XIX SCIENTIFIC-EXPERT CONFERENCE ON RAILWAYS RAILCON '20

THE REVIEW OF HARMONIZED STANDARDS OF PERSONAL PROTECTIVE EQUIPMENT FOR SAFE WORK ON RAILWAY

Vesna PAVELKIĆ[1]
Dragan MAJKIĆ[2]
Marija ILIĆ[3]
Aleksandar BLAGOJEVIĆ[4]

Abstract *– Using of personal protective equipment (PPE) is often essential, but it is generally the last line of defense after engineering controls, work practices, and administrative controls. Working in the rail industry encounter many hazards, as could be expect in any heavy industry. However, there are additional hazards that are specific to the rail industry as a cosequence of activities such as working around electrical cables at a substation or any equipment connected to the system, working around overhead wiring structures, near substation cables connect to the rails, working with cranes, elevating platform vehicles, tip trucks or other plant. As required by the harmonized standards (the new PPE Regulation 2016/425 took effect on April 20, 2016 instead of the old PPE Directive 89/686 EEC for the testing and certification of personal protective equipment), PPE must be selected which will protect employees from the specific hazards which they are likely to encounter during their work on-site.Selection of the appropriate PPE is a complex process which should take into consideration a variety of factors. Key factors involved in this process are identification of the hazards, or suspected hazards; their routes of potential hazard to employees, the performance of the PPE materials (and seams) in providing a barrier to these hazards. Other factors in this selection process to be considered are matching the PPE to the employee's work requirements and task-specific conditions. The site information may suggest the use of combinations of PPE selected from the different protection levels (i.e., A, B, C, or D) as being more suitable to the hazards of the work. In this paper we presented harmonized regulation for PPE for different protection levels, as well as standardized methods for PPE testing.*

Key words – Personal protective equipment, harmonized standards, railway, testing methods

1. INTRODUCTION

Occupational safety and health (OSH) is concerned with preserving and protecting human and facility resources in the workplace helping people by preventing them from being injured or becoming ill due to hazards in their workplaces. Occupational safety and health is an extensive multidisciplinary field, invariably touching on issues related to scientific areas such as medicine – including physiology and toxicology, ergonomics, physics and chemistry, as well as technology, economics, law and other areas specific to various industries and activities. Despite this variety of concerns and interests, certain basic principles of OSH including decent working conditions and a decent working environment. More specifically work should take place in a safe and healthy working environment; conditions of work should be consistent with workers' well-being and human dignity; work should offer real possibilities for personal achievement, selffulfilment and service to society [1].

"Occupational health should aim at: the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations; the prevention amongst workers of

[1] Academy of Technical and Art Applied Studies, Department High Railway School, Zdravka Čelara 14, Belgrade, vpavelkic@gmail.com
[2] Serbian Railways Infrastructure a.d., Nemanjina 6, Belgrade, dragan.majkic@srbrail.rs
[3] Faculty of Mining and Geology University of Belgrade, Djušina 7, Belgrade, marija.ilic@rgf.bg.ac.rs
[4] Academy of Technical and Art Applied Studies, Department High Railway School, Zdravka Čelara 14, Belgrade, aleksandar.blagojevic23@gmail.com

departures from health caused by their working conditions; the protection of workers in their employment from risks resulting from factors adverse to health; the placing and maintenance of the worker in an occupational environment adapted to his physiological and psychological capabilities; and, to summarize: the adaptation of work to man and of each man to his job" [2].

Personal Protective Equipment (PPE), are the tools that ensure the basic health protection and safety of users. PPE is any device or appliance designed to be worn by an individual when exposed to one or more health and safety hazards. PPE includes all clothing and other work accessories designed to create a barrier against workplace hazards, and using PPE requires hazard awareness and training on the part of the user. Employees must be aware that the equipment does not eliminate the hazard; if the equipment fails, exposure will occur. To reduce the possibility of failure, equipment must be properly fitted and maintained in a clean and serviceable condition.

2. OCCUPATIONAL SAFETY AND HEALTH HAZARDS IN RAILWAY INDUSTRY

Occupational safety and healt in railway industry are applicable to activities typically conducted by rail infrastructure operators dedicated to passenger and freight transport. OSH cover two main areas, namely rail operations, covering construction and maintenance of rail infrastructure as well as operation of rolling stock, and, locomotive maintenance activities, including engine services, and other mechanical repair and maintenance of locomotives and railcars.

Occupational health and safety hazards during the construction of railway systems are common to those of most large industrial facilities and their prevention and control additional health and safety issues specific to railway operations include the following:

- Train / worker accidents,
- Noise and vibration,
- Diesel exhaust,
- Fatigue,
- Electrical hazards,
- Electric and magnetic fields.

Railway workers, including locomotive crews and workers in stations, rail yards, and locomotive and car shops, may be exposed to exhaust from diesel locomotives and other diesel engines. Crew members riding immediately behind the lead engines of trains (e.g. trailing locomotives) and workers in indoor turnaround areas where locomotives are usually left operating, sometimes for prolonged periods, may be exposed to particularly high levels of diesel exhaust.

Occupational hazards typically associated with locomotive and railcar maintenance activities may include physical, chemical, and biological hazards as well as confined space entry hazards. Physical hazards may be associated with work in proximity to moving equipment (e.g. locomotives and other vehicles) and machine safety, including work-portable tools, and electrical safety issues [3].

Chemical hazards may include potential exposures to a variety of hazardous materials (e.g. asbestos, PCB, toxic paint, heavy metals, and VOCs, including those resulting from the use of solvent-based paints and cleaning solvents in enclosed spaces). Other chemical hazards may include the potential for fire and explosion during the conduct of hot work in storage tank systems [4,5].

Biological hazards may include potential exposures to pathogens present in sewage storage compartments [6]. Confined spaces may include access to railroad tank and grain cars during repair and maintenance.

Dangerous goods are frequently transported in bulk orpackaged form by rail, representing a potential risk of release to the environment in the event of accidents on a number of other causes. Examples include valve leakage or safety valve releases in pressurized and general-service tank cars or other hazardous material containers (e.g. covered hoppers, intermodal trailers and containers, or portable tanks). In intermodal containers, spills and leaks may result from improper packing and resultant load shifting during transport. Additionally, there is a potential for the release of diesel during fueling operations.

2. PERSONAL PROTECTIVE EQUIPMENT UNDER REGULATION (EU) 2016/425

The PPE Directive was one of the first New Approach Directives and is now over 20 years old. PPE is currently regulated by Directive 89/686/EEC. In order to reflect current technologies and processes for developing and bringing PPE to the market, it is in the process of being superseded by a new PPE Regulation (EU) 2016/425 Within the European Union.

It covers most domestic, leisure and professional safety products, requiring all PPE products to meet Basic Health and Safety Requirements (BHSR), [7]. PPE products are classified into one of three categories, depending upon the level of risk associated with their use.

Category I - PPE in this category is designed to protect users against minimal risks. These include superficial mechanical injury; contact with water or cleaning materials of weak action; contact with hot surfaces not exceeding 50°C; damage to the eyes due to exposure to sunlight (other than during observation of the sun); atmospheric conditions that are not of an

extreme nature.

Category II - includes risks other than those listed in Categories I and III. The following products are included: Safety spectacles and goggles, Industrial helmets and bump caps, hi visibility clothing, etc.

Category III - PPE falling under this category 'includes exclusively the risks that may cause very serious consequences such as death or irreversible damage to health' Risks include: substances and mixtures which are hazardous to health; atmospheres with oxygen deficiency; harmful biological agents; ionising radiation; high-temperature environments the effects of which are comparable to those of an air temperature of at least 100 °C; low-temperature environments the effects of which are comparable to those of an air temperature of – 50 °C or less; falling from a height; electric shock and live working; drowning; cuts by hand-held chainsaws; high-pressure jets; bullet wounds or knife stabs; harmful noise.

4. PERSONAL PROTECTIVE EQUIPMENT (PPE) DIRECTIVE (89/686/EEC)

High visibility products fall within the jurisdiction of the Personal Protective Equipment (PPE) Directive (89/686/EEC) and are intended to signal the wearers' presence visually in different light conditions and make the wearer stand out from the surrounding environment. Currently there are two standards for visibility clothing and one for accessories published as Harmonized Standards in Europe. For visibility clothing, there are defined areas of fluorescent background fabric and retro-reflective material. There are also requirements for the placement of both to ensure there is 360° visibility and that the human form is recognisable. Both standards for visibility clothing ensure enhanced visibility during daylight conditions (i.e. by the use of fluorescent fabric) and also in poor lighting or in darkness (from utilising retro-reflective material).

4.1 EN ISO 20471:2013 High Visibility Clothing

The wearing of high-visibility clothing is a mandatory requirement for all persons associated with track or lineside working. Railway workers may find themselves carrying out maintenance work on track, where no trains are running – called 'green zone working'. However, much work is undertaken on active railways, during day and night, and under different weather conditions. Under such circumstances (known as 'red zone working'), the dangers are real and ever-present, and it is important that the highest levels of visibility are maintained.

The main feature of high-visibility clothing is that it is made from materials that aid conspicuity by day and night. To enhance the visibility of a wearer during the day, garments are made from fluorescent materials of standard colours. The visibility of a person is aided at night by the inclusion of retro-reflective tapes within the construction of a garment. Retro-reflective materials reflect a high proportion of light back towards its point of origin.

"EN ISO 20471:2013 High visibility clothing" was published on the 1st March 2013 and was subsequently issued as BS EN ISO 20471 in July 2013 incorporating a corrigendum. It became a harmonized standard on 28th June 2013. EN 471:2003 + A1:2007 was withdrawn on 1st September 2013.

This standard specifies the requirements for clothing intended to provide conspicuity of the wearer in any light condition. Under daylight conditions, fluorescent high visibility material is used, which provides a high level of contrast between the product and the environment in which it is to be worn. The situations in which high visibility clothing to EN ISO 20471 is worn are classed as 'high risk' and this standard is not applicable to medium-risk and low-risk.

This standard gives performance requirements for the colour and retro-reflection, as well as, for minimum areas and the placement of the fluorescent and retro-reflective materials. There are only three colours specified – fluorescent yellow, orange-red and red. There are also requirements for the colour fastness, dimensional stability, strength and the water vapour resistance of the fluorescent and any non-fluorescent materials. The retro-reflective material is tested for photometric performance as new and after a number of pre-treatments.

4.2 Fabrics

The background fabrics must now meet the chromaticity and luminance after the maximum number of cleaning cycles (or if this is not stated by the manufacturer a minimum of 5 cycles). Colour fastness to perspiration (staining) is Grade 4 (both fluorescent and non-fluorescent materials). Colour fastness to washing/dry cleaning has had the staining requirement reduced to 4 for non-fluorescent fabrics.

For fabrics other than coated/laminates, the water vapour resistance must be less than 5 m^2Pa/W. If this is exceeded, then the thermal resistance must be tested and the water vapour permeability index (WPI) determined. The WPI must be ≥ 0.15. Tabards and waistcoats are exempt from this requirement. Contrast (non-fluorescent) outer materials must now meet the mechanical property requirements. Colour fastness to hot pressing is only required in the dry condition only.

4.3 Retro-reflective material

Retro-reflective material must now be tested after a

stated number of wash/dry cycles rather than the maximum number of wash cycles with one dry at the end. If the maximum number of wash cycles is not stated by the manufacturer, the retro-reflective material must be tested after a minimum of 5 cycles. The wash temperature can be specified by the manufacturer.

5. HIGH VISIBILITY PPE CERTIFICATION PROCESS

For all categories of PPE, the manufacturer must provide information about the measures it has taken in order to ensure the conformity of the PPE to the Basic Health and Safety Requirements (PPE Directive (89/686/EEC) Annex II) in technical documentation. For intermediate and complex category products, the technical file and the product it covers must be examined by a Notified Body for Type Approval. If the product and technical documentation meet all the requirements, the Notified Body will issue an EC Type Examination Certificate. This certificate allows the article to be CE marked. For complex category products, on-going surveillance is also required.

High visibility PPE falls within the category II or intermediate category and therefore requires an EC Type Examination. For high visibility clothing, it is common practice for the suppliers' of the fabrics and retro-reflective tape to get their products tested. The garment manufacturers can then use the suppliers' test reports or test certificates for certification purposes without testing these components themselves. If the suppliers have not had their products tested, the garment manufacturer will have to commission this testing. The test reports for the components are given as part of the technical documentation to the notified body along with samples of the clothing.

6. CONCLUSION

The purpose of personal protective clothing and equipment (PPE) is to shield or isolate individuals from the chemical, physical, and biologic hazards that may be encountered. Careful selection and use of adequate PPE should protect the respiratory system, [8] skin, eyes, face, hands, feet, head, body, and hearing. No single combination of protective equipment and clothing is capable of protecting against all hazards. Thus PPE should be used in conjunction with other protective methods. In general, the greater the level of PPE protection, the greater are the associated risks. for any given situation, equipment and clothing should be selected that provide an adequate level of protection.

ACKNOWLEDGEMENT

This work was financially supported by Ministry of education, science and technological development of the Republic of Serbia under the research project: ON172015.

REFERENCES

[1] ILO. *Conclusions concerning future action in the field of working conditions and environment*, adopted by the 70th Session of the International Labour Conference, 26 June, section I. 1984.

[2] The International Code of Ethics for Occupational Health Professionals, International Commission on Occupational Health (ICOH) and features in the 2002. http://www. icohweb.org.

[3] *Mechanical vibration and shock: Evaluation of human exposure to whole-body vibration*—Part 1: General requirements, Guidance for the evaluation of mechanical shock and vibration can be found in the International Organization for Standardization (ISO) 2631-1:1997.

[4] Van Wely E, Current global standards for chemical protective clothing: how to choose the right protection for the right job? Ind Health **55**, 485 – 499. (2017).

[5] Shaw A, Coleone-Carvalho AC, Hollingshurst J, Draper M, Machado Neto JG, Development of a new test cell to measure cumulative permeation of water-insoluble pesticides with low vapor pressure through protective clothing and glove materials. Ind Health **55**, 555 – 563. (2017).

[6] Shimasaki N, Shinohara K, Morikawa H, Performance of materials used for biological personal protective equipment against blood splash penetration. Ind Health **55**, 521 – 528. (2017).

[7] https://www.csagroupuk.org/2018/01/personal-protective-equipment-regulation-2016-425/