Application Note

Sound Power Determination with or without ISO 9614–1

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In Europe, a new "Machinery Directive" has been written, coming into force from 1/1/95. The purpose of this directive is to ensure the health of people using machines.

The directive states, among other things, that equipment sold in Europe must fulfil specified noise demands. The equipment covered by this directive is everything from jacks and garden tractors, to chain saws and plastic moulding machines.

What should be stated in the instruction manual for the equipment?

If the A-weighted sound pressure level is below 70 dB(A), this must be indicated (L_p < 70 dB(A) re 20 Pa).

Above 70 dB(A), the A-weighted sound pressure level should be stated.

If the sound pressure level exceeds 85 dB(A), the A-weighted sound power level should also be stated.

If the machine is very large, the sound power level is replaced by the sound pressure level measured at significant positions.

If the noise contains peaks exceeding 130 dB(C), this must also be stated.

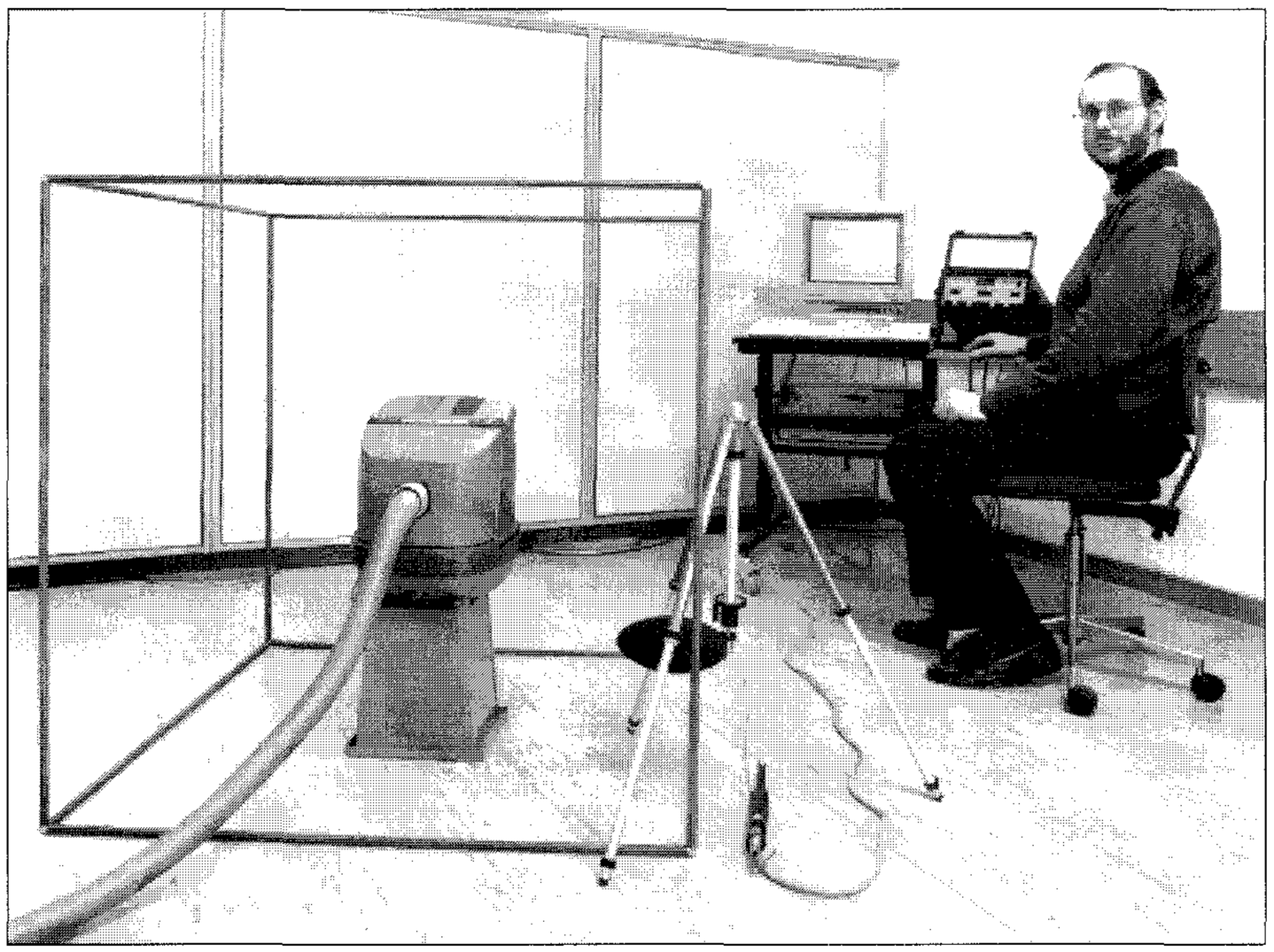

Fig.1 In this particular case the measuring conditions was improved by raising the vacuum cleaner 25 cm over the floor

Introduction

Driven by the new directive, a large number of factories, producers and small contractors will in the near future begin to make sound power measurements. For some, these measurements will be their first contact with the acoustic environment.

The purpose of this application note is to show novices how easily the sound power measurements can actually be performed. For this purpose we have chosen a modern "Nilfisk" vacuum cleaner from the Danish manufacturer Fisker & Nilsen. The measurements are first done according to ISO 9614–1, a suitable standard for this purpose, and then as simply as possible. As you will see, the results are very close.

Instrumentation

For the sound power determination of this vacuum cleaner we have chosen the new sound power, low-cost package **Type 3554**, containing all the necessary equipment and software.

To perform measurements according to the ISO standard, you need a computer with a National Instruments IEEE interface board. The computer then acts as controller and the Sound Intensity Analyzer as front end.

Making measurements

With the ISO 9614–1 standard

To ensure the quality of the sound power determination, the ISO standard prescribes a number of checks (boolean expressions). These checks are based on different measurement calculations called **Field indicators**.

Since the ISO standard came, people have spent a lot of time making advanced spreadsheets or tried to make the calculations by hand. But that is all history now.

The PC-program guides you through the difficult parts of the ISO standard giving good advice about what to do next.

The standard provides three grades of accuracy:

- Precision
- Engineering
- **Survey**

Note that only the survey grade supports A-weighted sound power determination.

For our vacuum cleaner we choose an arrangement of measuring points on a measuring surface that enclose the noise source. This surface is here a cubic box of 1 × 1 × 1 m with 4 measuring points on each surface.

The result of the measurement is illustrated in Fig.2. According to the machine directive, only the A-weighted value is of interest:

$$L_W = 68.5\ \text{dB(A) re 1 pW}$$

Without any standard

In this case we will instead of fixed points use the scanning method,

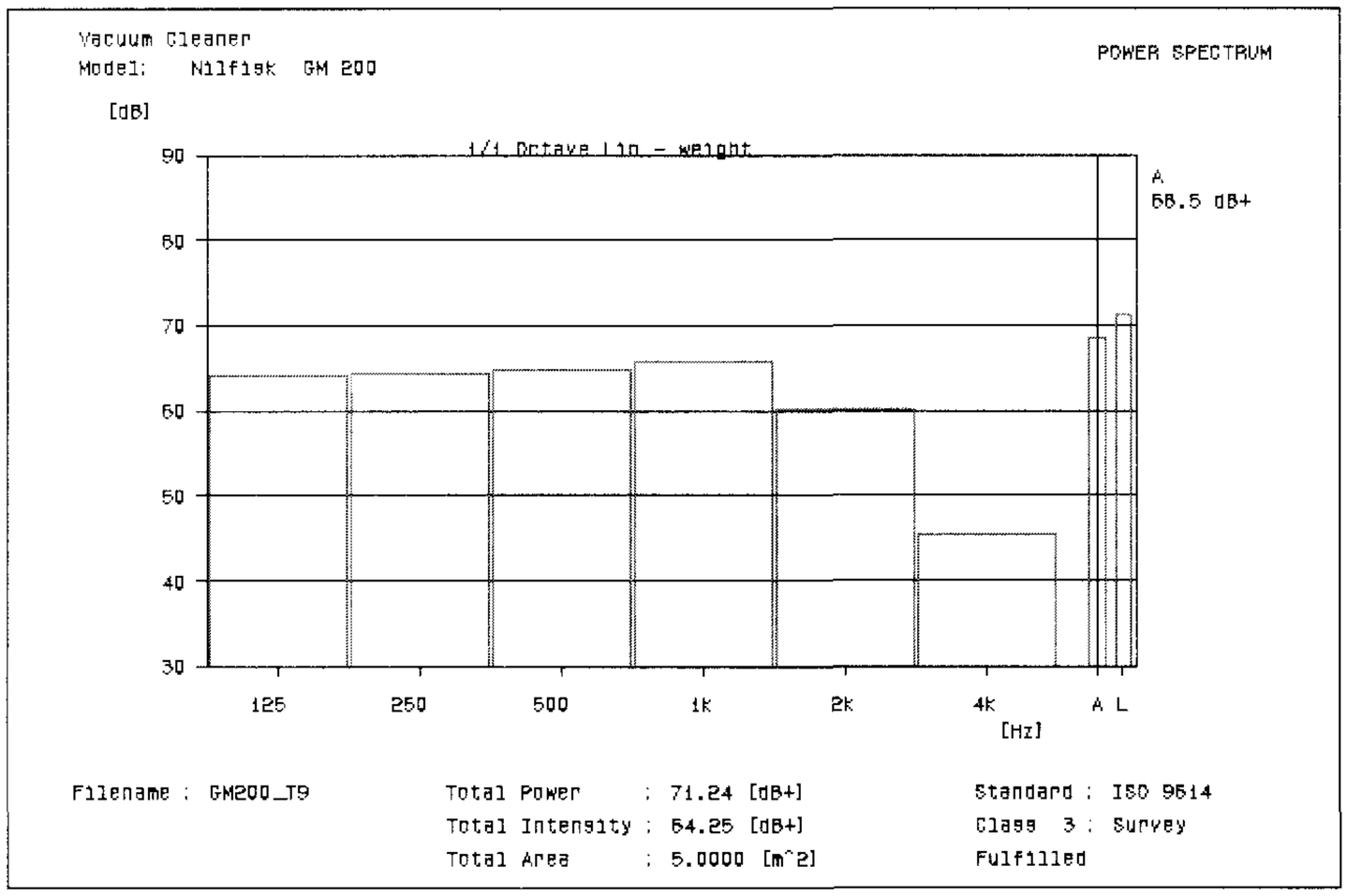

Fig.2 When fulfilling the machine directive, only the A-weighted sound power is of interest

which is described in the ISO 9614–2 standard. But we will make none of the field indicator checks, and we therefore don't need the computer.

This simple method of determining the sound power is actually described in a Nordic standard called INSTA 121, which is not very well-known.

The result of the measurement is illustrated in Fig.3, from where we get:

$$\mathbf{L_W = 68.1\,dB(A)\ re\ 1\,pW}$$

Conclusion

We have made two different types of sound power determination, one according to ISO 9614–1 and one very simple according to no standard. From the results it appears that both methods have proved equally good.

The machine directive does not say anything about how the results should be obtained, but for most people it is important that their measurements are made according to an international standard. That gives a sort of security.

During the pre-investigation of the vacuum cleaner, it was establish that raising the vacuum cleaner 25 cm over the floor improved the measurement conditions. But it is important to emphasize that other noise sources might be acoustically influenced if they are raised from the floor, and therefore emit a different power.

Regarding point measurements, one of the main problems which, especially at low frequencies can really influence the result, is that a relatively high negative intensity flow and/or standing waves can occur. This is due to reflections from the walls, and can be difficult to get rid of. One way is to move the vacuum cleaner around in the room, another is to go closer to the noise source, facing near field problems instead. Before making the measurement, try checking the intensity flow in each planned position. This is easily done moving around with the 4437 displaying "Fast" exponentially averaged intensity.

The point measurement took nearly two hours, calibration included, where the sweep measurement was concluded in less than half an hour!

The machine directive

According to the machine directive, the noise specification depends of the A-weighted sound pressure level. This can be determined from the sound power level.

We need to find the **sound pressure level** in free-field conditions one metre from the vacuum cleaner. We therefore subtract the number of

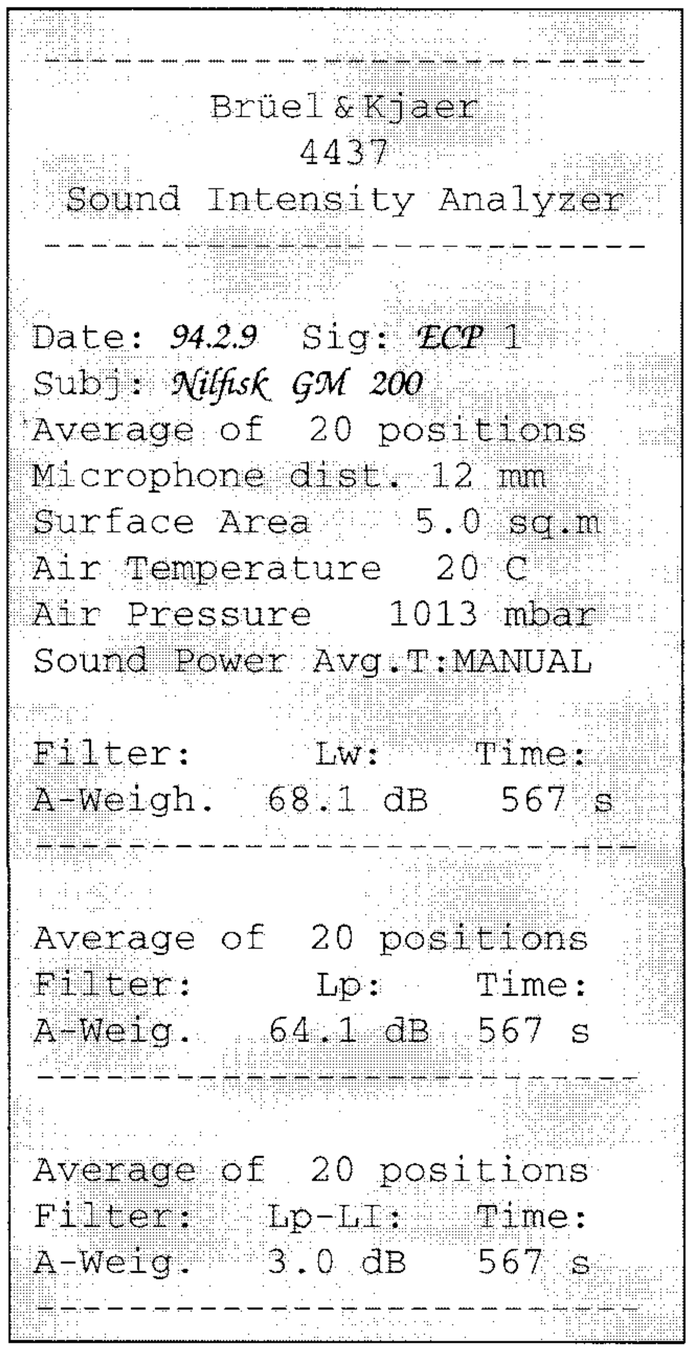

Fig.3 Using WT9347, you can transfer documentation directly to the PC

dBs corresponding to the area of a hemisphere of one metre radius:

$10\mathrm{Log}(2\pi r^2) = 8\,\mathrm{dB}$.

The sound pressure level is then:

$69\,\mathrm{dB(A)} - 8\,\mathrm{dB} = \mathbf{61}\,\mathrm{dB(A)}$

According to the machine directive, the Danish manufacturer, Nilfisk, therefore only have to state that their vacuum cleaner is "low noise". But as a competitive parameter for the future, it might be a good idea to state the sound pressure (at 1 m) and/or sound power level:

L_p: 61 dB(A) re 20 µPa

L_W: 69 dB(A) re 1 pW

which corresponds to the manufacturer's specifications.

How to operate the instruments is detailed described in: Guided Tour; Sound Power Determination using Type 3554, with or without ISO 9614-1; BS 0167.

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