



FÉDÉRATION EUROPÉENNE DE LA MANUTENTION
Section Industrial Trucks

FEM
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**Information of the application of the
EC Regulation on the noise of forklifts**

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0 Foreword

There are two EC Directives containing noise specifications that must be met by forklifts.

1. Machine Directive 98/37/EEC

This Directive concerning machinery safety applies to all industrial trucks. It requires the sound pressure level at the driver's ear to be quoted in the operating instructions.

If this value is greater than 85 dB(A), the sound power level must also be indicated. No limits are fixed.

Determination of the values is done according to the harmonised Standard EN 12053 (based on EN 12001 and EN ISO 3744). The noise level quoted is the sole responsibility of the manufacturer.

2. Directive on noise of machines operated outdoors 2000/14/EC

This Directive applies to 57 machine types, for 22 of which noise sound power limit values are defined. It requires listing of the sound power level (ambient noise emission levels).

Noise statements and labelling (without limits) are required for:

- Forklifts with internal combustion engines up to and including 10 t load capacity.

Noise statements and labelling subject to a maximum limit are required for:

- Forklifts with internal combustion engines, load capacity greater than 10 t, with the exception of forklift trucks specifically designed for container handling,
- Off-road forklifts (Rough terrain trucks)

The values are determined according to EN ISO 3744 and the special requirements in the EC Directive (2000/14/EC). Listing is mandatory in the Declaration of Conformity and on the forklifts. Special control measures, e.g. by testing offices, are provided for. This noise information also must be provided to national authorities and the EC Commission.

The following sections describe more details and recommendations for their application:

1. Comparison of noise data
2. Measurement of volume level, comparing methods of measurement
3. Determination of noise data
4. Listing of noise data in operating instructions
5. EC Declaration of Conformity

1 Comparison of noise data of counterbalanced trucks in accordance with the EC directives

Directive 2000/14/EC „Noise emission in the environment by equipment for outdoor use	EC directive 98/37 for machinery (EN12053 – Industrial trucks, noise emission)
Noise at drivers ear L_{PA}	
No data to be recorded	Always to be recorded L_{PAZ} Average value of Idling, Lifting, Driving and single values for Idling, Lifting, Driving
Data for sound power level L_{WA}	
Data for IC-trucks and plates on the truck < 10t guaranteed value > 10t < value limit	Only if $L_{PAZ} > 85\text{dB (A)}$ otherwise only for planning, Often used for determination of noise emission at the environment
Test method L_{WA} in accordance with ISO 3744, hemisphere	
4 measurement points according to EN 12053 plus 2 additional measurement points	4 measurement points according to EN 12053
Modes of operation and weighting	
Lifting 30 % Driving 70 %	Idling 58 % Lifting 18 % Driving 24 %
Examples of results of measurements on 10 m hemisphere radius	
Lifting 73 dB(A) Driving 76 dB(A) $L_{WA} = 103,3 \text{ dB(A)}$	Idling 59 dB(A) Lifting 73 dB(A) Driving 76 dB(A) $L_{WAZ} = 99,3 \text{ dB(A)}$
Evaluation of the results	
The result is not suitable for practical use of industrial trucks, because it does not reflect the real emission.	The result shows the real noise emission of industrial trucks in operation.

Verification of data	
<p>Manufacturers declaration of an “guaranteed” sound power level, including additions of the variation in production and the measurement uncertainties of the manufacturer. This additions can be 2 to 4 dB(A) So for the example</p> <p>$L_{WA} = 105 \text{ to } 107 \text{ dB(A)}$</p>	<p>By referencing EN-ISO 4871 the manufacturer shows the data of the measurement and an uncertainty K, which includes the variation in production and different methods of measurement. Accordingly, it should be recorded for example:</p> <p>$L_{WA} = 99 \text{ dB(A)}$ $K = 2\text{dB(A)}$</p>
Verification	
<p>a) Machinery without noise limit values: Internal controls following annex V - Documentation following annex V.3</p> <p>b) Machinery with noise limits values according to annex VI</p> <ul style="list-style-type: none"> - Internal control - Documentation in accordance to annex VI 3 - Check of the documentation through a notified body - Check of production through a notified body in accordance with the documents/audit or measurements <p>or according to annex VII Unit verification check of the documents and measurement through a notified body</p> <p>or according to annex VIII through a notified body a full quality assurance system with special reference to this directive</p>	<p>By manufacturer in its own responsibility</p> <p>Documentation in accordance with the machinery directive to be proven only on explicit request.</p>
Notification	
To national notified body	None

2 Measuring of the sound power level of forklifts

See measurement methods according to

- Directive 2000/14/EEC, described in Appendix III annex A (general) and annex B36 (for forklifts)
- Directive 98/37/EEC – EN 12053 noise measurement for industrial trucks

Both methods of measurement are based on the basic measurement standard EN ISO 3744 (measurements on a hemisphere above a hard surface). Thus the specifications for the measurement equipment, environment and framework conditions are the same. However, the following items require special attention as they do differ (labelled below as "EC" for Directive 2000/14/EC and "EN" for EN 12053):

Operation during testing

EC App. III, A 2.1 Blower fan rpm
- max. rpm
or
- rpm 0 and rpm max., from which mean weighted noise values are calculated
or
- at least 70% of max. rpm with continuously switched blower fans

EN 4.2 If the blower fan has several speeds the middle speed or speed below the middle speed (even number)

Remark: In cases where these sections refer to a forklift, it makes sense to run the "drive" and "lift" measurements at maximum blower fan rpm to avoid double measurements.

EC A 2.2 Test of devices at zero load.
A 2.3 Test of devices under load.

These general specifications are specified in greater detail in annex B36. They are identical with EN (although the measurement for "idle" is lacking).

Calculation of sound pressure level at the measurement surface

EC A 3 Take at least three separate measurements (as in EN) and calculate the sound pressure at the measurement surface.

EC Difference between two determined values: max 1 dB(A).

EN Difference between two determined values: max 2 dB(A).

EC & EN The volume level is calculated on the basis of the two highest levels with the above-mentioned difference.

Number of microphone positions

- EC** A 5 6 microphone positions are stipulated: Nos. 2, 4, 6, 8, 10 and 12. Positions 10 and 12 are $0.71 r$ (r = radius of hemisphere) high and $0.65 r$ away from the centre of the vehicle track.
- EN** 4 microphone positions are stipulated. Positions 1, 2, 3, 4, correspond to 4, 6, 8, 2 according to EC.
- Remark:** Theoretically, the result could be obtained with a single measurement point if the noise source produced noise evenly. For this reason, measurements of relatively homogeneous noise sources can be expected to produce the same result with 4 instead of 6 measurement points.

Radius of the hemisphere

- EC** A 5 $r \geq 2 \times$ the greatest length ℓ ("without added-on components"). In Part B36, indirect reference is made to ℓ according to Fig. 1, EN. Therefore, the specification is met if r is defined according to 6.2.2 EN.

Ambient correction factor K_{2A}

Ambient correction is required when the measurement surface is located near buildings that reflect sound. The measurements taken in such cases result in higher values than are actually present.

- EC** A 6 No correction permitted
 $K_{2A} = 0$
- EN** Correction by up to 2 dB(A) with reference to ISO 3744 is permissible.

- Remark:** At a wall distance of $\geq 3 \times$ measurement distance from the noise source, is $K_{2A} \leq 0.5$ dB(A), (e.g. 30 m wall distance from middle of forklift and measurement point with $r = 10$ m between wall and forklift)

Summary

If the above stipulations are complied with, the results for determination of noise values can be used according to 2000/14/EEC and EN 12053 for the same measurement.

3 Measurement of the noise data information according to the Directive 2000/14/EEC

Determination of “guaranteed” sound power levels

The “measured sound power level” is the value measured on a forklift or the mean of a number of measurements on different forklifts of the same type. The “guaranteed sound power level” must, according to Article 3 f) also include the measurement uncertainties and the production variations of the manufacturer in addition to the “measured sound power level”, so that the quoted value is complied with or fallen short of. For this reason, the statistical rules for measurement uncertainties and production scatter must be taken into account by adding a correction factor K (also known as the uncertainty factor) to the measured value:

$$L_{W\text{guar}} = L_{W\text{meas}} + K$$

whereby the following must be taken into account:

a) Repeatability standard deviation S_r

Measured sound power levels show, as does every measured value, deviations from the mean (measurement uncertainties). Every manufacturer must determine their own reproducibility standard deviation by means of statistical evaluation of the measurement results for

- the same machine
- the same measurement site
- the same measuring instruments
- the same measurement personnel
- different times of measurement

Standard deviations are calculated according to the formula:

$$S = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n - 1}}$$

where

- n is the number of measured values
- x is the individual measured value
- \bar{x} is the arithmetic mean of n measured values

According to the definition, the standard deviation indicates the greatest deviation from the mean is to be expected statistically expected for 68 % of all measured values.

b) Production standard deviation S_p

This is determined on the basis of the measured values for machines of the same type

- for different machines
- for the same measurement site
- the same measuring instruments
- the same measurement personnel

If no data are available, S_p can be estimate with ≤ 2 dB(A), see (ISO 4871, A2.3).

c) This results in a total standard deviation S_t

$$S_t = \sqrt{S_r^2 + S_p^2}$$

In order not to exceed the guaranteed sound power level with a statistical probability of 95 %, multiply the total standard deviation by a t-factor taking into account the so-called student-t distribution. This t-factor depends on the desired confidence interval for the statement (in this case 95 %) and the number of random samples evaluated:

Random samples	t-factor
2	6.314
5	2.132
10	1.833
∞	1.645

Thus the manufacturer's correction factor is

$$K = S_t \times \text{t-factor}$$

Example: the following values were determined:

- Repeatability standard deviation $S_r = 0.5$ dB(A)
- Production standard deviation $S_p = 0.9$ dB(A)
(for 5 machines)

this results in

$$\text{Total standard deviation } S_t = \sqrt{S_r^2 + S_p^2} = \sqrt{0,5^2 + 0,9^2}$$

$$S_t = 1.03$$

The t-factor for 5 random samples is 2.132. This means the correction factor is

$$K = 1.03 \times 2.132$$

$$= 2.2 \text{ dB(A)}$$

If S_t was derived from 10 random samples, then

$$K = 1.03 \times 1.833$$

$$= 1.9 \text{ dB(A)}$$

i.e. the difference in the numbers to be quoted would be only 0.3 dB(A). Such a small difference would only be significant in the final result due to the rounding-off rules.

Another important thing is that the sound power level to be quoted as the measured value is the arithmetic mean of the value measured under b), please see above. These listings apply for machines produced in series.

In the case of individual machines, the production scatter is lacking, so that only measurement uncertainty S_r is taken into account by adding it to the measured value

$$L_{W\text{guar}} = L_{W\text{meas}} + S_r$$

Presentation of the sound level information

2000/14/EC: The guaranteed sound power level is quoted as the sum of the measured value and K as a whole number (rounded off) in the Declaration of Conformity and on a plate attached to the forklift.

98/37/EC: The sound power level, when required, is listed in the operating instructions as a double value comprising the rounded-off measured value and K. The sound pressure level at the driver's ear, measured according to EN 12053 and including uncertainties, is always required to be listed in the operating instructions unless it is below 70 dB(A). If it is below 70 dB(A) then this has to be stated.

4 Proposals for the presentation of noise levels of industrial trucks for operating instructions

1. World wide information for all industrial trucks:

- 1.1 Sound pressure level at operators position $L_{PAZ} = xx \text{ dB (A)}$
Uncertainty factor $K_{PA} = 4 \text{ dB (A)}$

Measured according to the test cycles in **EN 12053** (Noise measurement industrial trucks) based on the weighted values in operating modes DRIVE, LIFT, IDLE.

- 1.2 Sound pressure level at operators position, measured according to the test cycles in

EN 12053

in operating mode	lift	$L_{Pa} = xx \text{ dB(A)}$, uncertainty factor $K_{PA} = 4 \text{ dB(A)}$
in operating mode	idle	$L_{Pb} = xx \text{ dB(A)}$, uncertainty factor $K_{PA} = 4 \text{ dB(A)}$
in operating mode	drive	$L_{Pc} = xx \text{ dB(A)}$, uncertainty factor $K_{PA} = 4 \text{ dB(A)}$

- 1.3 Sound power level $L_{WAZ} = xx \text{ dB (A) }^*$
Uncertainty factor $K_{WA} = 2 \text{ dB (A)}$

Measured according to the test cycles in **EN 12053** (Noise measurement industrial trucks) based on the weighted values in operating modes DRIVE, LIFT, and IDLE.

- 1.4 Sound power level, measured according to the test cycles in EN 12053

in operating mode left	$L_{Wa} = xx \text{ dB(A)}$, uncertainty factor $K_{WA} = 2 \text{ dB(A)}$
in operating mode idle	$L_{Wb} = xx \text{ dB(A)}$, uncertainty factor $K_{WA} = 2 \text{ dB(A)}$
in operating mode drive	$L_{Wc} = xx \text{ dB(A)}$, uncertainty factor $K_{WA} = 2 \text{ dB(A)}$

These noise emission values are given as per ISO 4871 (listing of noise values)

* This declaration is not prescribed by law, unless the sound pressure level at the operators position exceeds 85 dB(A), but the value is sometimes used to determine ambient noise emission levels.

2. Additional requirements of the EC for forklifts with internal combustion engines

Guaranteed sound power level according to Directive **2000/14/EC** $L_{WA} = xxx$ dB (A)

This information is required by law according to the Directive (2000/14/EC). The value is determined on the basis of the sound power levels only in the operating modes "drive" and "lift" with arbitrarily the determined time proportions of 70% for "drive" and 30% for "lift".

This does not represent the normal use of forklifts. Considerable proportions of time are still actually spent at lower noise emission levels, e.g. lowering, tilting, load handling – and these times are not taken into account in the procedure in the directive (2000/14/EC). For this reason, this information quoted cannot be used as a realistic statement of the noise emission level of the forklift.

Alternative text proposal:

This information is required by law according to the Directive (2000/14/EEC). The value is determined on the basis of the sound power levels for the operating modes "lift" and "drive". It can only be used as a comparative value for different forklifts. This value is not well-suited for determination of actual ambient noise emission levels, because it does not represent the normal use of forklift trucks, which also includes an idle mode.

5 EEC Declaration of Conformity

Manufacturer (Importer)

We declare, that the machine

Industrial truck type	Forklift
Type	xxx
Serial no.	xxx xxx xxx

meets the requirements of the latest valid version of the Machinery Directive 98/37/EEC and the latest valid version of EMC Directive 89/336/EEC for industrial trucks as implemented by the harmonised Standard EN 12895.

We also declare that it meets the specifications of Noise Emission Directive 2000/14/EC as measured and approved by the Conformity Evaluation Method set out in Appendix AAA ^{1), 2)}

Measured sound power level	$L_{VA} : xxx$ dB(A)
Guaranteed sound power level	$L_{VA} : yyy$ dB(A)

Place, Date

Name(s)
(Information on the undersigned)

Enter for AAA:

- 1) For devices for which only obligatory labelling applies
 - acc. to Appendix V (internal production control)

- 2) For devices with noise emission limit values
 - acc. to Appendix VI (Expertise by testing institute xxx as cited authority)
 - or
 - acc. to Appendix VII (Individual testing by testing institute xxx as cited authority)
 - or
 - acc. to Appendix VIII (Quality assurance acc. to ISO 9001 with monitoring by testing institute xxx as cited authority)