gendernyj aspekt Upravlenie zdravoohraneniem ed O.A. Kislicyna 66-77. 1 (43)
- [17] Artem'eva A A 2014 Ocenka vlijanija faktorov proizvodstvennoj sredy na sostojanie uslovij truda i professional'nuju zaboлеваemost' rabotnikov Federal'noe agentstvo zheleznodorozhnogo transporta, FGBOU VPO «Moskovskij gosudarstvennyj universitet putej soobshhenija (MIIT) ed A.A. Artem'eva 15-18.
- [18] Demyanova V S 2006 The disperse filled cements on the basis of lithotripsy. Ecological aspects of production M.: The Young Guard ed V S Demyanova and G N Kazin
- [19] Daviglius M.L., Liu K., Yan L.L. et al. Body mass index in middle age and health-related quality of life in order age: the Chicago heart association project in industry study. Arch. Intern. Med. 2003.Nov. 10; 163 (20):2448-55.