Evaluation of personal protective equipment used for work: considerations and proposed methodology – the criteria to be checked

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Abstract: The PPE selection can be really complex; to ensure a proper selection, a methodology is proposed. This methodology is based on four categories of evaluation criteria with a process to evaluate and validate each of those criteria. This is complete because the criteria are exhaustive with their conflicts and covering the different preoccupations of all actors in the industry. Therefore it is possible to make arbitration between the different possibilities and obtain a consensus from everybody involve in the PPE selection. It is also a very efficient methodology because each criterion needs to be evaluated and validated during the different steps of the methodology.
Keywords: Personal protective equipment (PPE), selection, multi criteria, performance, compromise.

1. Introduction

Personal protective equipment (PPE) evaluation and selection are part of a larger framework: occupational health and safety and work environment management. As PPE should be used as a last resort, eliminating hazards (at the source) and collective protection must still be implemented as a first line of defense.

The main objective of this article is to propose an organized methodology to select and evaluate PPE. The strong and complex relations between humans and equipment cause issues during their evaluation and selection process. Because PPE protects a worker efficiently only if he wears it properly, it is necessary to analyze many different aspects to ensure proper selection. The fundamental aspect of this choice is to ensure the PPE was designed or is selected to protect workers from the particular risk in their work environment. The evaluation of PPE is not well covered in the literature and bad selections of PPE are still causing problems. This article focuses on the evaluation criteria to be checked.

2. Method

Partly based on 89/656/CEE directive, this methodology defines clearly concepts and criteria and proposes an approach to go over all the different interest of all persons involved at the work place. This methodology proposes an approach to evaluate and select PPE based on criteria that ensure effective use and protection of workers, and then the appropriate PPE can be determined. The first step consists of analyzing every conditions of its use: metabolism, climatic conditions and job requirements.

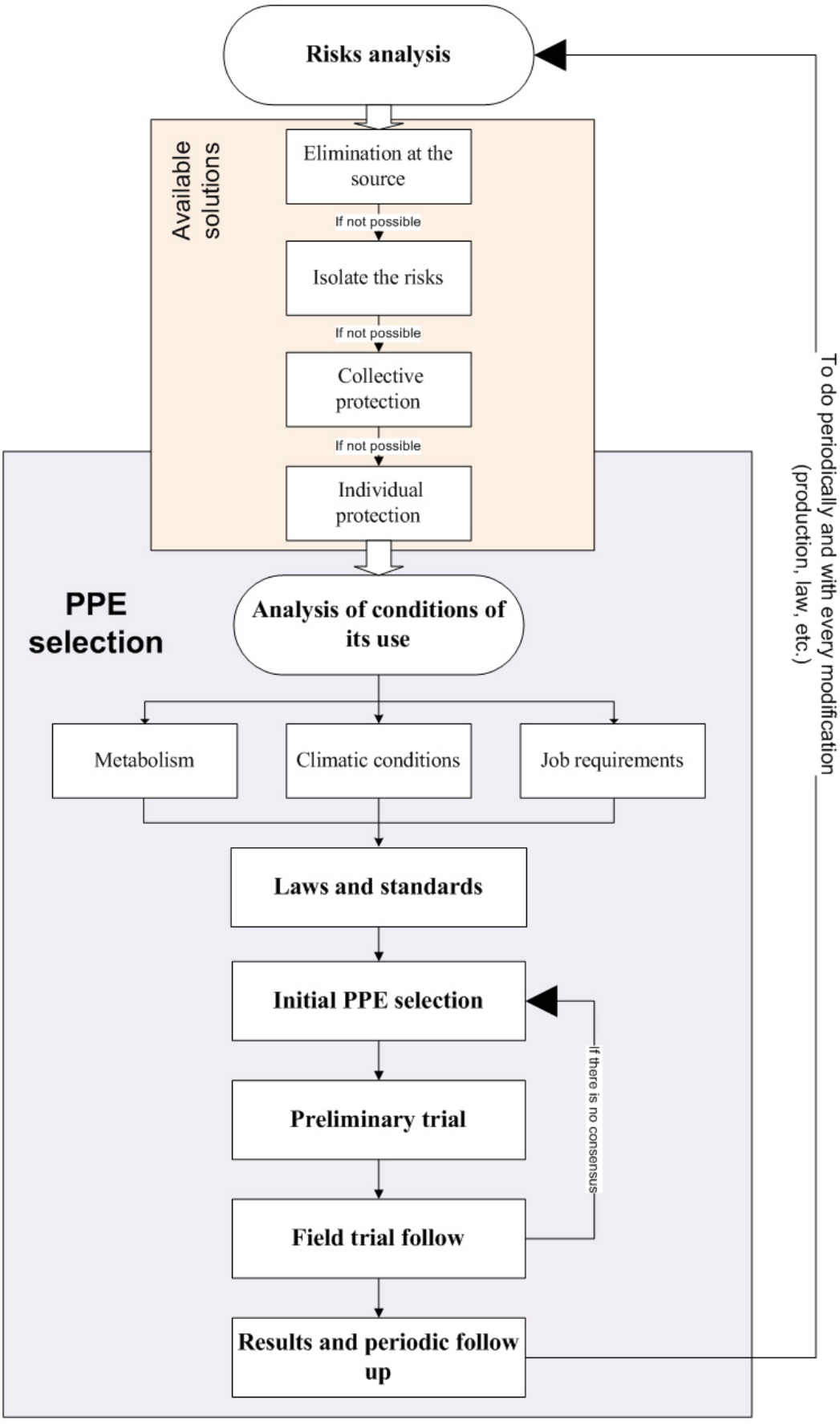

Figure 1: *PPE selection methodology*

Looking at laws and standards is also an important part of this methodology; some employers need a legal obligation to act. After, this first step, three trial stages are performed: initial PPE selection, preliminary trial and field trial follow. These stages are based on selection criteria that are evaluated or validated partially or totally at each of these three stages and therefore are evaluated at least one time during these three stages. There are four categories of criteria: performances, supplies, physic comfort and psychological comfort. When every criterion has been check and validated, the results and periodic follow up of the whole process complete the approach to select the right PPE. This methodology is illustrated on figure 1.

3. Results

Each of the four categories of criteria has been defined and the way to evaluate them has been identified. The risk evaluation, the environment particularities and the production stake must always be checked before PPE selection, when others protection devices are not enough to protect totally workers. How, with this information, choose which PPE users can wear? There are some selection guide, suppliers' catalogue and norms that help to make a first selection based mainly on efficiency, the ability to protect the user. The current evaluation methods available are normally specific to a particular PPE or a specific industry. The proposed methodology defines more precisely broader criteria and uses almost the same criteria for every PPE; the distinction is in the way to evaluate them.

The main reason why workers use PPE is to ensure a protection against one or many risks; the first category of criteria represents this function: the PPE performance. Three criteria need to be checked for the PPE performance: the efficiency, the reliability and the durability. The efficiency is defined as the realization of the protection functions without any disturbance to the bodily security, to the heath or to the safety of the user (Arteau & Giguère 1993). The reliability can be defined as the efficiency no matter to work's unanticipated unknowns, to environment conditions, to fatigue or to human factors (European Union 1989). The durability includes the solidity defined by the mechanical resistance, but globally it is the capacity to conserve its proprieties (comfort, look, protection performances, etc.) along a certain period. There are two kinds of PPE deterioration; the wear and tear like the one result from the use of a shoe and the degradation result from the environment condition like plastic with UV. The durability affects other PPE evaluation criteria like the comfort and the replacement cost.

The second category of evaluation criteria is the supplies. This category includes the cost, the availability, the accessibility and the maintenance requirement. The cost is not limited to the acquisition cost; it is the transaction cost that take account of the number of PPE, the spare pieces (if applicable), the inspection and maintenance needs, the durability (when to change it, if there is an expiration date, etc.) and the specific PPE requirement for external complement as the air system for some kind of respiratory protection devices. The PPE availability is synonym of it existence on the market; sometime, there is no PPE on the market to protect against a specific risk. The accessibility is the availability to the worker when he needs, where he needs, in the right size (if applicable) and in an acceptable delay. Finally, there are two kind of PPE for the maintenance requirement: one-time use (totally as disposable ear plug or partially as mask cartridge of a respiratory protection device) and reusable (make by

the user as cleaning the protection glasses or make by a specialist as calibration of a mask for airplane pilot).

The third category of evaluation criteria is the physic comfort. The comfort has an impact on the PPE effective wearing (Pringalle 1998). To wear properly a PPE is important to ensure the protection (Akbar-Khanzadeh et al. 1995; Arteau & Giguère 1993; Krawsky & Davillerd 1997; Pringalle 1998). Furthermore, in the accidental process, the advantage to wear a PPE occurs only if an accident happens; a rare fact, but a constant wearing. To define the comfort it is hard, to measure it, it is even harder (Vink 2005). It is bound to the sensations of ease or embarrassment when someone wears the PPE during a certain period. The activities to do and the environment conditions influence those sensations. The notion of physical comfort can be subdivided into several categories according to the elements which influence it (not exhaustive list): the thermal comfort, the adjustment, and the comfort of load and the freedom of movement. However, quite dependent on the PPE functioning and on its localization on the body, these elements can vary from a PPE to the other one. The PPE is not inevitably comfortable or uncomfortable, the range of neutrality, the grey zone, is wide. Furthermore, the discomfort is a precursor of pain, fatigue and TMS besides affecting the productivity and the workers performance (CCHST 1997). The adjustment, checks as for the mode of fixation and desirable regulation as well as a means to verify if the PPE was correctly fixed must be taken into account during the PPE evaluation (NF IN 13921 2007). A bad adjustment entails consequences both for the comfort of the user and for the protective efficiency of the PPE.

The last category of evaluation criteria is the psychological comfort, which includes the look and the conviviality. Even if it seems not important for the protection, this criteria category is important for the whole selection; this category has an impact on the PPE effective wearing. For the look, there is no miracle solution but to increase the worker acceptability, PPE should look like regular cloths. Furthermore, PPE can be used to increase the sense of belonging with logo printed on them. The PPE conviviality influences its use, its maintenance and its reliability. It can be defined as an ergonomics conception. The fact to know how to well-use a PPE results from the formation, but the usability and the reduce maintenance recover from the PPE conviviality.

4. Conclusion

Even if the four criteria categories are essential to ensure a proper PPE selection, it can be contradictory. To prioritize a criterion rather than another risk to affect is the effective protection or the real wearing. It is better to take "in consideration the method allowing specifying the best compromises between the protection, the character has a practice and the potentially fatal impact of the PPE wearing. If various solutions apply, so much compromise can be possible." It is a question of finding "the reasonable balance between the gravity of the dangerous phenomenon, the protection, the constraint and the duration" (NF EN 13921 2007). Especially since the European Directive 89/686/CEE stipulates to articles 1.1.2.1 Highest level of protection possible and 1.1.2.2 Classes of protection appropriate to different levels of risk that a lesser protection can be completely acceptable and even desirable to favour an effective wearing.

In conclusion, this approach proposes a way to evaluate and select PPE. This is complete because the criteria are exhaustive with their conflicts and covering the dif-

ferent preoccupations of all actors in the industry; the operators doesn't necessary want the same that the manager or the occupational health and safety (OSH) specialist. Therefore it is possible to make arbitration between the different possibilities and obtain a consensus from everybody involve in the PPE selection. It is also a very efficient methodology because each criterion needs to be evaluated and validated during the different steps of the methodology. This methodology has been compared with successful PPE selection process. This methodology describes and explains why these selections have been successful; it makes the PPE selection easier for everyone because it gives the process to follow up to get the right PPE.

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