ASSESSMENT OF HAND-ARM VIBRATION EXPOSURE BY MEANS ESTIMATION METHODOLOGIES: COMPARISON BETWEEN VIBRATION DATABASES (ISPESL) AND INFORMATION PROVIDED BY TOOL MANUFACTURERS

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1. INTRODUCTION

1.1. State of Implementation of Directive 2002/44/EC

Legislative Decree 81/2008 (Consolidated Act on Safety at Work) makes it compulsory to assess workers' exposure to risk through direct measurements, reference to accredited databases (ISPESL) or using emission values supplied by producers. Application of the direct measurement method is not always necessary or appropriate, due to: 1) the practical difficulty of identifying measuring conditions deemed to be representative of all actual working situations, 2) economic reasons, with the taking up of resources and time, 3) the high degree of relative uncertainty, and 4) the dearth of expert professionals in this field (Nitti et al., 2008). In this paper, we set out to cross-check and compare data obtained using the two methods, in order to gauge their reliability and to outline the pros and cons of both.

1.2. ISPESL Vibrations Database

Italian Regions (in particular Tuscany) and ISPESL have acted and are continuing to act to maintain the uniform nature of databases and insert them in a specialist Italian portal. This has led to the availability, since 1 December 2005, of a database that contains information on the vibration levels of about 1,300 work tools and 800 vehicles. The database can be consulted at the ISPESL website. As far as the ISPESL vibrations database is concerned, at least the following characteristic elements are specified: type of equipment (grinders, drills, etc.), category of equipment (rated power or size characteristics), power supply type (e.g. pneumatic, hydraulic, electric, internal combustion engine), properties of anti-vibration protection devices (handles, etc.), specific working conditions at time of measurement, speed of use (rpm, opm, etc.), type and properties of processed material.

1.3.Vibration Emission Data Supplied by Manufacturers

The first generation of harmonized technical standards on vibration emissions had been designed to satisfy the relative Essential Safety Requirements of the Machinery Directive, and to make possible comparisons between similar machines, i.e. those belonging to the same 'family'. These objectives have only been partly achieved, since the need to obtain measurements with a high degree of accuracy, repeatability and reproducibility has partly overshadowed the more important aim of informing users of residual risks. It is currently possible to compare machinery belonging to the same family, based on emission values. One of the aims of the present paper is to gauge the usefulness of these emission values. At present, however, declared emission values are often not representative of vibration levels under actual working conditions, sometimes being higher but more frequently lower.

When direct measurements and emission values are unavailable, it is possible to conduct an assessment using emission values of similar equipment, after applying correction factors given in Technical Report CEN TR 15350 for the type of equipment, for example, and the power level and supply (electrical, pneumatic or internal combustion engine). A second aim of the present paper is to gauge the reliability of this estimation method. Testing carried out by some experts in the sector, albeit limited to some families of equipment and small samples, had shown a substantial consistency between values estimated on the basis of adjusted emission values and values measured under practical operating conditions, or at least results falling within the typical accuracy range that can be obtained with measurements (Kaulbars, 2006). A study on a large scale sample of tools found that, in general, the manufacturers' declared emission data tended to underestimate the measured values under simulated workplace conditions, and adjusted emission data (after applying correction factors) tended to overestimate them (Rimell et al., 2008).

2. METHODS

Vibration emission values obtained from several difference sources - direct measurement, manufacturers' declarations, and with correction factors recommended by the CEN TR 15350 applied - were collated, cross-checked and compared. These data were analyzed, so as to describe, summarize and report on the important characteristics. The statistical Z test of means was applied to subsets of data reported by the ISPESL Database, and to relevant emission values, both adjusted (correction factors applied) and not, to compare relevant populations. Finally, linear regression analysis was done between measured vibration exposure values and declared vibration emissions, in order to test the reliability of declared values for use in ranking tools.

3. RESULTS

Vibration emission data have a statistical distribution which, as a whole, is plausibly similar to a log-normal distribution for a population of tools, and for a single type of tool. Vibration emission values from the ISPESL Database, particularly when values are available for the specific tool (in terms of type of equipment, power supply, brand, model, attachment and type of work) prove to be more reliable than estimating based on manufacturers' declared emission values, even if corrected by the factors recommended by CEN TR 15350.

Main reasons are: 1) declared emission values are often measured on a single-axis, not necessarily dominant, or for only one handle, not necessarily worst case; 2) manufacturers' data are often derived from tests performed in the laboratory and on new tools, thereby not reflecting real work conditions; 3) ISPESL Database values take into account more variables than those of the declared emission data: specific working conditions, speed of use, type of accessories, type and properties of processed material; and 4) ISPESL Database values are collected from independent sources.

With regard to the correlation between measured exposure values and manufacturers' declared vibration emission values, good correlation coefficients were generally obtained (between 0,729 and 0,977). This confirms the overall suitability of the method to compare, classify and choose equipment based on emission values declared by manufacturers, at least in the same machine family (same type of equipment and same power supply).

The declared vibration emission values, when adjusted by the correction factors, were more accurate than non-adjusted emission values. Adjusted emission values over-estimated vibration emissions by 27% on average, and under-estimated in 42% of cases. The unadjusted emission values under-estimated vibration emissions by 16% on average, and under-estimated in 73% of cases.

The correction factors used for emission values for some types of equipment were observed to be inadequate - for example, for chainsaws and electric sanders - resulting in exposure risks being under-estimated by adjusted emission values. In contrast, correction factors appeared to be adequate for concrete breakers, pneumatic drills, electric percussion and non-percussion drills, air sanders and polishers. And yet exposure risks for this group of tools were generally over-estimated by adjusted emission values, although under-estimates still occurred in 6% - 36% of cases.

4. DISCUSSION AND CONCLUSIONS

Vibration emission values from the ISPESL Database for specific tools were found to be more reliable than estimations based on manufacturers' declared emission values, or the values adjusted by correction factors. Vibration emission values declared by manufacturers, when suitably adjusted, appeared to be less reliable than the ISPESL Database values, and not conservative in a number of cases. Therefore, these values cannot be considered suitable for estimations to fulfil legal obligations.

On the other hand, the overall correctness of comparing, classifying and choosing equipment according to emission values declared by manufacturers, at least within the same family of equipment (same type, power supply) is confirmed. In the future, the accuracy of this method is expected to improve, as reference standards used to determine emission values are revised according to the new harmonized type B standard EN20642. Moreover, it will likely become possible to reliably compare and classify equipment which belongs to different families, and may be subject to different reference technical standards.

The ISPESL Database will also be extended to other physical agents (Nicolini et al., 2010). ISPESL and the Regions intend to create an Italian portal for hosting databases in four areas - noise, vibration, electromagnetic fields and artificial optical radiation. These databases are expected to include information such as certification and emission values of working equipment, risk levels measured in the field, scientific bibliography, laws and standards. The goals of this initiative are to: 1) estimate worker exposures, 2) expand and implement the current ISPESL vibration database, 3) enable identification of lower-risk equipment in the database, 4) publish examples of best practices - results, pros, cons and costs, and 5) facilitate choice of personal protective equipment based on attenuation values supplied.

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