



Buy Quiet as a Means of Reducing Workplace Noise

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Abstract Machinery supplied within the European Economic Area must comply with the noise requirements of Machinery Directive 2006/42/EC. Machine manufacturers must reduce noise to the lowest level achievable and provide noise emission data so people can use their products without risk from noise. Declared noise emissions should help purchasers and users identify low or lower noise machinery and provide information that can be used to develop a noise risk assessment. Purchasing quieter machinery is an effective way to avoid risk from occupational exposure to high noise. It also minimises the cost and effort needed to control any remaining noise risk. Effective selection of machinery, however, on the basis of the declared noise emissions is dependent on a number of factors including: (a) The availability of competing machinery with significantly different noise risk. (b) Manufacturers' declared noise emissions that are indicative of actual noise risk. (c) Purchasers who understand the declared noise emissions and other information describing noise risk. A preliminary market surveillance exercise across Europe found that compliance with the noise requirements of the Machinery Directive is very poor; noise information provided in 80 % of machinery instructions did not comply. Investigations of a small number of harmonised noise test codes identified a range of problems that limit the usefulness of the declared noise emissions to rank the noise of competing machinery and identify real use noise risk. Insufficient support is in place to help purchasers who want to “buy quiet”. To buy quiet in today's market purchasers need a high level of understanding of noise and noise control and must have a high degree of determination to achieve noise control in their workplace. Purchasers who successfully buy quiet seek out quieter machines and critically review the noise information supplied with them, which is often flawed. Such purchasers sometimes need to write, and check conformity with, their own specification for noise. It is likely purchasers would have more success in buying quiet if: (a) More manufacturers complied with the noise requirements of the Machinery Directive. (b) The standards supplementing the noise requirements of the Machinery Directive were more reliable. (c) The availability of quieter equipment was more widely publicised.

Keywords Noise · Control · Purchasers · Market surveillance · Risk indicators · Buy quiet

1 Introduction

In recent decades, the introduction of new working practices and modern machinery into British industry has resulted in reduced occupational noise exposure. Hearing damage, however, and other adverse effects from exposure to excessive noise, remains a significant risk in many workplaces.

Machinery supplied within the European Economic Area (EEA) must comply with the noise requirements of Machinery Directive 2006/42/EC [1]. Manufacturers must minimise noise risk and provide noise information, including emission

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values, in instructions so that employers are informed of any residual noise risk and can put in place control measures for workers to use equipment without risk from noise. The Machinery Directive expects the declared noise emissions to be useful for comparing machinery on the basis of noise, so buyers can be sure that the noise control on offer is state-of-the-art. Effective comparison relies on the consistent use of an appropriate and reliable noise test code.

Noise information supplied by manufacturers should help users identify low or lower noise machinery and provide information useful for developing a noise risk assessment [2]. Purchasing quieter machinery is an effective way to avoid risk from occupational exposure to high noise. It also minimises the cost and effort required to control remaining noise risk. Effective selection of machinery on the basis of the declared noise emissions is, however, dependent on a number of factors:

- The availability of competing machinery with significantly different noise risk.
- Manufacturers' declared noise emissions that are indicative of actual noise risk.
- Purchasers who understand the declared noise emissions and other information describing noise risk.

This paper describes the experience gained by the Health and Safety Executive (HSE) in recent years concerning the potential for purchasers to buy quiet as a means of reducing the risks associated with exposure to workplace noise. Factors considered are:

- Availability of information showing significant differences in the noise risk of competing machines, so purchasers have a genuine choice to buy quiet.
- Success of noise test codes in producing declared noise emissions for ranking competing machinery.
- Success of noise test codes in producing declared noise emissions that are credible indicators of actual risk for typical use(s) of the machine.
- Performance of manufacturers in meeting their legal duties to provide noise information that helps workers use machinery without risk from noise.
- Performance of manufacturers in meeting their legal duties to minimise the risks from noise and provide information describing any remaining noise risk, so machinery can be used without risk from noise.
- Skill of purchasers in selecting machinery using noise as a criterion and achieving reduced noise risk in workplaces.
- Customer demand for quieter machinery.

2 Noise Risk in Industry

Work carried out by the European Agency for Safety and Health at Work (EU-OSHA) [3] showed that exposure to

loud noise in Europe is not notably rising, but there are no significant improvements to be observed: 7 % of workers self-reported hearing disorders due to their work and around 10 % of workers were considered to be exposed (almost) permanently to noise "so loud that they would have to raise their voice to talk to other people". Industry sectors where workers were affected by loud noise included construction, manufacturing of metal and wood, forestry, textile production and food production. Machinery typically used in these industry sectors, including food packing and processing machinery, compaction machines, edge-banding machinery, floor-cutting machines, transportable circular saws, and yarn twisting machinery, was considered to be a major contributor to significant workplace noise exposure [4]. Although the EU-OSHA study identified application of a range of different noise control measures, typically control of noise risk in the workplace was heavily reliant on hearing protection.

Despite the fall in numbers of people reporting noise-induced hearing loss, workers remain exposed to high levels of noise. In Great Britain, hearing disorders are still being reported as a result of this exposure [5]. Lutman et al. [6] investigated the effectiveness of noise legislation in the United Kingdom designed to minimise risk from occupational exposure to noise. The study concluded there was sufficient compliance with the requirements of current noise legislation to prevent hearing damage in workplaces with moderate exposure to noise. As with the EU-OSHA study, however, participants were highly reliant on the use of hearing protection to control risk.

The provision of hearing protection should not be used as an alternative to controlling noise by technical and organisational means. Instead it is best used to control immediate risk while other protective measures are developed. For example, Shanks [7] showed that in the printing industry, engineering noise control technology is less widely applied by manufacturers and employers than it could be. There is no reason to suspect that this situation is any different to that in noisy industries in general. Actual control of noise risk by employers is still over-reliant on the use of hearing protection. Action to encourage designers to design quieter machinery and purchasers to buy it would reduce this reliance on hearing protection for future generations of workers.

3 European Legislation and Standards Requiring Low Noise Machinery

3.1 Legislation

Two European Directives currently require the provision of information on noise when certain equipment, including machinery, is placed on the market. These are:

- Machinery Directive 2006/42/EC (MD)
- Outdoor Noise Directive 2000/14/EC (OND) [8].

Both Directives are part of the European system for the removal of barriers to trade by applying common harmonised requirements to products in all Member States. The MD sets out essential health and safety requirements (EHSRs) for machinery, which include general and specific requirements for noise.

The MD requires manufacturers and importers of machinery to:

- Design and construct machinery so that it can be operated, adjusted and maintained without putting people at risk (EHSR 1.1.2) and, for noise, reduce risks from airborne noise emissions to the lowest level taking account of technical progress and the availability of techniques for reducing noise, particularly at source (EHSR 1.5.8).
- Inform users where there are residual risks, despite the inherent safe design measures, safeguarding and complementary protective measures adopted (EHSR 1.1.2 and 1.7.2).
- Provide information on how to reduce risks from noise, in the instructions accompanying the machinery, which includes:
 - Instructions relating to the installation and assembly for reducing noise (EHSR 1.7.4.2 (j)).
 - Instructions for the putting into service and use of the machinery and, if necessary, instructions for the training of operators (EHSR 1.7.4.2 (k)).
 - Information about the residual risks that remain after all other protective measures have been taken into account (EHSR 1.7.4.2 (l)).
 - Instructions on the protective measures to be taken by the user, including, where appropriate, the personal protective equipment to be provided (EHSR 1.7.4.2 (m)).
 - Information on airborne noise emissions (EHSR 1.7.4.2 (u)):
 - The A-weighted emission sound pressure level at workstations, where this exceeds 70 dB(A); where this does not exceed 70 dB(A), this fact must be indicated.
 - The peak C-weighted instantaneous sound pressure value at workstations, where this exceeds 63 Pa (130 dB).
 - The A-weighted sound power level emitted by the machinery, where the A-weighted emission sound pressure level at workstations exceeds 80 dB(A).
 - Whenever sound emission values are indicated the uncertainties surrounding these values must be specified.

- Include the information on airborne noise emissions in the sales literature describing the performance characteristics of the machinery (EHSR 1.7.4.3).

The OND requires the guaranteed A-weighted sound power level (a value that should not be exceeded when the test is reproduced) to be marked on more than 50 types of machines intended to be used outdoors. For 22 of these outdoor machine types, the guaranteed sound power level must not exceed the permissible sound power level specified in the OND. The OND sets out a detailed technical specification about how to measure and report the sound power level for machinery it covers.

The MD specifies how the emission sound pressure level (and peak instantaneous sound pressure level) is obtained for both machinery it covers and that under the OND. For machinery covered by both the MD and the OND, the sound power level required is the guaranteed sound power level obtained according to the OND. For machinery covered by the OND, the sound power level is reportable regardless of the sound pressure level at workstations.

In this paper declared noise emissions refer to the emission sound pressure level, peak C-weighted instantaneous sound pressure value and/or sound power level required by the MD or the guaranteed sound power level required by the OND.

3.2 European Harmonised Standards

While the MD sets out the mandatory EHSRs for machinery, harmonised standards provide supplementary technical specifications about how to comply with them. Use of harmonised standards by manufacturers is optional. Where followed in full, these standards give a presumption of the product's conformity with the EHSRs of the MD within the scope of the standard and any qualifications on its application. A harmonised standard is mandated by the European Commission and published in the Official Journal of the European Union. Harmonised standards are listed by Directive on the Commission's Europa website [9].

There are over 700 harmonised standards that include a noise clause; over 300 of these cover machinery for which noise is considered a significant hazard. Harmonised standards are the most popular method chosen by manufacturers to demonstrate compliance with European legislation. Many standards provide for a presumption of conformity with EHSR 1.7.4.2 (u), that is the provision of airborne noise emission. This in turn should be useful to demonstrate compliance with EHSR 1.5.8 (minimising risks from noise). The standards may also help manufacturers meet other requirements for noise, for example the provision of information on installation, residual risk and use of hearing protection. Some harmonised standards are more helpful than others in this respect.

The guide to the application of the MD [2] states that the noise emission declaration provided in machinery instruction manuals has two main purposes:

- To help users choose machinery with reduced noise emission.
- To provide information useful for the risk assessment to be carried out by the employer in accordance with the requirements of the Physical Agents (Noise) Directive 2003/10/EC [10] on the exposure of workers to the risks arising from noise.

While the MD focuses predominantly on protecting the health and safety of machinery users, the OND focuses on limiting noise emission in the environment from outdoor equipment, for example by setting mandatory noise limits and providing information to help in the selection of quieter equipment.

4 Noise Information in Machinery Instructions

4.1 Evaluation of Compliance

The NOMAD (name derived from **NO**ise **MA**chinery **Dir**ective) project [11] was a preliminary market surveillance exercise carried out across 14 European Member States between 2009 and 2012. Its aim was to assess the noise-related content of instruction manuals supplied with machinery against the requirements of the MD. More than 1500 sets of instructions were assessed covering 40 different types of machinery involving 800 different manufacturers. The noise information contained in 80 % of the instructions assessed did not meet the requirements of the MD, though some did have a presumption of conformity through use of harmonised standards. The main failings were:

- Absent or incomplete declared noise emissions.
- Absent or incomplete traceability to machine operating conditions or measurement methods for declared noise emissions.
- Declared noise emissions that were not credible, either against stated operating conditions or as warnings of likely risk in real use.

The findings from NOMAD highlighted issues with the credibility of emission data provided in accordance with harmonised noise test codes. Noise emission values may be credible for the operating conditions defined within the noise test code but not as representing the actual risk during typical use. Noise emission values may not always be capable of indicating the relative risk when there is a difference in actual risk between competing machinery, that is, some do

not help manufacturers to demonstrate state-of-the-art low noise designs.

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

A NOMAD Task Force was set up in 2012 under the auspices of the European Commission and with representation from regulators for machinery from a number of Member States. The purpose of the Task Force is to implement the recommendations from the NOMAD report. These include helping duty holders (manufacturers, suppliers, users, etc.) and other stakeholders improve compliance with the requirements of both the MD and OND and facilitating market surveillance according to European guidance outlined by the European Commission [12].

4.2 Evaluation of Harmonised Noise Test Codes

Harmonised noise test codes should provide noise emission data representative of real use noise and facilitate comparison of the noise of competing machines making it easier to identify lower-noise designs. It is common for these test codes to be based on artificial and simplified operations. The NOMAD project found that the noise emission data for some machine types may not reflect the noise generated during typical use.

Noise test codes should be drafted in accordance with EN ISO 12001:2009 [13], which specifies the technical requirements of a noise test code. Clause 7.4.4 states: “The noise test code shall specify an operating condition that is reproducible and is representative of the noisiest operation in typical usage of the machine under test. If necessary, more than one operating condition shall be specified; if other test codes exist (eg for hand-arm vibration), the operating conditions shall, if practicable, be the same.” The extent to which operating conditions in noise test codes are validated with regard to the requirements in Clause 7.4.4, or represent the latest and best knowledge, requires further investigation.

A small number of noise test codes for machines, including hand-held concrete breakers, sanders and polishers, and wood chippers, have been evaluated for the purpose of:

- Assessing the test method for usability and repeatability.
- Comparing measured noise emission values with manufacturers’ declared noise emissions and with the noise generated by the same machines during real use.
- Establishing the credibility of declared noise emissions to represent real use risk.

4.2.1 Hand-held Concrete Breakers

The requirements of both the MD and the OND apply to hand-held concrete breakers. The Health and Safety Laboratory (HSL) determined sound power levels for concrete breakers according to the method defined in the OND [14]. During the test, the breaker was mounted on a tool embedded into a concrete block sunk into the ground and it was supported by a device (not defined in the standard test) rather than an operator. The test did not involve breaking up a surface. The guaranteed sound power levels provided by the manufacturers were exceeded when the tests were reproduced at HSL for 4 of the 6 breakers tested. It was considered likely that this was due in part to ambiguities in the defined test method.

Differences in the manufacturers' guaranteed sound power levels indicated one of the breakers was lower noise. HSL measurements of the sound pressure level at the operator's ear during real use, however, were not significantly different and so did not reflect the lower noise finding; levels were between 92 and 95 dB(A). These tests led to the conclusion that using manufacturers' guaranteed sound power levels is an unreliable means of selecting and purchasing low noise concrete breakers.

The OND sets a maximum permissible sound power level for breakers. All but one of the breakers tested were declared at or 1 dB below this permissible level. The European Commission database of noise emissions for outdoor equipment determined under the OND [15] shows that reporting sound power level at or within 2 dB of the permissible level is widespread, even when the reported measured level is lower by 10 dB or more. The true differences between sound power levels from competing machinery may be masked by declaration at or near the limit value. The OND requires reporting of the guaranteed sound power level, which takes account of measurement and production uncertainties. The Commission database includes measured sound power levels, from which the guaranteed values are derived. The measured levels may provide a better means of comparing noise emissions of competing machinery.

A review of current standards showed that it is difficult to identify an appropriate test method for determining emission sound pressure levels for hand-held concrete breakers. Emission sound pressure levels for hand-held tools are commonly calculated from measured sound power levels and a factor based on the measurement surface used in the tests. Breakers are excluded from the noise test code for non-electric power tools [16]. The harmonised standard for electric hand-held tools [17] defines the emission sound pressure level as the measured sound power level minus 11 dB; this correction is based on a 1 m radius combined hemispherical/cylindrical measurement surface. The particular requirements for concrete breakers [18], however, specify that a 2 or 4 m radius

hemispherical measurement surface is used to determine sound power level. There is no guidance on how to determine emission sound pressure level from this measured sound power level. Some concrete breaker manufacturers quote sound power levels according to the OND and emission sound pressure levels to one of the basic acoustics standards, for example EN ISO 11203 [19].

The real use sound pressure levels measured at the operators' ears for a small sample of breakers were within 3 dB [14]. The significance of this difference is small taking into account all measurement uncertainties. A practical benefit of selecting breakers on the basis of noise emissions seems unlikely when the difference between the quietest and loudest breakers is less than 5 dB according to the manufacturers' noise declarations.

4.2.2 Sanders and Polishers

The requirements of only the MD apply to sanders and polishers. A review of noise emission values for sanders and polishers [20] found that manufacturers' noise declarations varied greatly in terms of the test method used (if detailed) and the format and type of noise information provided. These variations made it difficult to compare competing machines within the same family. Reproduced measurements did not verify the declared noise emissions provided by the manufacturers for the majority of sanders and polishers.

A review of declared noise emissions provided in over 60 sander instruction manuals found that over half the emission sound pressure levels were not credible indicators of real use risk [21]. The data were not suitable for use in a noise exposure assessment as they were lower by between 9 and 14 dB than real use sound pressure levels. Figure 1 also shows that manufacturers' declared noise emissions do not allow the sanders to be reliably ranked in terms of noise risk.

The noise test codes for sanders give priority to the measurement of sound power level. The emission sound pressure level is calculated from the measured surface sound pressure

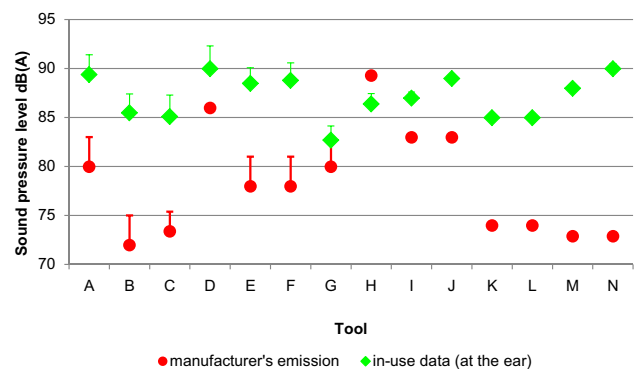


Fig. 1 Comparison of declared and real use noise levels for orbital and random orbital sanders

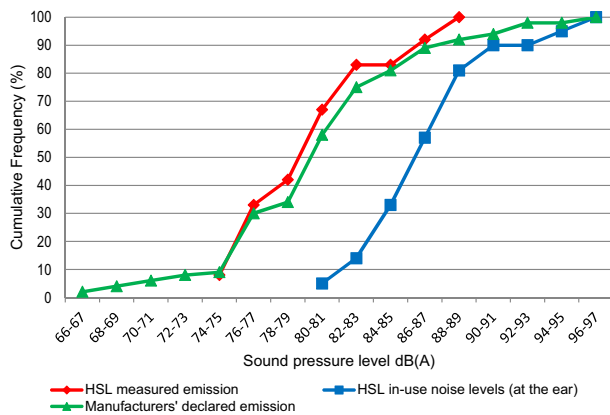


Fig. 2 Cumulative percentage frequency distribution of noise emission values and real use noise levels for orbital and random orbital sanders

levels used to estimate the sound power level. The resultant emission sound pressure levels are typically much lower than the level at the operator's position during real use, as shown in Fig. 2.

The range of reported real use values in Fig. 1 is approximately 5 dB, with absolute sound pressure levels generally between 85 and 90 dB(A). This range is considerably smaller than the range of more than 10 dB in manufacturers' declared noise emissions. The data suggest that there may be an opportunity to reduce noise at the ear by up to about 5 dB, by substituting the quietest for the noisiest model of sander. Further analysis is required to confirm whether these differences are statistically significant and therefore reflect a real choice for purchasers. While it is essential that efforts are made to produce emission sound pressure levels indicative of the actual noise risk to be managed, the benefit of precise ranking reduces when the range of real use noise levels is small.

4.2.3 Wood Chippers

The requirements of both the MD and the OND apply to wood chippers. The OND provides a test method in which the sound power level is determined from measurements over a hemispherical array of microphones, during the chipping of pine or plywood logs. Under the MD, a harmonised standard defines the method of measuring both wood chipper emission sound pressure level and sound power level. In these tests, measurements are made during the chipping of dry pine laths.

A Position Paper published by the European Commission in December 2001 [22] stated that the noise test code in the OND only applies to garden shredders/chippers and not wood chippers, which are designated as forestry equipment. The Position Paper recommended that sound power levels should be determined by applying the operating conditions from the harmonised standard for wood chippers to the measurement procedure specified in the OND.

The range of operating conditions defined in the noise test codes for the MD and OND result in different emission values. Emission sound pressure levels obtained by Brueck [23] for wood chippers chipping dry pine lath (MD) were typically 6 dB higher than chipping pine logs (OND) and 8 dB higher than chipping brush. Chipping of logs and brush are typical chipping operations.

The noise test codes produce emission data that clearly indicate there is a noise risk associated with the use of wood chippers; emission sound pressure levels were up to 117 dB(A) chipping dry pine lath and up to 112 dB(A) chipping pine logs. While it is preferable that noise risk is overestimated rather than underestimated, overstating the noise emission by 5 dB at these levels may make it difficult for employers to identify adequate control measures. For example, employers might look for hearing protectors with a higher performance than necessary to achieve noise at the ear below 80 dB(A). It may be more appropriate for the noise test codes to specify a test wood representative of normal use.

The noise test codes for wood chippers allow sound power levels to be determined from measurements above absorptive or hard reflecting surfaces, using between 6 and 20 microphone positions over a hemispherical array that can have a 4 or 10 m radius. The sound power level can vary by up to 6 dB depending on the number of microphone positions and the orientation of the wood chipper within the microphone array [23]. Noise test codes for wood chippers need to be simplified, clearly specified and consistent with current acoustic practice to ensure that noise emission values from different manufacturers are comparable.

Standard tests for wood chippers produce peak sound pressure levels above the declaration threshold of 130 dB(C). Peak levels were between 133 and 141 dB(C) when chipping dry pine lath and between 129 and 136 dB(C) when chipping pine logs [23]. The presence of peak noise above the declaration threshold is an indicator of risk. The peak noise for wood chippers varied erratically, but current standards do not provide guidance on how to treat this variability.

The OND and MD require the provision of uncertainty data for noise emission declarations. Several standards on reporting uncertainty exist, which provide different definitions for uncertainty and may or may not take the standard deviation of production into account. Uncertainty data must be calculated using a consistent approach for them to be of use. Based on guaranteed and measured sound power levels for shredders and chippers reported by the European Commission [15], uncertainty data are typically between 1 and 3 dB although values up to 33 dB are observed. Uncertainty according to standards under the MD is typically 3 or 4 dB.

Emission sound pressure levels for wood chippers are based on measurements at the operator's ear; this is a simple

measurement process. A measure of the sound pressure level at the operator's position is likely to be useful for comparing the noise risk of competing machines and, if the noise tests made are representative of normal use of the machine, planning for control of that risk. It is likely that peak noise will need to be declared for wood chippers to satisfy the MD but, given the observed 7–8 dB variability in measured peak values, further guidance is required on how best to indicate peak noise risk and its management.

Comparable measured noise emissions for 9 wood chippers showed that there is approximately 7 dB between the quietest and noisiest of these machines, both in terms of sound power level and emission sound pressure level [23]. This suggests that purchasers buying quiet have a genuine choice.

4.2.4 Printing Machinery

The noise information in a small sample of printing machinery instruction manuals was assessed against the requirements of the MD [24] and against real use levels measured for a range of machines and processes at printing premises during 2010 and 2011 [7]. All the instructions contained emission sound pressure levels. The majority of these were comparable with real use noise levels and were generally considered to be a reliable indicator of actual risk. The instructions provided information on using hearing protection, acoustic enclosures and sound covers.

There are several reasons why credible noise emission values appear in instructions for printing machinery. This machinery can be very large and the MD allows for the declaration of emission sound pressure levels at specified positions around the machine. The operating conditions specified in the harmonised noise test code for printing machinery are those associated with significant noise emission at typical operator workstations, for example control desk, delivery unit, winding unit. For some large printing presses the manufacturers' declared noise emissions varied by up to 20 dB, highlighting the noisiest parts of the process and the effectiveness of acoustic enclosures [24]. This study of the printing industry has shown that harmonised noise test codes exist that are capable of providing noise emission data that can be used to assess and manage real use risk.

There is evidence in the printing industry of effective noise control measures capable of reducing operator exposure. Figure 3 shows a newly installed acoustically enclosed reel stand, which reduced operator exposure by 10 dB compared with an older acoustically open reel stand in use at premises that had not been modernised (Fig. 4). It seems that there are opportunities to select between printing machinery on the basis of noise, but the extent to which this is possible has not been quantified.

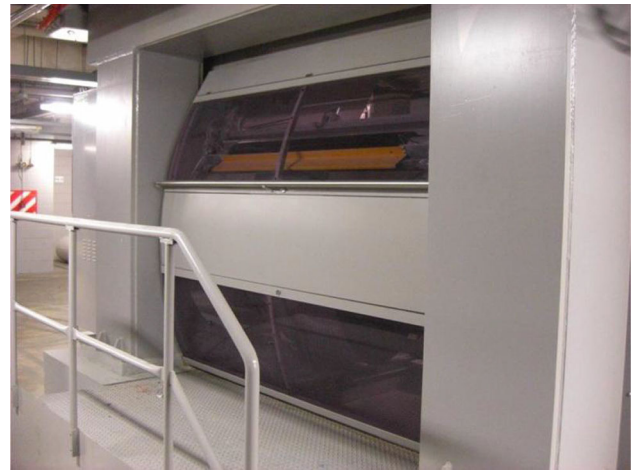


Fig. 3 Acoustically enclosed reel stand where the operator exposure is 76 dB $L_{EP,d}$



Fig. 4 Acoustically open reel stand where the operator exposure is 86 dB $L_{EP,d}$

5 An Infrastructure for Successful Buy Quiet Campaigns

5.1 Buy Quiet

Buy Quiet is a noise risk management initiative that:

- Encourages purchasers to seek out quieter machinery to reduce worker noise exposure.
- Encourages wide availability of reliable information on machinery noise levels, making purchasers aware of the opportunity to buy quieter products.
- Encourages manufacturers to design quieter machinery in response to purchasers' demands for quieter products.

The global nature of trade in machinery means that Buy Quiet is inevitably an international initiative. There are Buy Quiet campaigns in the United Kingdom and other Euro-

pean states, Australia, New Zealand and the United States and wider global interest led by the International Institute of Noise Control Engineering.

5.2 Promotion of Quieter Machinery

Promotion of quieter machinery can be based upon reported noise emissions. The MD requires reporting of emission sound pressure level, peak sound pressure level and sound power level (which for some machines is produced according to the OND). Manufacturers who design and construct machinery so that the risks from airborne noise emissions are reduced to the lowest level at source (or by protective measures), should be able to rely on harmonised standards to produce noise emission information that facilitates reliable comparison of the noise risk with that of competing machinery.

Comparing the noise of competing machinery relies on the availability of reliable and representative comparative noise emission data. This in turn is dependent upon reliable standards, or other methods of determining noise emissions, so the potential for risk can be identified and the relative ranking of machinery can be determined. The experience outlined in this paper for breakers, sanders and wood chippers has shown that noise data produced according to harmonised standards are not always a robust indicator of noise risk; nor do they allow relative ranking of the noise emissions of competing machines.

Promotion of quieter machinery could be achieved through publication of noise emissions. The European Commission hosts a database [15] of sound power levels determined under the OND, in accordance with Article 16 of the OND; there is no similar requirement to publish noise data determined according to the requirements of the MD. Some of the data for breakers and wood chippers reported by the Commission are more than 10 years old and there are some large discrepancies between the guaranteed and measured sound power levels. The usefulness of the OND noise database for selecting quieter machinery is further limited by poorly specified test methods and sound power levels that do not rank noise in the same order as noise measured at the operator's position during normal use. The potential of the OND database, if improved, to identify quieter machinery to purchase should be explored further.

5.3 Provision of Reliable Noise Emission Data

A number of issues with manufacturers' noise emission declarations [11] mean they may not be effective for the intended purposes. Examples include:

- Poorly defined noise test codes may result in noise emission declarations for similar machines, which are inconsistent and not comparable.

- Noise test codes may produce noise emission data that underestimate real use noise levels making them unsuitable for use in estimating noise exposures.
- Noise test codes that give priority to the measurement of sound power level may not provide emission sound pressure levels that represent noise levels at workstations during normal use; the differences can be large. Emission sound pressure levels appear more likely to be reliable when based on measurements at the operator's ear.
- Noise emission values may indicate that there are high noise and low noise models for a particular type of machinery. However, in real use, noise emissions of competing machinery can be indistinguishable and purchasers may be misled into believing there is a real choice to buy quiet.

Noise emission values may not be credible indicators of real use risk. Most commonly this is because the operating conditions specified in the noise test code do not represent the noisiest operations or include all those likely during typical use of the machine. In some cases the type of material being processed during the noise test or the consumable or tool, may be sufficiently different from that which the user intends to work to cause large differences in the noise emission.

At present, some noise test codes do not produce noise emission data representative of the noise generated by the machines during typical use. Based on the evidence presented for sanders and wood chippers, manufacturers' declared noise emissions may underestimate or overestimate workplace noise levels. Few examples have been found of manufacturers providing additional information when there is a gap between the risk associated with the declared noise emissions and the actual risk during the intended use(s) of the machinery.

There are opportunities for noise experts to improve the technical reliability of noise emission declarations when standards come up for periodic review by the European Committee for Standardisation (CEN) and the European Committee for Electrotechnical Standardisation (CENELEC). Harmonised standards should help manufacturers meet the requirements of the MD.

Manufacturers can take immediate steps to improve their compliance and the usefulness of the information provided, for example, by properly referencing the noise test code used (including date and part number as appropriate) so that emission values are traceable.

5.4 User Demand for Low Noise Machinery

Employers have a duty under Directive 2003/10/EC to manage the risks associated with exposure to workplace noise. This Directive expects appropriate use to be made of noise

information supplied by manufacturers of machinery. Purchasers and users should be able to use manufacturers' noise emission data to:

- Determine the existence of significant differences in the noise emissions, within the bounds of uncertainty of the tests, such that the opportunity to buy quieter machinery is clear.
- Determine the contribution of machinery to noise in the workplace during intended uses.
- Determine appropriate controls for high noise modes of operation, for example processing different types or thicknesses of material.
- Plan for and purchase additional noise control measures to manage the propagation of noise to workstations. This may be necessary only for some high noise modes of operation of the machine.
- Establish the minimum standard of hearing protector performance required to protect against the likely noise of the machine to ensure appropriate hearing protection is provided.

Currently, manufacturers' data are rarely suitable for purchasers' use in addressing the above points. Consequently, purchasers and users rarely have the information required from which they can choose low noise machinery.

6 Can Buy Quiet Reduce Workplace Noise?

Buy Quiet encourages manufacturers and users of machinery to work together to reduce workplace noise risk. It supports users in their duty to avoid high noise machinery when suitable lower noise machinery is available and manufacturers in their duty to minimise noise risk (at source) by preventive measures and by provision of information.

Examples of noise control technology applied in the printing industry show that noise can be reduced significantly. Application is, however, not uniform across this industry and it seems probable that this is the case in other industry sectors. The printing industry provides examples of the achievements possible when machine purchasers have recognised the noise hazard, drawn up specifications for noise when purchasing machinery, evaluated potential machinery against those specifications and given preference to low noise machinery, that is, they have successfully applied the principles of Buy Quiet.

Effective selection of quieter machinery on the basis of declared noise emissions has been shown in this paper to require a high level of understanding and caution on the part of the purchaser. Noise measurements during real use show that for some machine types there are noisier and quieter models. For example, the work on the wood chippers showed a real choice, with differences of 7 dB between the noisiest and quietest machines. Similarly, in the printing industry

the noise of comparable machinery differed by more than 10 dB. For powered hand-held tools such as breakers and sanders, the differences between the noise emissions of the models considered was small; perhaps too small, when taking measurement uncertainties into account, to warrant effort to choose between them on the basis of noise.

Declared noise emissions from harmonised noise test codes do not always provide a credible representation of the actual risk during typical use; for example, emission sound pressure levels for sanders were typically much lower than the level at the operator's position during real use. Nor may they indicate the differences in actual noise risk between competing machines. The noise test codes for wood chippers and breakers were found to be poorly defined and complex, particularly for sound power level. Consequently declared noise emissions could be highly variable depending on how the requirements of the noise test code were interpreted by those conducting the noise tests.

Based on the declared noise emissions studied here, purchasers need to recognise and take account of the weaknesses in manufacturers' information currently supplied if they are to successfully Buy Quiet. This requires purchasers to have a high level of understanding of noise to carry out a critical review of declared noise emissions. This includes understanding the differences between emission sound pressure level, sound power level, and peak instantaneous sound pressure level and what these quantities can and cannot be used for. Suitable guidance for purchasers has not been found.

The emission sound pressure level required by the MD should be sufficient for purchasers to compare the noise of machines and should help users identify and manage noise risk. The additional complexity of measuring sound power level, over the relative simplicity of measuring emission sound pressure level, does not appear to have added value for the small sample of machinery studied here.

Buy Quiet will, currently, only result in lower workplace noise risk if the purchaser has a high level of understanding of noise and a high commitment to reduce noise risk through selection of quieter machinery.

7 Future Potential for Buy Quiet to Reduce Workplace Noise

A NOMAD Task Force is already taking action to tackle the weaknesses found during the preliminary market surveillance NOMAD study by:

- Raising the awareness of manufacturers of their legal duties concerning noise.
- Raising the awareness of purchasers of their legal duties on noise and the resources available to support them.

- Providing guidance for manufacturers on drafting the noise content of instruction manuals.
- Providing an internet-based database of harmonised noise test codes for manufacturers, etc.
- Working with standards bodies and manufacturers' associations to improve referencing and traceability of harmonised standards.
- Supporting targeted market surveillance of the noise content of technical sales literature, in parallel with noise measurement campaigns to verify declared noise emissions and establish indicative values of noise risk.
- Providing a checklist for market surveillance personnel, which includes a brief description of the noise related requirements and examples of good and inadequate declarations.
- Working with Notified Bodies to achieve good, fit for purpose standards of noise reporting, for Annex IV (MD) and other machines, useful as models of good practice for self-assessors.

One of the NOMAD findings was that emission data derived from noise test codes may not be capable of indicating the relative noise risk between comparable machines, when a difference exists in actual noise risk. Investigating the weaknesses in harmonised noise test codes (and the test codes for sound power level set out in the OND) is outside the scope of the current work of the NOMAD Task Force. A new approach to noise test codes may be required for some machine types, such as power hand-held tools, whereas revision of existing codes may achieve the required improvements for other machines, such as wood chippers.

Buy Quiet depends on shared knowledge of reliable noise emission information. Noise measurement campaigns to verify declared noise emissions and establish indicative values of noise risk appear central to widespread Buy Quiet success. These projects have potential to identify where there is a genuine choice for purchasers helping ensure Buy Quiet makes a positive contribution to reducing workplace noise risk. They might also be designed to show the potential for developing harmonised noise test codes to fulfil this role.

In addition to the above, separate work should be done to evaluate the extent to which appropriate noise control technology is applied by manufacturers of competing machinery. This should quantify the potential to reduce machinery noise before or after supply.

Buy Quiet has potential to result in lower workplace noise risk if noise information can be made simpler and more reliable. This may require a departure from the harmonised standards approach and a greater reliance on shared information based on noise risk assessed during normal work.

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