NoiseBody	Work Group of Notified Body's 2000/14/EC **Recommendation for Use**	RfU No. **07-003 R1**

Key Words: Uncertainty K, Uniform assessment of conformity

Question/Problem:

Directive 2000/14/EC demands statistical safeguarding of the declared sound power levels, but at the same time it does not specify the method of calculating the uncertainty K which is to be added to the averaged sound power level. Up to now various different formulas have been used throughout Europe to determine uncertainty K, leading to noteworthy diverse results.

Solution:

In the following, a Uniform management of uncertainty is presented. This proposal specifies the minimum requirements which should be fulfilled in order to verify the conformity whatever module (V, VI or VIII) is used.

This proposal has been guided by the following essential criteria. The model shall:

- Lead to realistic results
- Be acceptable by industry and authorities
- Be verifiable (the decision itself as well as the declared L_{WAd} under control of production (COP) and market surveillance)
- Have reference to international or at least European standards
- Be easy to handle

After weighting disadvantages and advantages the best solution seems to use a calculation in convergence to ISO 7475-4 in combination with realistic values of σ_R listed in a table[1]:

$$K = 1.5 \cdot \sigma_t$$

with

σ_t total standard deviation, $\sigma_t = \sqrt{\sigma_R^2 + \sigma_P^2}$

σ_R standard deviation of reproducibility (see table 1)

σ_P standard deviation of production, which has to be assumed for later (mass-) production.

Values for σ_R have to be taken from table 1 attached to this proposal which is a commitment based on the experience of the European Notified Bodies.

[1] The proposed values for σ_R are estimations based on the experience of European Notified Bodies. Generally verification by round robin test is considered to be desirable.

Preconditions for use of the values listed in table 1 are:

- Time synchronous measurements at all positions[2]
- Qualification of the environment correction K_{2A} using a calibrated reference sound source (measurement and correction)[3]
- Retraceable calibration of measurement devices (class 1)
- Measurement carried out by skilled personal only (sound technicians and trained operators)
- Minimum sample size has to be $n \geq 5$
- Ambient temperature[4] 20℃ ± 10℃
- Sufficient repeatability[5] $s_r < 0.5 * \sigma_R$

If the preconditions given above are not fulfilled, the NB shall <u>not accept</u> these minimum values of reproducibility given in the table 1[6].

To obtain reasonable values for σ_p different ways are possible:

1. The σ_p is calculated individually from the measurement results of at least the first 5 machines produced. Determine s_p for an sample size of $n \geq 5$ machines. Because the production variation may enlarge under later production conditions, it is recommended to calculate σ_p as follows:

$$\sigma_p = SF \cdot s_p$$

The necessary size of the safety factor SF depends on the relation between s_p and σ_R as well as on the sample size n.

n	$s_p \leq \boldsymbol{\sigma_R}$	$s_p > \boldsymbol{\sigma_R}$
5 -7	**1.3**	**1.5**
8 - 12	1.2	1.3
13 – 19	1.0	1.1
≥ 20	1.0	1.0

2. The Notified Body (the manufacturer) knows from long year experience which value for σ_p could be achieved for this type of machine under the manufacturing conditions given. Evidence on a base of sample sizes $n \geq 18$ ($\sigma_p > \sigma_R$) or $n \geq 12$ ($\sigma_p \leq \sigma_R$) is necessary.

[2] In some cases the use of 3 sound level meters, in case of stationary noise 1 sound level meter, is sufficient.
[3] It is necessary to ensure that K_2 is within a range of ±0.4 dB, otherwise small values of σ_R as proposed in table 1 are not valid. Correction needs a lot of experience and comparison-measurements at optimal conditions.
[4] Measurements may also be done at temperatures higher or lower. But in that case a correction is necessary.
[5] Try to achieve a repeatability of less than 0.15 dB.
[6] It is always in the responsibility of the Notified Body (Annex V: manufacturer) to use a σ_R, which is adapted to the accuracy of the measurement. Estimated values of σ_R in table 1 are valid only for optimized measurement conditions.

The guaranteed sound power level L_{WAd} following directive 2000/14/EC is calculated as:

$$L_{WAd} = L_{WAm} + K$$

rounded[7] to a whole figure, where L_{WAm} is the averaged sound power level of the sample.

As long as no 5 machines for averaging are available[8], declare L_{WA} following annex VII or have an estimation using a K from experience (example: $K \geq 2$ dB). Check the plausibility of declaration by ongoing sampling.

Under certain circumstances, the averaged sound power level L_{WAm} and the σ_t may change during ongoing production. So it is proposed to verify L_{WAm} and σ_t by ongoing sampling, anyway necessary for COP. Re-calculate L_{WAd} with the growing sample size. So your accuracy will grow year by year ($n \rightarrow \infty$). If necessary the manufacturer has to modify his declaration of conformity (DOC).

Conformity Verification

By periodically checking[9] the Notified Body[10] has to verify the conformity of the certified product during ongoing production. This control of production (COP) follows the principle of shared risk.

Measurements for COP have to fulfil the same preconditions listed above (except the sample size).

This verification is a double-sample test with sample size $n_1 = 1$ for the first sample and sample size $n_2 = 2$ for the second sample as described at ISO 7574-4 section 6.3 and table 2[11]. These sample sizes are also the most practical way for COP and market surveillance.

The same σ_t used during declaration shall be used also for verification.

This is why it is important for the manufacturer to show the σ_t value used in the technical documentation. If no σ_t is available in the technical documentation, set $\sigma_t = 2.5$ dB.

The procedure is shown in figure 1 as a graphic.

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[7] Rounding down may cause problems at COP and market surveillance (see paragraph "Verification").
[8] For machines sold not so often, this process may take more than 1 year. Statistic may be based also on former annex VII results.
[9] Once a year should be the normal time interval, but it may be increased for rare produced machines as well as decreased for large scale production.
[10] The same duty is to manufactures following annex V.
[11] For large scale production an increased number of samples or sample size may be necessary.

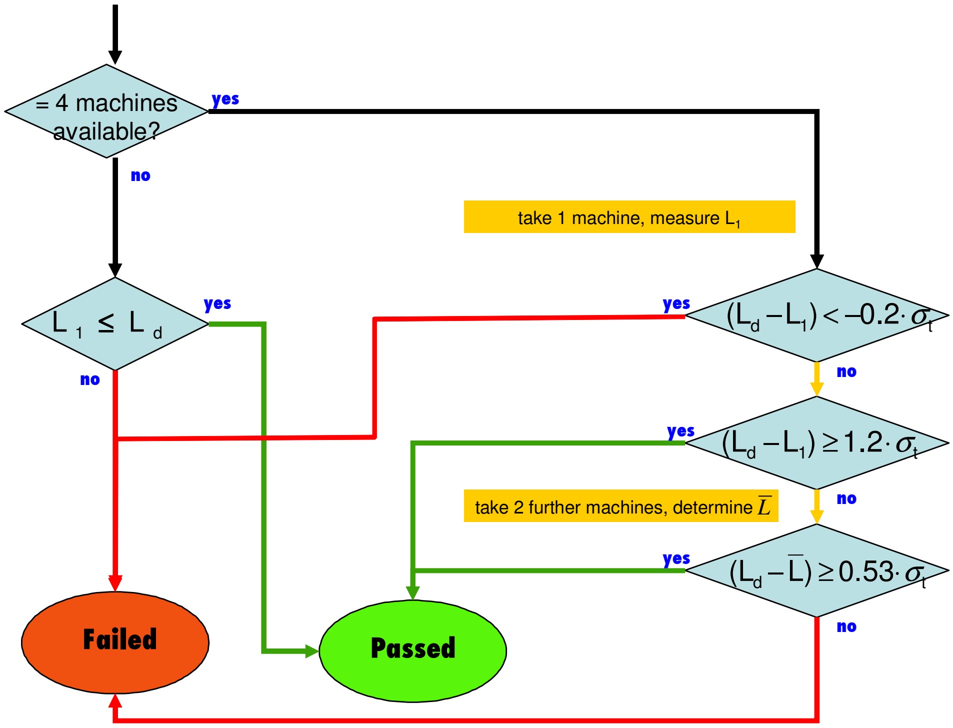

Fig. 1: Verification procedure

The procedure for COP described here may fail, if for comparison the whole figure of L_{WAd} which comes from rounding down to get the final labelled sound power level, is used. The calculation must be based on the un-rounded result of L_{WAm} + K. This term may be shown in the technical documentation too.

Table 1 Suggested values for σ_R for use within assessment following 2000/14/EC

No	Type of Equipment	Article 12	Article 13	σ_R
1	Arial access platforms with combustion engine		x	0.70
2	Brush cutters		x	0.50
3	Builders hoist for the transport of goods	x		0.60
4	Building site band saw machines		x	0.50
5	Building site circular saw bench		x	0.50
6	Chain saw, portable		x	1.00
7	Combined high pressure flusher and suction vehicle		x	0.50
8.1	Compaction machine, non vibrating rollers	x		0.50
8.2	Compaction machine, vibrating rollers for ride on operation	x		0.50
8.3	Compaction machine, vibratory plates, vibratory rammers and walk behind vibrating rollers	x		0.80
8.4	Compaction machine, explosive rammers	x		1.00
9.1	Compressor; P ≤ 15 kW	x		0.50
9.2	Compressor; P > 15 kW	x		0.50
10	Concrete-breakers and picks, hand held	x		1.00
11	Concrete or mortar mixer		x	0.50
12	Construction winch	x		0.60

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Continuation Table 1 Suggested values for σ_R for use within assessment following 2000/14/EC

No	Type of Equipment	Article 12	Article 13	σ_R
13	Conveying and spraying machine for concrete and mortar		x	0.50
14	Conveyor belt		x	0.50
15	Cooling equipment on vehicles		x	0.50
16	Dozer	x		0.50
17.1	Drill rig, drilling only		x	0.50
17.2	Drill rig, roto hammers		x	1.00
18.1	Dumper; P ≤ 55 kW	x		0.50
18.2	Dumper; P > 55 kW	x		0.50
19	Equipment for loading and unloading of silos or tanks on trucks		x	0.50
20	Excavator, hydraulic or rope-operated	x		0.50
21.1	Excavator-loader; P ≤ 55 kW	x		0.50
21.2	Excavator-loader; P > 55 kW	x		0.50
22	Glass recycling container		x	1.00
23	Grader	x		0.50
24	Grass trimmer/grass edge trimmer	x		0.40
25	Hedge trimmer		x	0.60
26	High pressure flusher		x	0.50
27	High pressure water jet machine		x	0.80
28	Hydraulic hammer		x	1.00
29	Hydraulic power pack	x		0.70
30	Joint cutter		x	0.50
31	Landfill compactor, loader-type with bucket	x		0.50
32.1	Lawnmower; L ≤ 120 cm	x		0.40
32.2	Lawnmower; L > 120 cm	x		0.40
33	Lawn trimmer/lawn edge trimmer	x		0.50
34	Leaf blower		x	0.60
35	Leaf collector		x	0.60
36	Lift truck, combustion-engine driven, counterbalanced	x	x	0.50
37.1	Loader, P ≤ 55 kW	x		0.50
37.2	Loader, P > 55 kW	x		0.50
38.1	Mobile crane; P ≤ 55 kW	x		0.60
38.2	Mobile crane; P > 55 kW	x		0.60
39	Mobile waste container		x	1.50
40	Motor hoe; P ≤ 3 kW	x		0.50
41.1	Paver-finisher; P ≤ 55 kW	x		0.60
41.2	Paver-finisher; P > 55 kW	x		0.60
42	Piling equipment		x	1.00
43	Pipe layer		x	0.50
44	Piste caterpillar		x	0.40
45	Power generator	x		0.50
46	Power sweeper		x	0.60
47	Refuse collection vehicle		x	0.50
48	Road-milling machine		x	0.50
49	Scarifiers		x	0.50
50	Shredder/chipper		x	1.00
51	Snow-removing machine with rotating tools		x	0.50
52	Suction vehicle		x	0.50
53	Tower crane	x		0.40
54	Trencher		x	0.50
55	Truck mixer		x	0.50
56	Water pump unit		x	0.80
57	Welding generator	x		0.50

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