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Quality of noise emission data: An experimental verification for outdoor equipment

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ABSTRACT

We have experimentally examined noise emissions of different kinds of outdoor equipment - leaf blowers, lawn mowers, motor hoes and chainsaws. The potential of a Buy-Quiet strategy regarding the purchase of different kinds of outdoor equipment is discussed. Besides the measurement results we describe the issues connected with carrying out the measurements according to the applicable, harmonized European standards. Differences and inconsistencies of the standards applicable to the studied outdoor equipment are pointed out. We discuss challenges of the conflicting requirements of the Machinery and the Outdoor Noise Directive.

Keywords: Noise, Environment, Buy-Quiet
I-INCE Classification of Subject Number:11

1. INTRODUCTION

The NOMAD survey (2012), a European market surveillance campaign, demonstrated that 80% of the noise emission data, provided with machinery, were not reliable.

However, reliable noise emission data are a prerequisite for buyers and users of machinery to successfully implement a Buy-Quiet strategy. Whereas more than 1500 instruction manuals were reviewed against the requirements of the Machinery (2006/42/EC) and (where applicable) the Outdoor Noise Directive (2000/14/EC), measurements to verify the declared noise emission values could not be carried out within the framework of the NOMAD survey.

Since machine noise is one of the main sources of noise exposure of workers a verification of noise emission data by measurements seems to be adequate. Here, were present our results for certain kinds of outdoor equipment.

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2. INTERPLAY OF OUTDOOR NOISE AND MACHINERY DIRECTIVE

The noise requirements on outdoor equipment are covered by two European Directives the Outdoor Noise Directive 2000/14/EC (OND) and the Machinery Directive 2006/42/EC (MD). Since the OND has priority over the MD the sound power level has to be declared and labelled on the machine according to the OND. In contrast to the requirements of the MD, the sound power level is declared as a single number, containing the uncertainty. The resulting quantity is the guaranteed sound power level.

One can further distinguish between machines, whose guaranteed sound power level is restricted to a certain limit value (Article 12, "Equipment subject to noise limits"[1], 22 kinds of equipment) and those machines that just have to be labelled with a guaranteed sound power level (Article 13, "Equipment subject to noise marking only").

Another huge difference between the OND and the MD is that the OND is a Global Approach Directive, while the MD is a New Approach Directive. This means that the OND directly specifies all requirements within its scope and contains dated references to standards, while the MD only contains essential health and safety requirements for machinery. Manufacturers either have to document how their machine complies with these requirements or can use a harmonized, machine specific standard (C-standard) listed in the Official Journal of the European Union (OJEU), if available, and benefit from the presumption of conformity with the requirements of the directive.

These differences between the OND and the MD can lead to a situation, where the standards that have to be used to document/determine conformity with the requirements of the respective directive differ (see Section 5.2, for example).

3. EXPERIMENTAL DETAILS

All measurements have been performed in the hemi-anechoic test room at BAuA in Dortmund, which is qualified according ISO 3745 for 1/3-octave bands with center frequencies ranging from 63 Hz to 12,5 kHz. The sound power level was determined from sound pressure measurements at six positions on a hemisphere with a radius of 4 m. The microphones were positioned as specified in ISO 11094:1991.

The uncertainty of the determined sound power level is 2,5 dB(A), but does not include the spread of the sound power level resulting from product variations.

Where specified in the relevant standard the measurements were conducted over an absorbing floor, which meets the requirements of ISO 11094:1991.

Regarding the chainsaws it is important to note that in contrast to the requirements in the standards the tested chainsaws were not new and partly had been subject to other safety tests prior to our noise emission measurements.

4. EQUIPMENT SUBJECT TO NOISE LIMITS

4.1 Lawn mowers

The declared, guaranteed sound power level L_{WA} of five combustion engine powered (M3; M11 to M14) and nine mains powered (M1 and M2; M4 to M10) lawn mowers were checked by measurements according to EN ISO 3744:1995 and ISO 11094:1991.

However, already the declared noise emission values are of interest here: Six of the tested lawn mowers were declared with the limit value of 96 dB(A), four mowers were declared close to the limit value with 93 dB(A) and 94 dB(A), respectively. Thus, only four mowers were declared lower than the limit value: M1: 92 dB(A); M7: 89 dB(A); M9: 92 dB(A); M10: 89 dB(A).

It seems that only a few significantly quieter models are among our sample, but is this reflected by our determined sound power level?

The manufacturer or the involved Notified Body has to add the uncertainty K to the determined sound power level including the uncertainty resulting from product variations. However, the difference between the determined and the declared sound power level ranges from one to seven dB, which suggests a large variation of the uncertainty chosen by the different manufacturers. This might be the result of a large variation of the uncertainty resulting from product variations or of different approaches to determine the uncertainty.

Taking into account the results of our measurements there are six machines which are significantly quieter than the limit value ($L_{WA} < 90$ dB(A)) among the studied lawn mowers (determined sound power level): M1: 85 dB(A); M2: 87 dB(A); M5: 87 dB(A); M7: 84 dB(A); M9: 88 dB(A); M10: 84 dB(A).

Thus, about half (6 of 14) of the tested lawn mowers would represent a good choice regarding a Buy-Quiet strategy, but this could be recognized from the declared value only for four of the six quieter lawn mowers.

While our measurements do not indicate that the manufacturers did not comply

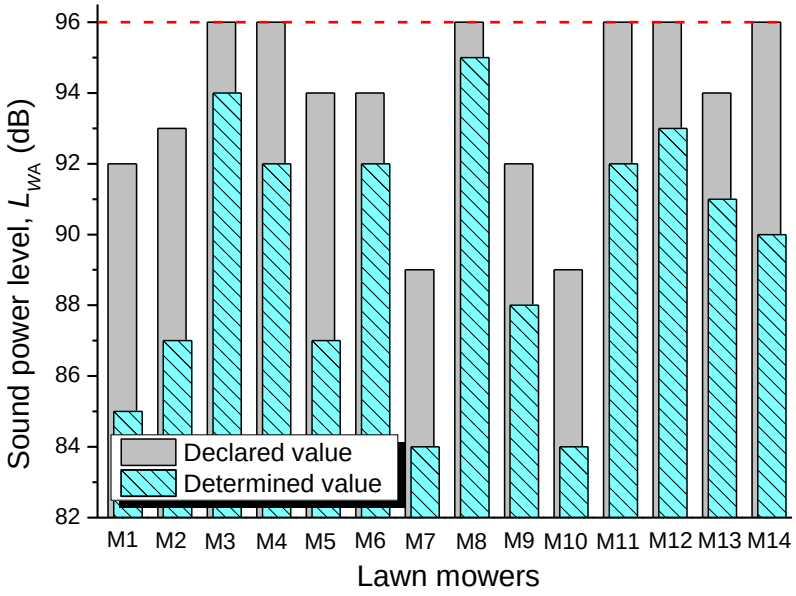

Fig. 1 – Sound power level of the 14 lawn mowers. For six lawn mowers (M3, M4, M11, M12) the declared guaranteed sound power level is equal to the limit value of 96 dB(A) (shown by the dashed red line).

with the requirements of the OND, they imply that some of the studied lawn mowers either have a large spread of the L_{WA} due to product variations or have been declared quite conservatively. The latter would mean that the competitive advantage of quieter machines is wasted and Buying-Quiet is made more difficult for consumers and employers.

Furthermore, the lawn mowers are also covered by the MD. Thus, the emission sound pressure level has to be declared (see Essential Health and Safety Requirements in the MD, Section 1.7.2u), too. ISO 4871:1996 is listed as a harmonized standard under the MD in the OJEU and specifies how to declare the noise emission values of machines and how one can verify the declared values. It is important to note that the mowers were obtained and measured in different years: M1 to M3 in 2005; M4 to M10 in 2010; M11 to M14 in 2017.

In good agreement with the results of the NOMAD survey[1] only 12 of the 14 studied lawn mowers were provided with a declaration of the emission sound pressure level in the instruction manual, although this quantity is very important for the risk

assessment by the employer. Furthermore, the uncertainty K of this value was only specified for four lawn mowers and three lawn mowers were declared at an unrealistically low L_{pA} below 75 dB(A).

We measured the emission sound pressure level of four lawn mowers according to EN 60335-2-77:2011. Table 1 shows the results. According to ISO 4871:1996 Cl. 6.2 one can verify the declaration of a single machine, if the measured emission sound pressure level L_1 meets the following criterion:

$$L_1 \leq L_{pA} + K_{pA} \quad (1)$$

This is the case for lawn mowers M11 and M12. However, already the declaration of the emission sound pressure level for M13 does not meet the requirements of ISO 4871:1996, since the uncertainty has not been declared. If one assumes an uncertainty $K_{pA} = 3$ dB, the declared value would be verified.

M14 does not comply with the requirements of the MD, since the emission sound pressure level has not been declared in its instruction manual.

Table 1 – Declared and measured emission sound pressure level of the lawn mowers.

Mower	Declared L_{pA} in dB	Declared uncertainty K_{pA} in dB	Measured L_1 in dB	Measurement uncertainty K in dB
M11	84,5	3	83	2,6
M12	81,9	3	83	2,6
M13	80	-	81	2,6
M14	-	-	80	2,6

In conclusion, the quality of the declaration of the emission sound pressure level is worse than that of the sound power level, since only 4 declarations mostly meet the requirements of the MD. Even here one declaration does not contain a reference to the standard used or the operating conditions for the measurement of the emission sound pressure level.

4.2 Lawn trimmers

The declared, guaranteed sound power level L_{WA} of 11 mains powered lawn trimmers (T1 to T11) were checked by measurements according to DIN EN ISO 3744:1995 and DIN EN ISO 11094:1991. T2 obviously did not comply with the OND,

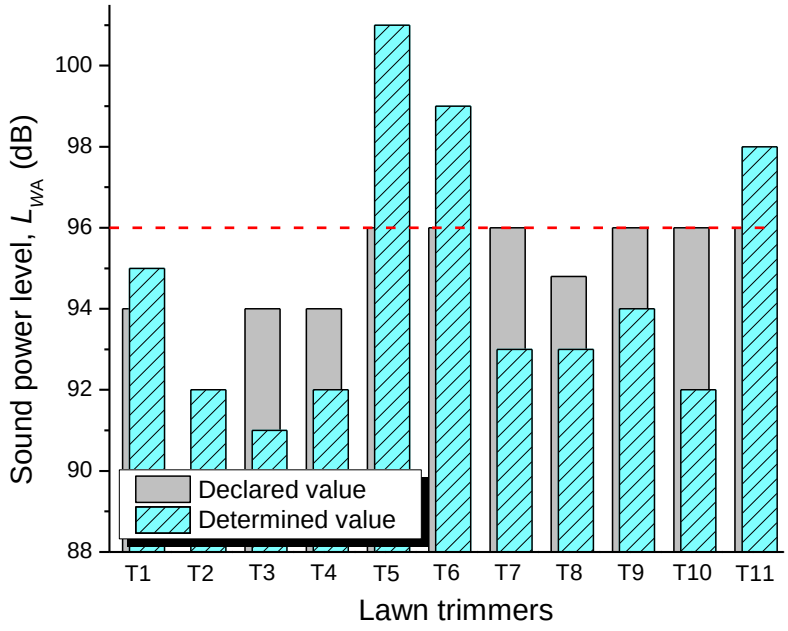

Fig. 2 –Sound power level of the 11 lawn trimmers.3 out of the 11 measured sound power level exceed the limit value (shown by the dashed red line).

because it was not labelled with a guaranteed sound power level. The other lawn trimmers were either declared with the limit value (6 of the 11) or with guaranteed sound power level very close to it (4 of the 11): 94 dB(A) and 94,8 dB(A), respectively. Thus, it would be very difficult for a potential buyer to identify a quieter alternative among the studied sample. But is there any such alternative?

Our findings in Fig. 2 hint at a problem with the conformity with the requirements of the OND, since three lawn trimmers exceed the limit value and one further lawn trimmer at least exceeds its guaranteed sound power level. Furthermore, there are only slightly quieter lawn trimmers among the studied sample: T2: 92 dB(A); T3: 91 dB(A); T4: 94 dB(A); T10: 92 dB(A).

In conclusion, the poor competition in terms of noise emissions among the manufacturers of this kind of equipment, which is implied by the declared sound power level, results in a low potential to Buy-Quiet in practice, too.

While we did not measure the emission sound pressure level, we checked the declared emission sound pressure level. The result is similar to that for the lawn mowers: Only eight of the eleven tested lawn trimmers were provided with a declaration of the emission sound pressure level in the instruction manual. Only one of these declarations contained the uncertainty of the L_{pA} and only five a reference to the standard used to determine this quantity. Furthermore, two lawn trimmers were declared with an unrealistically low L_{pA} below 75 dB(A).

4.3 Motor hoes

We studied a sample of ten mains powered motor hoes, which all were obtained in 2018. According to the OND this kind of equipment should be measured the same way as lawn mowers using the standards EN ISO 3744:1995 and ISO 11094:1991, but for motor hoes the "tool shall be disconnected during measurements". However, we found no reference to these standards in the conformity declarations, provided in the instruction manual, but references to EN 709:1997+A4:2009 and EN 60335-1:2012.

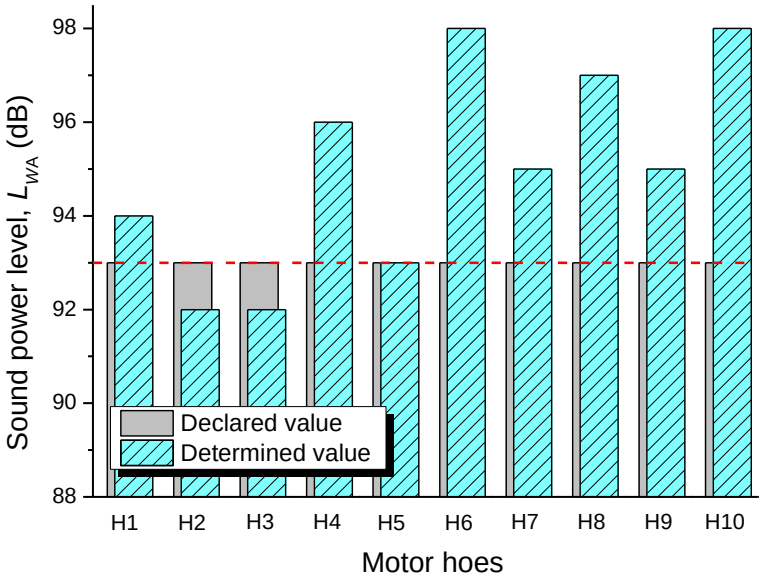

Fig. 3 – Sound power level of the 10 motor hoes.Seven motor hoes exceed the limit value (emphasized by the red dashed line) for this kind of equipment.

All motor hoes were declared at the limit value for the guaranteed sound power level of 93 dB(A). Thus, a potential buyer could not recognize a quiet model (at least among the motor hoes in our sample) by the labelled guaranteed sound power level.

Our measurements according to EN ISO 3744:1995 and ISO 11094:1991 over an absorbing floor imply yet another issue with this kind of equipment: The results of our measurements, illustrated in Fig. 3, show that seven out of ten tested motor hoes (70%!) exceed the limit value and guaranteed value, respectively. This observation implies that the lowering of the limit value from 96 dB(A) (Stage I of the OND, entered into force on 2 January 2002) to 93 dB(A) (Stage II of the OND, entered into force on 2 January 2006 through Directive 2005/88/EC) might not have led to the desired decrease in noise emissions from this kind of outdoor equipment.

While H1 only slightly exceeds the limit value and an effort of the manufacturer to just meet the legally required minimum in terms of low noise emissions might be recognizable, H6, H8 and H10 even exceed the old limit value of 96 dB(A). H4, H7 and H9 clearly exceed the limit value of 93 dB(A), but would comply to the old limit value of 96 dB(A). In conclusion, Buying-Quiet based on the guaranteed sound power level labelled on the machine is impossible for the tested motor hoes.

We checked the declared emission sound pressure level and tried to verify them by our own measurements according to EN 709:1997+A4:2009. Might it still be possible to Buy-Quiet based on the values declared according to the requirements of the MD? The declared emission sound pressure level of the different motor hoes are similar (see Fig. 4), which is in good agreement with the declared and determined sound power level. Only one motor hoe (M2) is declared at a significantly lower emission sound pressure level $L_{p\mathrm{A}} = 71{,}3$ dB(A). Such a significant difference compared to the other studied motor hoes could only result from a strong directivity of this machine.

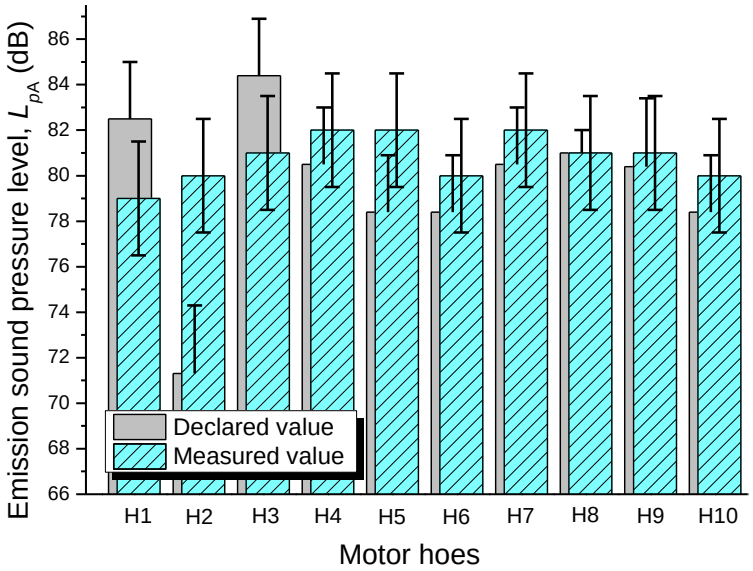

Fig. 4 – Emission sound pressure level of the tested motor hoes. All measurement values except for one are lower than or within the uncertainty of the declared value. However, the declared emissions sound pressure level of H2 is clearly lower than the measured value.

In contrast to the measurement according the OND, the harmonized standard listed under the MD EN 709:1997+A4:2009 requires a measurement over a reflecting floor. This inconsistency between the requirements of both directives increases the measurement effort.

According to Equation (1) (see also ISO 4871:1996 Cl. 6.2) the declared values of all motor hoes but motor hoes H2 and H5 could be verified. The measured emission sound pressure level for motor hoe H2 would even allow one to reject a whole batch of

machines, based on the criterion of ISO 4871:1996 Cl. 6.3.1 for the verification on the basis of measurements on a single machine from a batch:

$$\left[(L_{p\mathrm{A}} + K_{p\mathrm{A}}) - L_1\right] < -0{,}5 \text{ dB} \quad (2)$$

This false declaration is problematic not only because of the non-compliance with an Essential Health and Safety Requirement of the MD, but also from an Occupational Health and Safety point of view. The declared low emission sound pressure level of 71,3 dB(A) might lead to an underestimation of the noise risk of this machine.

In conclusion, Buying-Quiet based on the emission sound pressure level $L_{p\mathrm{A}}$ would be impossible, too. The span of the declared emission sound pressure level (excluding H2) is 6 dB(A), while the span of the measured emission sound pressure level is 3 dB(A). Furthermore, there are machines that are up to 3 dB quieter than declared and vice versa.

5. EQUIPMENT SUBJECT TO NOISE MARKING ONLY

The OND sets no limit values for the guaranteed sound power level for this kind of equipment, but does this lead to less or more competition in terms of products with low noise emissions?

5.1 Leaf blowers

We determined the sound power level $L_{W\mathrm{A}}$ of 20 leaf blowers (three combustion engine powered (L6, L8 and L12), one battery powered (L19) and 16 mains powered leaf blowers) according to the OND using EN ISO 3744:1995 and ISO 11094:1991 and compared these data to the declared, guaranteed sound power level $L_{W\mathrm{A}}$. All tested machines differ at least by make or model, but due the practice of rebranding it might be possible that two or more machines are of the same type. The span of the declared $L_{W\mathrm{A}}$ is 12 dB, where the noisiest leaf blower has a declared sound power level of 110 dB(A) and the quietest two machines an $L_{W\mathrm{A}}$ of 98 dB(A). Thus, the declared values suggest

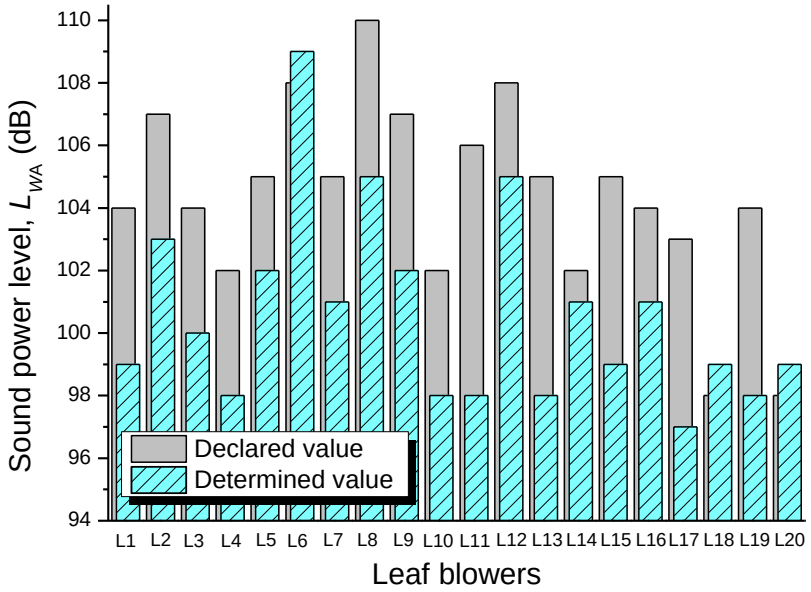

Fig. 5 – Declared and determined sound power level of 20 leaf blowers. Cyan bars exceeding the corresponding gray bars hint at a possible non-compliance with the requirements of the OND.

that there are quieter alternatives available and Buying-Quiet should be possible for this kind of equipment.

Fig. 5 shows the L_{WA}, which have been determined from our measurements, in comparison to the guaranteed sound power level. While the span of the determined sound power level is also 12 dB, the results indicate that some of the tested leaf blowers might not comply with the requirements of the OND. The determined sound power level of L6 (109 dB(A) versus a declared value of 108 dB(A)), L18 (99 dB(A) versus a declared value of 98 dB(A)) and L20 (99 dB(A) versus a declared value of 98 dB(A)) exceed the declared guaranteed sound power level.

The large spread of the difference between the declared and the determined sound power level, partly in combination with non-compliance with the requirements of the OND, prevent a potential buyer from recognizing quiet alternatives. If one were to select between L13 and L14 or L19 and L20 based on the declared sound power levels (see Fig. 5) one would end up with a louder machine in both cases. Furthermore, many quiet options cannot be recognized because of very conservative declarations.

5.2 Chain saws

Following the Joint Action on Machinery 2014[4] (JAMach14), where the NOMAD TF contributed by checking the declared noise emission values of the studied chainsaws similar to the "original" NOMAD survey[1,5], the possibility to perform noise emission testing on the chainsaws, investigated within JAMach14, was discussed among the NOMAD TF. As a result, BAuA and Health and Safety Executive (HSE, United Kingdom) performed noise emission tests on some of these chainsaws.
Here, we present the results and observations of the measurements at BAuA.

The OND contains a reference to EN ISO 9207:1995 for the determination of the sound power level of chainsaws. However, this standard has become obsolete and has been replaced by EN ISO 22868:2011, which is listed as a harmonized standard under the MD in the Official Journal of the European Union. However, EN ISO 9207:1995 as an obsolete standard is not listed under the MD anymore.

As discussed by *Brereton et al.*[5], manufacturers would have to perform tests according to both standards, EN ISO 9207 and EN ISO 22868, in order to presume conformity with both directives, the MD and the OND. This would mean a repetitious determination of the sound power level using different operating conditions.

We did not find any reference to EN ISO 9207:1995 in the instruction manuals, but to the following standards: EN ISO 11681-1:2011 and -2:2011, EN ISO 22868:2011 and for mains and battery powered chainsaws EN 60745-2-13:2011.

Thus, we assumed that the guaranteed sound power level required by the OND had been determined using EN ISO 22868, too. Furthermore, based on a comparison of EN ISO 9207 and an early draft of EN ISO 22868 the results should be similar using both methods, whereupon the method introduced with EN ISO 22868 might yield a slightly higher sound power level (about 1 dB) than EN ISO 9207[6].

In contrast to other machines covered by the OND, the sound power level of the chainsaws has to be determined by measurements over a reflecting plane. This did not change in ISO 22868:2011, the standard superseding the obsolete ISO 9207:1995 (referenced in the OND). However, the measurement effort increases for this kind of outdoor equipment, because the emission sound pressure level has to be determined from measurements over an absorbing floor that meets the requirements of ISO 11094:1991.

We were provided with 33 pairs of chainsaws. However, due to the damage some chainsaws sustained during the testing in JAMach14, due to practical difficulties (only certain chainsaw models were compatible to our water brake) and due to incomplete technical data we tested only 7 different models. C1 to C3 are combustion engine powered, C4 to C6 are mains powered and C7 is battery powered.

16 of 25 combustion engine powered chainsaws were not provided with the rotation speed at maximum power. Thus, it was impossible to measure at the operating condition "full-load". Here, the saw has to work against the water brake and the water pressure is adjusted, so that it runs at the rotation speed at maximum power. This failure to comply with the requirements of EN ISO 11681-1:2011 or ISO 11681-2:2011 regarding the contents of the instruction manual can prevent noise testing by market surveillance authorities, since not all necessary information is provided with the product.

Fig. 6 shows a chainsaw mounted for testing under the condition "full load". Here, we faced the problem that ISO 22868:2011 requires the chainsaw to be positioned quite close to the wooden block (10 ± 5 mm from the claw stop of the chainsaw), while the exhaust of most chainsaws faces in the direction of the blade. Thus, the hot exhaust gases are blown directly at the wooden block, which almost caught fire during the measurements. The photo (Fig. 6) reveals that we had to protect the wood with a metall plate, which might have slightly altered the sound absorption properties of the wooden block.

Another problem were the requirements regarding the rotation speed during the measurements: It was difficult to ensure that the rotation speed would fluctuate less than $\pm 3{,}5\ \mathrm{s}^{-1}$ during a measurement (ISO 22868:2011 Cl. 7), especially for combustion

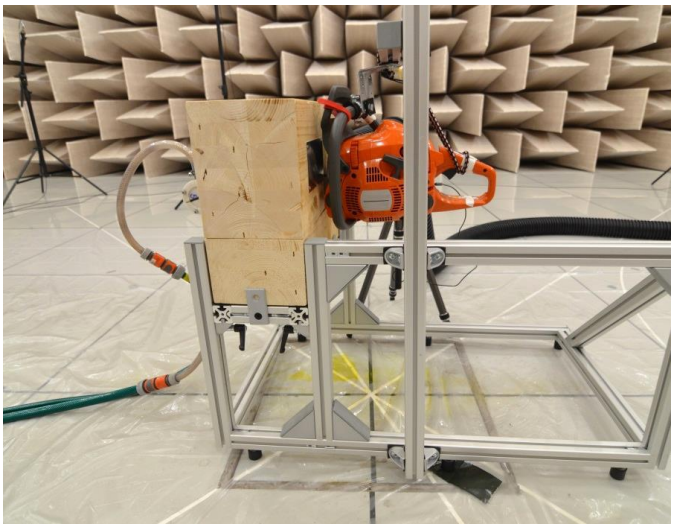

Fig. 6 – Photo of a chainsaw mounted for testing the "full load" condition.

engine powered chainsaws.

Fig. 8 shows the declared and determined sound power level of the tested chainsaws. Note that the testing was not completely according to ISO 22868:2011, since the requirement of Cl. 7 to use new machines was not met. The "full load" condition for the mains powered chainsaws C4 to C6 was achieved by adjusting the water brake and measuring the current, so that one reached the rated current of the chainsaw. We used a stabilized power supply that ensured a voltage $U_{\mathrm{rms}} = 230\ V$.

The battery powered chainsaw (C7) was tested at maximum speed only ("racing test"), since EN 60745-2-13:2011 contains no clear instructions on how to deal with battery powered chainsaws and IEC FDIS 62841-4-1:2016 specifies two operating conditions for the testing of battery powered chainsaws that are essentially "racing tests".

All tested chainsaws seem to comply with the requirements of the OND (see Fig. 7). The fact that the determined sound power level for C3 slightly exceeds its declared

value might be explained by the condition of the chainsaws under test. The chainsaws have been subject to safety testing in JAMach14 and partly sustained damage, whereas

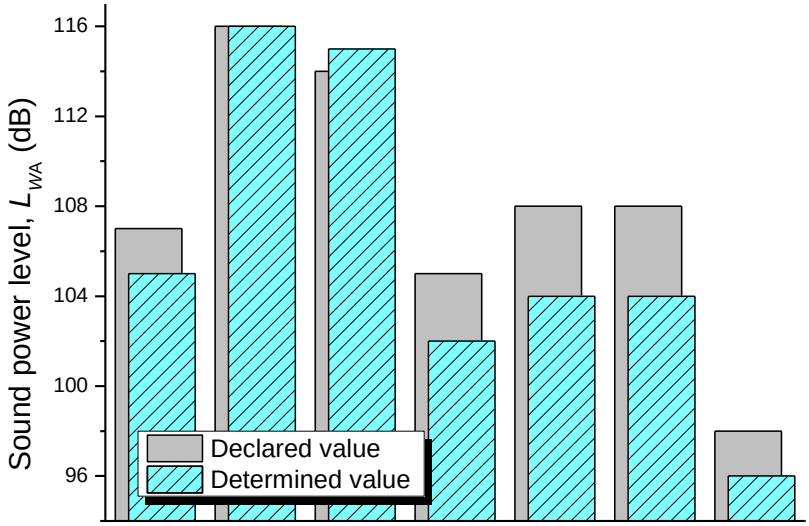

Fig. 8 - Declared and determined sound power level of 7 chainsaws.

according to ISO 22868:2011 the tested chainsaws should be new, unused machines.

Regarding the quality of the noise emission data of chainsaws we refer to *Brereton et al.*[5] Fig. 8 shows our measurements of the emission pressure level of the chainsaws.

Note that for mains power chainsaws (EN 60745-1:2009 Cl. 6.1.2.3) the emission sound pressure level has to be calculated from the sound power level L_{WA}

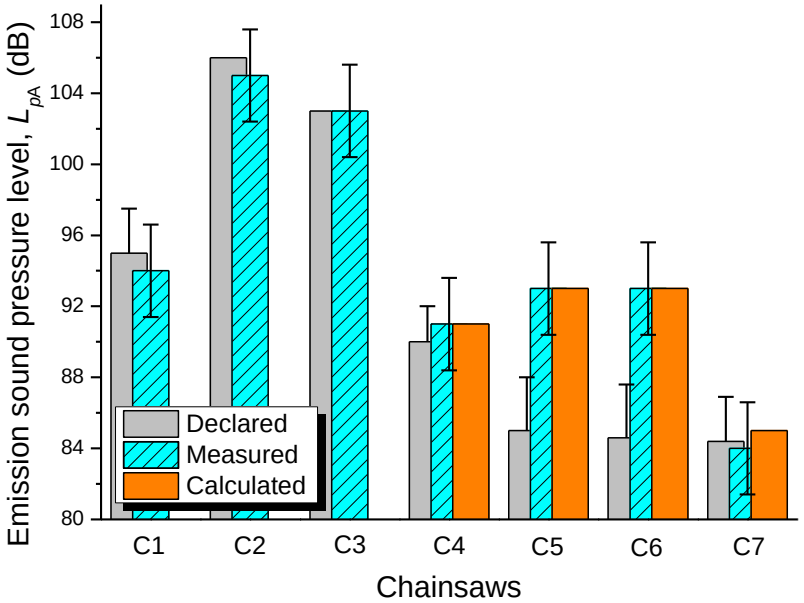

Fig. 7 – Declared and measured emission sound pressure level of the tested chainsaws. The inset shows a comparison to the emission sound pressure level calculated from the sound power level.

following EN ISO 11203.

However, we measured the emission sound pressure level also for the mains and battery powered chainsaws to see if the calculated values represent the real noise hazard resulting from the chainsaws. Here, the battery powered chainsaw was tested at maximum speed only ("racing test"). The inset shows a comparison of the measured

emission sound pressure level and those calculated from the determined sound power level shown in Fig. 8. To that end 11 dB(A) are subtracted from the determined sound power level. However, note that according to IEC FDIS 62841-4-1:2016 the emission sound pressure level should be determined from measurements (operating condition "racing test").

Our results hint at a problem with the declared emission sound pressure level of the mains powered chainsaws C5 and C6, which was also mentioned in the review of the noise emission declarations provided in the instruction manuals of the chainsaws investigated during JAMach14[5]: The difference between the guaranteed sound power level of 108 dB(A) and the declared emission sound pressure level of 85 dB(A) (C5) and 84,6 dB(A) (C6) is about 23 dB, which is an improbable difference and much more than the 11 dB specified for the calculation of the emission sound pressure level in EN 60745-1:2009.

As a result, from the false declaration of the emission sound pressure level for chainsaws C5 and C6 (see criterion in Equation (2)) employers might underestimate the noise hazard from this kind of equipment and, for example, select improper personal protective equipment for their employees.

6. DISCUSSION

We found that the interplay of the OND and the MD regarding the requirements for noise testing and noise information for outdoor equipment can increase the measurement effort and sometimes makes it necessary to conduct measurements according to two similar standards (see Section 5.2).

While for some kind of "equipment subject to limit values" (e.g. the lawn mowers) we found at least compliance with the limit value, about 27% of the tested lawn trimmers and 70% of the tested motor hoes did not comply with the requirements of the OND. The potential to Buy-Quiet on the basis of the guaranteed sound power level for equipment subject to limit values was particular low due to the tendency to simply declare the limit value. As a consequence, relatively quiet machines (see sound power level of the lawn mowers in Fig. 1) might not be recognized as such in some cases, while in other cases, e.g. the motor hoes, this practice reflects the fact that there is no potential to Buy-Quiet among the studied sample.

Buying-quiet based on the guaranteed sound power level could be difficult, if not impossible for most of the studied "equipment subject to noise marking only", too. Our measurement revealed a tendency to declare the sound power level of the studied leaf blowers quite conservatively, while at the same time some of the tested leaf blowers exceeded their declared sound power level. This could lead to a situation, where the leaf blower with a higher declared sound power level is actually quieter. Although the studied sample of chainsaws is rather small, it suggests that for chainsaws buying-quiet on the basis of the declared sound power level should be possible.

Regarding the potential to Buy-Quiet on the basis of the emission sound pressure level, declared in compliance with the requirements of the MD, we have less measured data. In total 70 % of the declared emission sound pressure level (14 of 20) could be verified for the tested machines. However the span of the declared emission sound pressure level, which could be verified for a certain kind of equipment, is rather low, so one could hardly recognize a quiet machine on the basis of the emission sound pressure level. Furthermore, our results indicate that there are some false declarations that are already obvious from a comparison to the declared sound power level (e.g. the declared values for motor hoe H2: $L_{pA} = 71{,}3$ dB; $L_{WA} = 93$ dB) This issue is especially surprising for mains powered chainsaws, because here the emission sound pressure

level has to be calculated from the measured sound power level. The results of our survey of the declared data are similar to that of the NOMAD survey[1] and suggest that the quality of the noise emission declarations has to be improved.

7. CONCLUSION AND OUTLOOK

The poor overall compliance with the requirements of both the MD and the OND, observed in our study, suggests that market surveillance activities, targeting noise emission data, should be increased. This would also benefit a fair competition regarding low noise emissions.

Regarding the observed tendency to declare outdoor equipment quite conservatively, we encourage manufacturers to perform the measurements according to the standard and only add a reasonable uncertainty, if the product variations allow for it.

BAuA is a member of the NOMAD Task Force, which is a working group under the aegis of Administrative Cooperation of EU Member states. This task force has published a guide for manufacturers on how to report noise emission data in instruction manuals[7] to aid manufacturers to fulfill their legal obligations.

In order to support manufacturers determining and declaring the noise emissions of their machines, BAuA is conducting research aimed at a simplification of noise emission measurement standards[8].

7. ACKNOWLEDGEMENTS

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8. REFERENCES

1. Report on the "NOMAD" project, 2012, http://www.hse.gov.uk/noise/nomad-report.pdf.
2. Directive 2000/14/EC of 8 May 2000 on the approximation of the laws of the Member States to noise emission in the environment by equipment for use outdoors, Official Journal of the European Communities L 162/1, 3 July 2000.
3. Directive 2006/42/EC on machinery, and amending Directive 95/16/EC (recast) of 17 May 2006, Official Journal of the European Union L 157/24, 9 June 2006.
4. Joint Action on Machinery 2014, http://www.prosafe.org/index.php/jamach2014.
5. Paul Brereton and Jacqueline Patel. Compliance of Chain-saw Noise Information with the Machinery Directive 2006/42/EC3744. *Proc. INTER-NOISE 2018*; 26-29 August 2018; Chicago, United States of America 2018.
6. Eleonora Carletti. Experience regarding Directive 2000/14/EC related to the future introduction of noise limits for combustion engine chain saws. *Proc. INTER-NOISE 2010*; 13-16 June 2010; Lisbon, Portugal 2010.
7. B. Juan y Seva Guevara, M. Szyszko, P. Brereton, J. Patel, T. Wu, D. Korver, P. Kurtz, J. Jacques, C. Maujean, St. Nygård. Guide for manufacturers on how to report noise emissions and other literature in accordance with Machinery Directive 2006/42/EC and Outdoor Noise Directive 2000/14/EC, Germany 2016. https://www.baua.de/EN/Service/Publications/Report/NOMAD-Guide.html
8. Fabian Heisterkamp and Ilka Arendt. Simplified Determination Of the Environmental Correction For Noise Emission Measurements. *Proc. INTER-NOISE 2018*; 26-29 August 2018; Chicago, USA 2018.