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Can sander noise emission declarations be used to manage workplace noise risk?

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ABSTRACT

Machinery supplied within the European Economic Area must comply with the noise requirements of Machinery Directive 2006/42/EC so that it can be used without putting persons at risk. For noise, the key requirements are that machinery must be designed to reach the lowest noise level achievable and be supplied with noise emission data. The noise emission declarations provided in over 60 instruction manuals for orbital and random orbital sanders were assessed against the noise requirements of Directive 2006/42/EC. Although the majority of instructions reviewed were for sanders that had gained a presumption of conformity through application of harmonised standards, none included information that fully complied with the noise requirements of Directive 2006/42/EC. Noise test codes for sanders determine the sound power level, from which the emission sound pressure level is calculated. Over half the instruction manuals reviewed provided emission sound pressure levels that were on average 9 dB lower than noise levels measured at the operator's ear during real use. Noise emission declarations provided in sander instruction manuals generally underestimate real use levels. Consequently, it is considered highly likely that users will have insufficient information to understand what control measures are necessary to mitigate the risks from noise for these tools during real use.

Keywords: Noise, Emission, Sanders I-INCE Classification of Subjects Number: 12.5.1

1. INTRODUCTION

The Machinery Directive 89/392/EEC (recast 98/37/EC and 2006/42/EC) (1) was introduced to enable free trade and consistent standards of safety for machinery across Member States and European Free Trade Association (EFTA) countries. A range of standards have been developed to assist and enable compliance with Essential Health and Safety Requirements (EHSRs) of the Machinery Directive. Where these standards are harmonised, they can provide machinery manufacturers with a straightforward route to conformity with the EHSRs within their scope.

The Machinery Directive places duties on machine manufacturers to design and construct their products "*in such a way that risks resulting from the emission of airborne noise are reduced to the lowest level, taking account of technical progress and the availability of means of reducing noise, in particular at source*". The Machinery Directive also requires manufacturers, importers and suppliers to provide information on noise in the instructions accompanying the product, such that the product can be used without risk from noise. Noise emission information must appear in technical sales documents describing the products.

When the Machinery Directive was recast in 2006, the clarity of the existing requirements relating to noise was improved. There was also a requirement for instructions to include the uncertainties associated with noise emission values and information about residual risk.

Despite changes to the Machinery Directive and improvements in the supporting standards and test codes, the revised standards for random orbital sanders continue to be weak. Also, manufacturers have failed to address the requirement to report residual risk information for noise. Reporting emission values representative of real use levels would compensate for the weakness of the emission test codes. Poor quality emission data from sander manufacturers can make it difficult for employers to control

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workplace risks from noise, especially when risk assessments have been based on manufacturers' information; these may under-estimate noise exposures, sometimes to a very large extent.

HSE investigated the harmonised standards for orbital and random orbital sanders and assessed the noise emission information provided in accordance with the requirements of the Machinery Directive. The results of this study are reported here.

2. REVIEW OF SANDER STANDARDS

2.1 Current harmonised standards

A number of harmonised safety standards and noise test codes for orbital and random orbital sanders give presumption of conformity with regard to the provision of the following information on airborne noise emissions: the A-weighted emission sound pressure level at workstations L_{pA}; the peak C-weighted instantaneous sound pressure value L_{pCpeak}; and the A-weighted sound power level L_{WA} emitted by the machinery, where the emission L_{pA} exceeds 80 dB(A). All the harmonised standards for sanders are listed in the Official Journal (2).

2.1.1 Electric orbital and random orbital sanders

EN 62841-1:2015 (3) provides the general requirements for hand-held motor operated electric tools. Compliance with Part 1 and a relevant machine specific part of EN 62841 is required to achieve presumption of conformity with the EHSRs of Directive 2006/42/EC. For orbital and random orbital sanders this is EN 62841-2-4:2014 (4).

The noise test code for measuring noise emissions is provided in Annex I (normative) of EN 62841-1. For hand-held tools, L_{WA} is determined from measurements at five microphones on a hemispherical/cylindrical measurement surface, which are located 1 m from the centre of the tool. The L_{WA} is given by L'_{pA} + Q dB; where L'_{pA} is the surface sound pressure level and Q is an experimentally determined correction provided in the noise test code for hand-held power tools. The emission L_{pA} is given by L_{WA} – 11dB; it is equivalent to the value of the surface sound pressure level at a distance of 1 m from the power tool. The values for the uncertainties, K_{WA} and K_{pA} are expected to be 3 dB. During the emission tests, sanders are suspended with the plate of the tool horizontal and tested at no load.

EN 62841-1 requires the instruction manual include the following: the noise emission values L_{pA} and L_{WA} and associated uncertainties K_{pA} and K_{WA}, and L_{pCpeak} where required/appropriate; a recommendation for the operator to wear hearing protection; information that the declared noise emission values have been measured in accordance with a standard test method and may be used for comparing one tool with another and in a preliminary assessment of exposure; and a warning that noise emissions during actual use of the power tool can differ from the declared values depending on the ways in which the tools is used, especially what kind of work piece is processed.

2.1.2 Non-electric orbital and random orbital sanders

The harmonised safety standard for non-electric orbital and random orbital sanders is EN ISO 11148-8:2011 (5). Noise emission is measured and declared in accordance with EN ISO 15744:2008 (6) and the noise emission values must be included in the instruction manual.

EN ISO 11148-8 requires the instruction manual to include the following: a recommendation to use hearing protection; and, if values for noise emissions obtained during the appropriate tests do not adequately represent the emissions during the intended uses of the machine, additional information and/or warnings to enable an assessment and the management of the associated risks. No guidance is provided on how to assess the adequacy of the noise emission values for reflecting real use noise levels or how to obtain real use noise levels that will help users assess and manage real use risk.

The noise test code described in EN ISO 15744 is comparable with that specified EN 62841-1. The measurement method is the same but the operating conditions are different. EN ISO 15744 requires that orbital and random orbital sanders are tested by trained operators during sanding. The sander is fitted with sanding paper and operated on a horizontal rigid plain steel plate. The feed force is specified and the operator is required to move the sander over the surface of the steel plate in a figure-of-eight pattern. The likely values of the uncertainties K_{WA} and K_{pA} are 3 dB, according to the basic acoustics standards from which they were determined.

2.2 Previous work

The NOMAD (NOise MAchinery Directive) project (7) was a survey carried out across 14 European Member States between 2009 and 2012. The aim of the project was to assess the

noise-related content of instruction manuals supplied with machinery against the requirements of the Machinery Directive. More than 1500 sets of instructions were assessed, covering 40 different types of machinery and from 800 different manufacturers. The assessment showed that 80% of the instructions assessed did not meet the legal requirements with regard to noise. The main failings were: absent or incomplete declared noise emission values; absent or incomplete traceability to machine operating conditions or measurement methods for declared noise emission values; and declared noise emission values that were not credible either against stated operating conditions or as warnings of likely risk in real use.

The NOMAD project showed that it is highly likely purchasers and users of machinery will be unable to make informed choices regarding the risks from noise associated with potential purchases. Nor will they understand what control measures are necessary to mitigate the risks from noise during real use.

In work separate to the NOMAD project, HSE investigated noise emission test codes for sanders (8). This work showed that standard emission values for noise were not representative of real use levels. Therefore including emission values from harmonised standards in instruction manuals may be misleading to purchasers and users when assessing and managing real use risk.

3. ASSESSMENT OF EMISSION DATA

3.1 Collection of instruction manuals

An internet search was carried out between October and December 2013 to obtain instruction manuals for orbital and random orbital sanders currently on the market. Every effort was made to ensure that the list covered a broad range of manufacturers, importers and suppliers.

3.2 Assessment of emission information

The internet search provided 65 instruction manuals from 27 different manufacturers, importers and suppliers of orbital and random orbital sanders. The declared emission information included in the sander instruction manuals was assessed against the noise requirements of the Machinery Directive using the checklist given in Table 1.

Table 1 – Checklist for reviewing noise emission information

1	Are noise data or information provided? This may be emission L_{pA} or L_{WA}, or information on the provision of hearing protection.
2	Are numerical values of L_{pA} provided? This could include a statement that the sound pressure level at the workstation is less than 70 dB(A).
3	If L_{WA} is required, is it provided? For Directive 2006/42/EC, L_{WA} is required when emission L_{pA} exceeds 80 dB(A). For 98/37/EC, L_{WA} was required when emission L_{pA} exceeded 85 dB(A).
4	If the manual refers to 2006/46/EC, are uncertainties for the numerical values given?
5	Are noise emission values traceable to a measurement method and operating conditions? This may be reference to a harmonised standard, noise test code, or manufacturer's own test code. The reference should include the date and, where appropriate, the relevant part number of the standard.
6	Are noise emission values credible according to the operating conditions to which they are traceable?
7	Do the noise emission values provide users with a credible indicator of real use risk? This subjective assessment is based on in-use noise levels for sanders during a range of typical uses.
8	Is residual risk information provided for noise? This could include a statement that the declared emission data does not reflect real use risk, provision of real use values (although this is more likely to be a warning that noise when working can exceed 80 dB(A) or 85 dB(A)), etc.
9	Is information provided on any protective measures intended to minimise noise risk? This could include advice to wear hearing protection, provision of health surveillance, etc.

The checklist in Table 1 was compiled to ensure a systematic approach was taken when assessing the emission information in the 65 sander instruction manuals.

The traceability of numerical data was assessed against the standards and directives referenced in

the instruction manuals. These references provide details of the measurement method and operating conditions under which numerical data were obtained. The credibility of the sander manufacturers' declared emission L_{pA} values was assessed by comparison with measured noise emission values obtained by Shanks (8). Although data were measured for a small sample of 10 orbital and random orbital sanders, they indicated the range of emission values achievable using the standard noise test codes for electric and pneumatic sanders. The credibility of the sander manufacturers' declared L_{WA} values was assessed by considering the difference between L_{pA} and L_{WA}, which should be 11 dB or 13 dB based on the value of Q given in the harmonised noise test codes. The credibility of the declared emission values, as indicators of the likely real use noise levels, was assessed by comparison with noise levels measured at the operator's ear measured during real use sanding operations. The range of HSE emission L_{pA} values and real use noise levels are summarised in Table 2.

Table 2 – Noise emission L_{pA} and real use noise levels

Parameter	Range of values
Noise emission values measured by HSE, L_{pA} dB(A)	74 - 89
Real use noise levels measured by HSE during sanding, L_{pA} dB(A)	81 - 97

The information on protective measures and residual risk provided in the instruction manuals was assessed. It can cover, for example, installation of machinery, workplace design, provision and use of suitable hearing protection, training requirements. The instruction manuals should recommend the use of hearing protectors during sanding operations, as real use noise levels at the operator's ear can range from 81 to 97 dB(A). The legal requirement to use hearing protectors is based not on the level of noise but on noise exposure, which takes into account both the level of noise and the duration of exposure. It is possible manufacturers do not consider it their duty to state that hearing protection is required without knowledge of typical work patterns. However, the instruction manual should contain sufficient advice to warn the user that noise exposure needs to be controlled.

Previous research (8) has shown that there is often a gap between declared emission values and real use noise levels. The instruction manuals should warn the user when declared emission values cannot be used to assess risk, in particular when declared emission values underestimate the noise generated during normal use.

Manufacturers should provide sufficient data for the tool to be used safely. Harmonised standards should be designed to help manufacturers provide emission data representative of real use levels, enabling the employer to effectively manage risk due to noise.

3.3 Scoring system

The emission information in the instruction manuals was assessed by applying the following scores to each of the checklist questions in Table 1:

Score '1': Required information is included in instructions and is adequate, for example numerical values are provided, values are traceable to a full referenced safety standard (date and part number), sufficient information is provided on protective measures and residual risk.

Score '0': Required information is not included in instructions, or information is included but it is not adequate, for example numerical values do not represent real use risk.

Score '0.5': Required information is included but it is not completely adequate, for example values are traceable to an appropriate safety standard or test code but the date is missing, the limitation of the declared emission data is stated but no additional information is provided to help the user manage risk.

The scores were summed and used to categorise the noise emission information contained in the instruction manuals into three groups:

Machinery Directive requirements mostly met: Information is correct but minor omissions, for example correct safety standard and part number referenced but not dated, information on protective measures provides general rather than machine-specific guidance, no uncertainty data.

Machinery Directive requirements met to some extent: Within this category there was considerable variation in the information provided. Common omissions included: incomplete

reference to safety standards (no part number), no additional information provided for noise emission values that did not reflect real use risk.

Machinery Directive requirements not met: Information absent or unusable.

4. COMPLIANCE WITH MACHINERY DIRECTIVE REQUIREMENTS

4.1 Machinery Directive requirements mostly met

None of the instruction manuals assessed contained noise emission information that fully met the requirements of Machinery Directive 2006/42/EC. However, the contents of 10 of the 65 instructions mostly met the requirements, that is they included noise emission values that were: traceable to a measurement method and operating conditions; credible according to the operating conditions to which they were traceable; and, credible as an indicator of real use noise levels.

The instructions generally failed to meet just one of the requirements of the Machinery Directive. Common failings were: no uncertainty data, or incomplete reference (no date) to the correct safety standard or test code, or inadequate or no information on protective measures.

4.1.1 No uncertainty data

The Machinery Directive 2006/42/EC requires that the uncertainties associated with the emission values are specified. Earlier versions of the Machinery Directive did not explicitly require this information. However, the safety standards and test codes for both pneumatic and electric orbital and random orbital sanders have required the declaration of noise emission values as a dual-number, that is the emission value and associated uncertainty, since about 2000. The lack of uncertainty data will hinder verification of the declared emission values by interested parties, for example enforcement authorities and maybe purchasers.

4.1.2 Incomplete reference (no date) to the correct safety standard or test code

All the instructions that mostly met the requirements of the Machinery Directive referenced appropriate safety standards or test codes. However, while correct part numbers were referenced, the dates for some were missing. A full reference should be provided, that is part number and date. This is particularly important if the test methods have changed between different revisions of the standard. For example, in 2003 the measurement surface in the noise test code for electric sanders changed from a 2 m cuboid to a hemispherical/cylindrical surface with radius 1 m. This change resulted in a 2 dB difference in the calculated emission values, which was due to the measurement method and not the noise generated by the tool.

4.1.3 Inadequate or no information on protective measures

The only information missing from some of the instructions that mostly met the requirements of the Machinery Directive was on protective measures. Where it was provided for noise, this information was generally limited to advice on hearing protection, for example: *always wear suitable hearing protection* (L_{pA} 88 dB); and *depending on the task, noise may exceed 85 dB(A), in which cases wear hearing protection* (L_{pA} 81.3 dB).

The safety standards for electric and pneumatic sanders both require instructions to include a recommendation for the operator to wear hearing protection, if appropriate. It is debatable whether this general guidance is useful, especially when the range of in-use levels for orbital and random orbital sanders is between 81 and 97 dB(A). Machine-specific guidance is preferable.

4.2 Machinery Directive requirements met to some extent

Of the 65 instruction manuals assessed, 45 contained noise emission information that met the requirements of the Machinery Directive to some extent. However, all had important omissions and failed to include one or more of the following: information on how the data were obtained, that is there was no traceability to a measurement method or operating conditions; credible emission values according to the operating conditions under which they were obtained; credible emission values that reflected real use levels; and information on residual risk and protective measures.

4.2.1 Traceability of emission data

Of the 45 instruction manuals with important omissions, 29 failed to provide adequate information on how the noise emission values had been obtained. As a result of this omission, it is unclear how the data were obtained in terms of what measurements were made, the location of these measurements and the operating conditions during tests. It will be difficult to justify using data, which are not traceable to an appropriate measurement method and operating conditions, to assess and manage the noise risks

associated with using sanders in the workplace.

For the majority of instructions, the lack of traceability was due to an incomplete reference to the correct safety standard, for example EN 62841 and EN ISO 11148. These series of standards have multiple parts, in which the operating conditions for the specific machine types are specified. If the correct part number is not referenced, there is no information on the operating conditions under which the noise emission data were obtained.

The majority of instructions with incomplete references to appropriate safety standards were for electric orbital and random orbital sanders. There may be a financial reason why manufacturers fail to include full references in instructions, for example to avoid the cost of revising manuals (which may have to be produced in many different languages) when the date of the latest version of the standard or test code changes. But this is not a valid reason. The instructions should contain both the date and part number of all relevant standards, so it is clear how and under what conditions the emission data were obtained. The results presented in this paper suggest there may be some scope for working with manufacturers of electric tools or manufacturers' associations to improve the traceability of declared emission values.

4.2.2 Credibility according to operating conditions during emission tests

Shanks (8) carried out emission tests on orbital and random orbital sanders, from which the range of measured noise emission values shown in Table 2 was compiled. The purpose of assessing the credibility of the manufacturers' declared emission values against this range, was to give an indication of whether standard tests are likely to have been followed, and if so, whether they were followed correctly.

Of the 45 instruction manuals with Machinery Directive requirements only partially met, 31 did not include emission values that were credible according to the operating conditions to which they were traceable. However, the main failure was that operating conditions were not traceable because of an incomplete or missing reference to an appropriate standard. Other reasons noise emission values were assessed as not credible were: non-standard differences between L_{pA} and L_{WA}, which were assumed to suggest measurement error, values not derived from measurements, or data obtained using an undefined test method; and unclear descriptors of noise parameters, for example "noise" or "sound", which makes it very difficult to decide whether the reported value refers to a sound pressure level or a sound power level.

The results presented in this paper suggest that providing guidance for manufacturers on how to draft noise declarations could improve the credibility of their emission data.

4.2.3 Credibility to reflect real use noise levels

Following a harmonised standard is the main way for manufacturers to demonstrate compliance with the requirements of the Machinery Directive. However, the noise emission data obtained using a harmonised standard may not reflect real use noise levels. Of the 45 instructions with important omissions, 25 contained noise emission values that did not reflect real use levels.

Figure 1 shows the cumulative percentage frequency distribution of the manufacturers' declared emission L_{pA} values, the HSE measured emission L_{pA} values and real use noise levels measured by HSE at the operator's ear. This presentation of the data shows a clear discrepancy between the manufacturers' declared emission L_{pA} values, obtained in accordance with appropriate harmonised standards, and real use noise levels; the manufacturers' data generally underestimates real use noise levels. Real use noise level were between 81 and 97 dB(A); they were higher than the manufacturers' declared emission L_{pA} values by between 3 and 24 dB(A) (mean 9 ± 6 dB).

The range of real use noise levels highlights the challenges machine manufacturers face in providing emission data that reflect in-use levels, but it does not explain why declared emission values are at the bottom of the range of noise levels found in normal use.

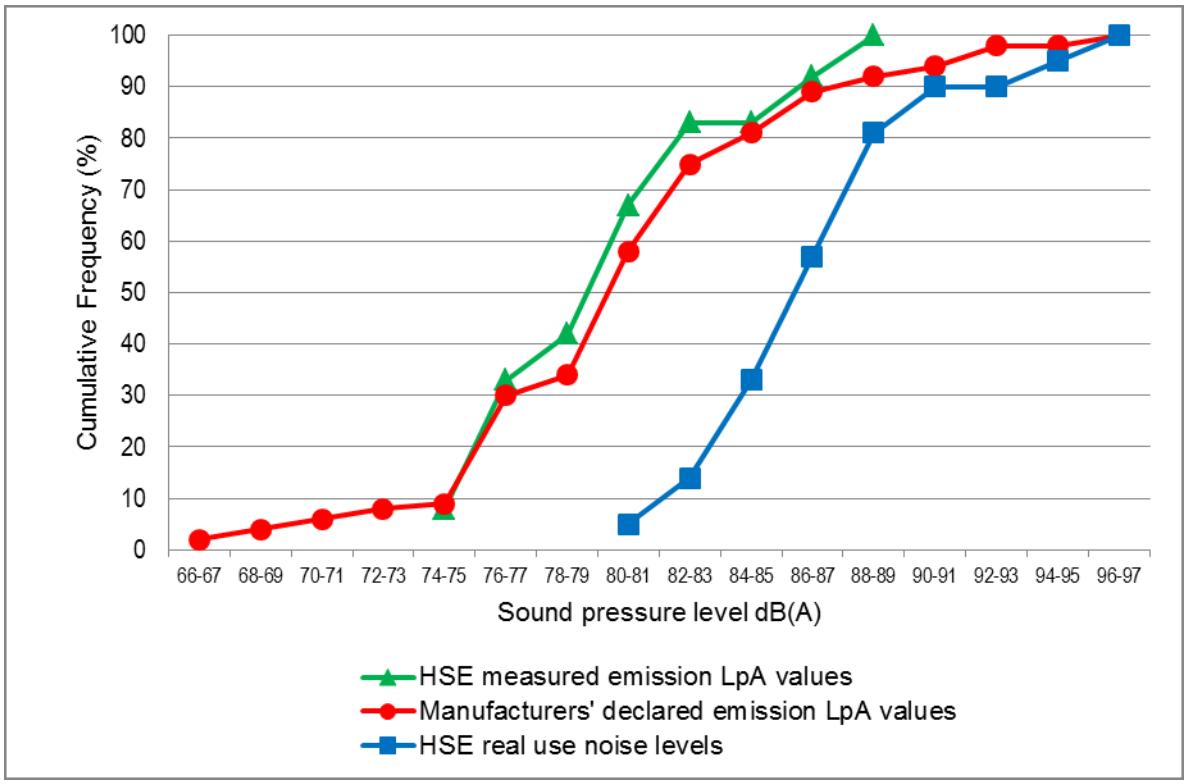

Figure 1 – Cumulative percentage frequency distribution of emission L_{pA} values and real use noise levels

4.2.4 Residual risk information

The evidence presented in this paper suggests the current standards for sanders could be improved to provide values of emission data that help with assessing and managing workplace risks for noise. EN ISO 11148-8 requires the provision of additional information and/or warnings to enable an assessment and the management of the associated risks, where the noise emission values obtained during the specified tests do not adequately represent the emissions during the intended uses of the machine. Additional information was not provided in any of the instruction manuals assessed, but it is possible it may be provided with newer sanders as a result of improved harmonised safety standards.

The provision of additional information relies on machine manufacturers understanding the limitations of emission data for their products. Many factors may affect the level of noise generated by sanders during normal use, for example the attachments used (hose, dust bag, silenced exhaust), the type of work the tool is designed for, the work pieces being processed in terms of material, size, location, etc. Manufacturers should understand what factors affect the noise generated by their machines during typical use. They should also know when the declared emission values do not represent real use risk. This understanding is essential to help them provide emission data that will help the user manage the noise risks associated with using the tools.

The Machinery Directive defines residual risk as the risk that has not been sufficiently reduced by inherently safe design measures or by integrated technical protective measures. The Machinery Directive requires manufacturers to provide information in the instructions on residual risk, to enable the user to take the necessary protective measures to control that risk. For noise, a numerical emission declaration that clearly reflects that hazard is likely to be a sufficient warning of residual risk. However, when the numerical declaration does not make clear the hazard, another method must be found.

It is unclear whether the residual risk actions defined in the Machinery Directive were intended to address cases where noise emission values under-represent real use risk. However, manufacturers do have a duty to supply machinery that can be used without risk. They should therefore inform the user when there is a gap between the risk associated with the declared emission values and actual risk during real use.

A comparison of declared noise emission values and real use noise levels showed that the data from standard tests for orbital and random orbital sanders typically underestimates real use noise. However,

of the 45 instructions with important omissions, 20 failed to provide additional information on the noise risks not adequately represented by the declared emission values.

None of the instructions contained numerical values indicating the absolute real use risk although some contained warnings. However, the message they conveyed was mixed depending on the manufacturer. Some stated that emission data obtained under standard test conditions were not adequate for use in a risk assessment and values measured in individual workplaces may be higher, others that the emission data may be used in a preliminary assessment of exposure.

4.2.5 Information on protective measures

Of the 45 instructions with important omissions, 17 contained no information on suitable protective measures. The information provided was generally limited to advice on hearing protection. There is some value in instructions advising users to "wear hearing protection" or "wear hearing protection during continuous use". However, some instructions advised the use of hearing protection "as recommended by the employer", "as recommended by legislation", "for appropriate conditions", and "where available". If declared emission values provided in instruction manuals do not reflect in-use levels, it will be difficult for employers to assess whether hearing protection is needed, and if so, select suitable protectors.

4.3 Machinery Directive requirements not met

Of the 65 instruction manuals assessed, 10 did not meet the noise requirements of the Machinery Directive. Of these 10 instructions, 6 contained no noise emission information while 4 advised users that hearing protection was needed without providing any numerical noise emission values. Although this advice will alert the user of a potential noise problem, it does not allow them to select suitable hearing protection as there is no indication of likely noise levels. All but one of the instructions that failed to meet the requirements of the Machinery Directive were for electric orbital and random orbital sanders.

5. CONCLUSIONS

The inclusion of information on noise emissions in instruction manuals is a legal requirement under Machinery Directive 2006/42/EC. A key finding of the work reported here is that 15% (10 of the 65) of the instruction manuals for orbital and random orbital sanders did not contain any noise emission information. The instructions that did not meet Machinery Directive requirements were mostly for electric sanders currently available for purchase.

In accordance with the Machinery Directive, all instructions should contain information on the emission L_{pA}, even if this is just a statement to say that it does not exceed 70 dB(A) at the workstation; if emission L_{pA} exceeds 80 dB(A), L_{WA} must also be provided. The Machinery Directive also requires that the operating conditions and measurement methods, under which the declarations are obtained, be described. Of the declared noise emission values assessed, 53% (29 out of 55) were not fully traceable to an appropriate noise test code.

The credibility of the declared noise emission values was assessed against HSE measured emission data and noise levels measured during real use. This assessment showed that 44% (24 out of 55) of the noise emission values provided in instruction manuals for orbital and random orbital sanders were credible according to the measurement method and operating conditions under which the values had been determined; 55% (30 out of 55) were credible indicators of real use noise levels.

The results presented in this report show that approximately half of the instructions assessed contained noise emission data that were not traceable or credible, either with regard to the stated operating conditions or as indicators of real use noise levels. The main reasons were: incomplete reference to an appropriate safety standard or test code; noise emission values were derived from standardised tests that generally underestimate risk; and no additional information provided when the noise risks were not adequately represented by the declared emission values.

The study reported here has shown that a large number of manufacturers and suppliers of orbital and random orbital sanders are not providing noise emission information that meets the noise requirements of the Machinery Directive. The findings presented in this paper suggest that even if manufacturers do follow the appropriate harmonised standards for orbital and random orbital sanders, the declared emission data are likely to underestimate real use risk. Consequently, it is considered highly likely that users will have insufficient information to understand what control measures are necessary to mitigate the risks from noise for these tools during real use.

The results reported here may be sufficient to challenge the harmonised standards for orbital and

random orbital sanders. Until these standards are improved, manufacturers have a duty to provide better supplementary information. This information must be sufficient to alert the user of the gap between the risk as indicated by the declared emission values and the likely risk during real use.

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