II

(Acts whose publication is not obligatory)

COMMISSION

COMMISSION RECOMMENDATION

of 6 August 2003

concerning the guidelines on the revised interim computation methods for industrial noise, aircraft noise, road traffic noise and railway noise, and related emission data

(notified under document number C(2003) 2807)

(Text with EEA relevance)

(2003/613/EC)

THE COMMISSION OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Community,

Having regard to Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise ([1]), and in particular point 2.2 of Annex II thereto,

Whereas:

(1) In accordance with Annex II to Directive 2002/49/EC, interim computation methods for the determination of the common indicators L_{den} and L_{night} for industrial noise, aircraft noise, road traffic noise and railway noise are recommended for Member States that have no national computation method or Member States that wish to change computation methods.

(2) In accordance with point 2.2 of Annex II to Directive 2002/49/EC, the four recommended interim computation methods must be adapted to the definitions of L_{den} and L_{night}. In this respect, the Commission is required to publish guidelines on the revised computation methods and provide emission data for road traffic noise, railway noise and aircraft noise, on the basis of existing data.

(3) The measures set out in this Recommendation are in accordance with the opinion of the Committee set up by Article 18 of Directive 2000/14/EC of the European Parliament and of the Council ([2]),

HEREBY RECOMMENDS:

1. The guidelines on the revised interim computation methods referred to in paragraph 2.2 of Annex II to Directive 2002/49/EC and the emission data for road traffic noise, railway noise and aircraft noise on the basis of existing data are set out in the Annex to this Recommendation.

2. This Recommendation is addressed to the Member States.

Done at Brussels, 6 August 2003.

For the Commission

Margot WALLSTRÖM

Member of the Commission

([1]) OJ L 189, 18.7.2002, p. 12.

([2]) OJ L 162, 3.7.2000, p. 1.

ANNEX

Guidelines on the revised interim computation methods for industrial noise, aircraft noise, road traffic noise and railway noise, and related emission data

1. INTRODUCTION

In accordance with Article 6 and Annex II of Directive 2002/49/EC, interim computation methods for the determination of L_{den} and L_{night} for road traffic noise, railway noise, aircraft noise and industrial noise are recommended for Member States that have no national computation methods or Member States that wish to change computation methods. These methods are the following:

— FOR ROAD TRAFFIC NOISE: the French national computation method 'NMPB-Routes-96 (SETRA-CERTU-LCPC-CSTB)', referred to in 'Arrêté du 5 mai 1995 relatif au bruit des infrastructures routières, Journal Officiel du 10 mai 1995, Article 6' and in the French standard 'XPS 31-133'. This method is referred to as 'XPS 31-133' in these guidelines.

— FOR RAILWAY NOISE: the Netherlands national computation method published in 'Reken- en Meetvoorschrift Railverkeerslawaai '96, Ministerie Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, 20 November 1996'. This method is referred to as 'RMR' in these guidelines.

— FOR AIRCRAFT NOISE: ECAC.CEAC Doc. 29 'Report on Standard Method of Computing Noise Contours around Civil Airports', 1997. This method is referred to as 'ECAC doc. 29' in these guidelines.

— FOR INDUSTRIAL NOISE: ISO 9613-2: 'Acoustics — Abatement of sound propagation outdoors, Part 2: General method of calculation'. This method is referred to as 'ISO 9613' in these guidelines.

The abovementioned methods must be adapted to the definitions of L_{den} and L_{night}.

These guidelines relate to the revised interim computation methods and provide emission data for aircraft noise, road traffic noise and railway noise on the basis of existing data. It should be noted that these data are provided on the basis of a review of existing data available for use with the interim computation methods recommended for transportation noise. While the emission data provided in these guidelines cannot cover all the specific situations that may be encountered in Europe, in particular for road and rail traffic, means are provided here to obtain additional data through measurements. Finally, the use of the data provided in these guidelines is not compulsory, and Member States willing to use the interim computation methods are free to use other data that they would consider appropriate, provided such data are suitable for use with the methods concerned.

2. ADAPTATION OF THE INTERIM COMPUTATION METHODS

2.1. *General adaptations relating to the noise indicators L_{den} and L_{night}*

2.1.1. General considerations

Articles 3 and 5 and Annex I of Directive 2002/49/EC define the noise indicators L_{day} (day-time indicator), $L_{evening}$ (evening-time indicator), L_{night} (night-time indicator) and the compound indicator L_{den} (day-evening-night noise indicator). According to Article 5 of Directive 2002/49/EC, the noise indicators L_{den} and L_{night} must be used for the calculation of strategic noise maps.

L_{den} is derived from L_{day}, $L_{evening}$ and L_{night} using the following formula:

$$L_{den} = 10 \cdot \lg \frac{1}{24} \left(12 \cdot 10^{L_{day}/10} + 4 \cdot 10^{\left(L_{evening}+5\right)/10} + 8 \cdot 10^{\left(L_{night}+10\right)/10} \right)$$

Directive 2002/49/EC requires L_{day}, $L_{evening}$ and L_{night} to be long-term noise levels according to ISO 1996-2:1987. They are determined over all day, evening and night periods of a year.

ISO 1996-2:1987 defines the average long-term level as an equivalent A-weighted continuous sound pressure level that can be determined by computation accounting for variations in both source activity and meteorological conditions influencing the propagation conditions. ISO 1996-2 allows the use of meteorological correction terms, and a reference is made to the meteorological corrections in ISO 1996-1, although no method to determine and apply such correction is provided.

Finally, Annex I of Directive 2002/49/EC permits Member States to shorten the evening period by 1 or 2 hours. Daytime and/or night-time period(s) must be lengthened accordingly. The basic equation to calculate L_{den} has to be adapted to reflect these changes in one or more of the rating periods. This leads to a more general form of the equation:

$$L_{den} = 10 \cdot \lg \frac{1}{24} \left(t_d \cdot 10^{L_{day}/10} + t_e \cdot 10^{\left(L_{evening}+5\right)/10} + t_n \cdot 10^{\left(L_{night}+10\right)/10} \right)$$

where:

— t_e is the length of the shorter evening period, where $2 \leq t_e \leq 4$,

— t_d is the resulting length of the daytime period,

— t_n is the resulting length of the night-time period,

and

— $t_d + t_e + t_n = 24$ hours

2.1.2. Receiver height

For the purpose of strategic noise mapping, Directive 2002/49/EC imposes the receiver point (or 'assessment point') height at 4 ± 0,2 m above the ground. As that L_{den} is a compound indicator calculated from L_{day}, $L_{evening}$, L_{night}, this height is also mandatory for these indicators.

2.1.3. Meteorological correction

Annex I of Directive 2002/49/EC defines characteristics of the time period 'year' with respect to sound emission (a relevant year as regards the emission of sound) and meteorological conditions (an average year as regards the meteorological conditions). With respect to the latter, no additional information is provided in the Directive as to what should be considered as an average year.

In the meteorological community, it is common practice to derive average meteorological conditions for a site from a statistical analysis of 10 years of detailed meteorological data measured on or near to the site. This need for long-term measurements and analysis reduces the likelihood of obtaining sufficient data for all sites that have to be noise mapped. Therefore the use of a simplified form of meteorological data proportional to the occurrence of variations in propagation conditions is suggested where sufficient data is not available. Following the example of the simplified assumptions contained in XPS 31-133, such data should be chosen in accordance with both the precautionary principle and the prevention principle applied in EU environmental legislation, which provides for protection of the citizen from potentially dangerous and/or harmful effects. In the light of this, it is recommended that a conservative (favourable to propagation) approach be taken when selecting such simplified meteorological data. Therefore, the approach described in Table 1 is recommended for producing meteorological corrections when calculating the EU noise indicators:

TABLE 1

Meteorological correction decision grid

Condition	Action
Site: Meteorological data measured on the site or derived from a sufficiently large number of nearby sites by meteorological methods that ensure that the resulting data is representative for the site of interest. Period: Sufficiently long measurement time to allow for a statistical analysis that describes the average year with accuracy and continuity to ensure that the data sampled is representative of all daytime, evening and night-time periods of the year.	Derive average meteorological data from an analysis of detailed meteorological data.
No meteorological data available for the site of interest or the available meteorological data does not comply with the above requirements	Adopt a simplified assumption for overall meteorological data.

2.2. *Adaptation of the road traffic noise method 'XPS 31-133'*

2.2.1. Description of the calculation method

The recommended interim computation method for road traffic noise is the French national computation method 'NMPB-Routes-96 (SETRA-CERTU-LCPC-CSTB)', referred to in 'Arrêté du 5 mai 1995 relatif au bruit des infrastructures routières, Journal Officiel du 10 mai 1995, Article 6' and in the French standard 'XPS 31-133'. This method describes a detailed procedure to calculate sound levels caused by the traffic in the vicinity of a road, taking into account the meteorological effects affecting propagation.

2.2.2. Meteorological correction and calculation of long-term levels

The long term-level $L_{longterm}$ is calculated by the following formula:

$$L_{longterm} = 10.\lg\left[p.10_{L_F/10} + (1 - p).10_{L_H/10}\right]$$

where:

— L_F is the sound level calculated in favourable sound propagation conditions,

— L_H is the sound level calculated in homogeneous sound propagation conditions,

— p is the long-term occurrence of meteorological conditions favourable to the propagation of sound determined following 2.1.3.

2.2.3. Summary table of adaptations needed

Subject	Result of comparison/action
Noise indicator	The definitions of the base indicators are identical: equivalent continuous A-weighted sound pressure level determined over the year taking into account variations in emission and transmission. However, the common noise indicators, including the three assessment periods day, evening, night following Directive 2002/49/EC have to be introduced.
Source	Source emission data provided in Guide du Bruit, adapted to introduce road surface corrections (see 3.1).
Propagation	
— influence of meteorological conditions	Define percentage of occurrence of favourable conditions following 2.1.3.
— atmospheric absorption	Data have to be chosen at national level in order to establish a table with air attenuation coefficient versus temperature and relative humidity typical for various European regions concerned, based on ISO 9613-1.

2.3. *Railway noise*

2.3.1. Description of the calculation method

The recommended interim computation method for railway noise is the 'RMR' Netherlands national computation method published in 'Reken- en Meetvoorschrift Railverkeerslawaai '96, Ministerie Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, 20 November 1996', which provides two different calculation schemes, SRM I (simplified scheme) and SRM II (detailed scheme). The conditions under which each of the schemes can be used, as described in the Dutch document, should be followed in order to determine which method to use for the purpose of strategic noise mapping following Directive 2002/49/EC.

2.3.2. Summary table of adaptations needed

Subject	Result of comparison/action
Noise indicator	RMR calculates equivalent noise levels but does not calculate long-term equivalent noise levels according to ISO 1996-2:1987. To calculate long-term indicators with RMR, average train data for the relevant year have to be provided and assessment periods day, evening, night following Directive 2002/49/EC have to be introduced.
Propagation	
— influence of meteorological conditions	Long-term average levels are calculated taking into account the meteorological correction factor CM (with C0 set to 3.5 dB)
— atmospheric absorption	Table 5.1 of RMR provides air attenuation versus temperature and relative humidity coefficients. In some particular situations in some Member States, these coefficients may need to be adapted. This should be done following ISO 9613-1.

2.4. *Aircraft noise*

2.4.1. Description of the calculation method

The recommended interim noise computation method for aircraft noise is ECAC.CEAC Doc. 29 'Report on Standard Method of Computing Noise Contours around Civil Airports', 1997. Of the different approaches to the modelling of flight paths, Annex II.2 of Directive 2002/49/EC states that the segmentation technique referred to in section 7.5 of ECAC Doc. 29 will be used. However, the latter document does not provide the procedures needed for such segmentation calculations. These guidelines provide such procedures (see 2.4.2).

It should be noted that in 2001, the European Civil Aviation Conference (ECAC) launched a revision of its Doc. 29 with a view to producing state-of-the-art in aircraft noise contour modelling. While Directive 2002/49/EC as published in July 2002 explicitly refers to the 1997 version of ECAC Doc. 29, attention should be paid to the revised version of the method when it is adopted by ECAC so as to allow, if appropriate and considered necessary, for the new method to be introduced in Annex II of Directive 2002/49/EC as the recommended method for aircraft noise computation. Such an introduction should be considered further to an assessment of the suitability of the revised method for strategic noise mapping as required by Directive 2002/49/EC.

2.4.2. Segmentation technique

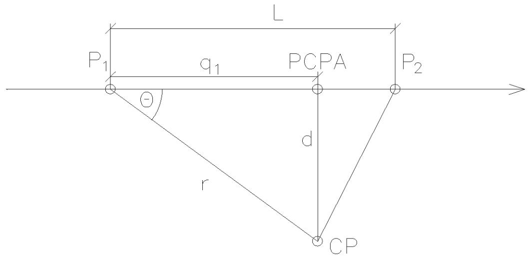
In line with Directive 2002/49/EC, sound exposure level generated by aircraft during operations should be computed using a segmentation technique. Although ECAC doc. 29 refers to such a technique, it does not provide means to implement such computations. These guidelines recommend the use of the segmentation method described in the Technical Manual of the Integrated Noise Model (INM) Version 6.0, as published in January 2002. This method is briefly described in the text below.

The flight path (both for straight and circular sections) is divided into segments, each of which is straight, (and the power setting and the speed are constant). The minimum value of the length of a segment is 3 m. For each sub-arc three x-y-points are computed. These three points define two line segments; the first point is at the start of the sub-arc, the third point is at the end of the sub-arc, the second point is half-way along the sub-arc.

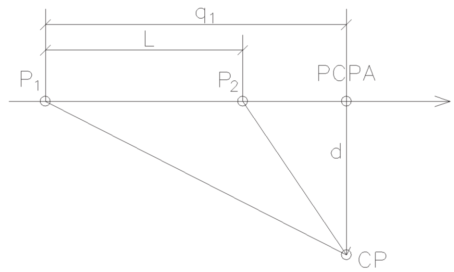
For each of the flight path segments or, if necessary, the extended flight path segment the perpendicular closest point of approach (PCPA) to the observer and the slant distance from the observer to this PCPA is determined (see Figure 1).

Figure 1 — Definition of perpendicular closest point of approach PCPA on the flight path and slant distance d for a segment P_1P_2, when the calculation point CP is astride the segment (a) or when it is ahead of the segment (b) or when it is behind the segment (c).

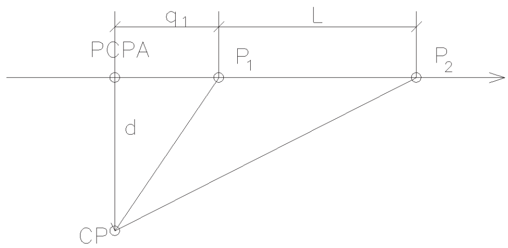
(a)



(b)



(c)



The slant distance d to the PCPA defines the data to be read from the Noise-Power-Distance(NPD)-curves; it defines also the elevation angle. The distance in the horizontal plane from the calculation point CP on the ground to the vertical projection of the PCPA defines the lateral distance for the calculation of the lateral attenuation (if relevant).

— If the height is changing in the segment, the height is set as follows: if the calculation point CP is astride the segment the height at the PCPA (linear interpolation) is used, if the CP is behind or ahead of the segment the height at the nearest end of the segment to the CP is used.

— If the speed is changing in the segment the speed is set as follows: if the calculation point CP is astride the segment, the speed at the PCPA (linear interpolation) is used, if the CP is behind or ahead of the segment, the speed at the nearest end of the segment to the CP is used.

— If the power setting is changing in the segment or the sound level according to the power setting is changing (Δ_ξ) the level is set as follows: if the calculation point CP is astride the segment, the level at the PCPA (linear interpolation) is used, if the CP is behind or ahead of the segment, the relevant level at the nearest end of the segment to the CP is used.

The proportion of the sound energy from a segment, or 'noise fraction', is calculated following the model used in INM 6.0.

If the default data referred to in 3.3.2 is used ($L_{A,max}$ based), then the 'scaled distance' s_L referred to in INM 6.0 Technical Manual should be calculated following:

$$s_L = \frac{2}{\pi} \cdot v \cdot \tau$$

where:

— v is the actual speed in m/s and,

— τ is the duration of flypast in seconds.

The ‘scaled distance’ is introduced to ensure that the total exposure obtained from the ‘noise fraction’ calculation is consistent with the NPD-data.

The sound event level of a whole flypast is calculated by adding up the sound event levels of the single segments on an energetic basis.

2.4.3. Calculation of the overall noise levels

Before the noise sound exposure in a calculation point from the total traffic can be determined, the sound exposure level (SEL) has to be calculated for each individual aircraft operation, following:

— If the calculations are based on SEL NPD-data for a reference speed (usually 160 knots for jet aircraft and 80 knots for small propeller driven aeroplanes):

$$SEL(x,y) = SEL(\xi,d)_{v,ref} - \Lambda(\beta,l) + \Delta_L + \Delta_V + \Delta_F$$

— If the calculations are based on $L_{A,max}$-NPD-data (as the default data referred to in 3.3.2):

$$SEL(x,y) = L_A(\xi,d) - \Lambda(\beta,l) + \Delta_L + \Delta_A + \Delta_F$$

where:

— $SEL(\xi,d)_{v,ref}$ is the SEL at a point having co-ordinates (x,y) caused by a movement on an arrival or a departure route of an aeroplane with thrust ξ at the shortest distance d taken from noise-power-distance curve for thrust ξ and shortest distance d,

— $L_A(\xi,d)$ is the sound level at a point having co-ordinates (x,y) caused by a movement on an arrival or a departure route of an aeroplane with thrust ξ at the shortest distance d taken from noise-power-distance curve for thrust ξ and shortest distance d,

— $\Lambda(\beta,l)$ is the extra attenuation of sound during propagation lateral to the direction of aeroplane, for horizontal lateral distance l and elevation angle β,

— Δ_L is the directivity function for take-off roll noise behind the start-of-roll point,

— Δ_V is the correction for actual speed on the flight path where $\Delta_v = 10.lg\,(v_{ref}/v)$ with:

  — v_{ref} is the speed used in the NPD-data,

  — v is the actual speed on the flight path,

— Δ_A is the duration allowance depending on speed v calculated following 3.3.2,

— Δ_F is the correction for the finite length of the segment of the flight path.

The number of movements of any of the aircraft groups on any of the flight paths during a whole year has to be determined for the time periods day, evening and night separately.

With this, the Directive 2002/49/EC noise indicators L_{den} and L_{night} are calculated as follows:

$$L_{den} = 10 \cdot \lg\left(\frac{1}{86\,400}\sum_{i,\,j}(Nd{,}i,\ j + 3{,}16 \cdot Ne{,}i,\ j + 10 \cdot Nn{,}i,\ j) \cdot 10_{SEL_{i,\,j}/10}\right)$$

and

$$L_{night} = 10 \cdot \lg\left(\frac{1}{T_n}\sum_{i,\,j} N_{n,i,\,j} \cdot 10_{SEL_{i,\,j}/10}\right)$$

where:

— $N_{d,i,j}$ is the number of movements of the j[th] aircraft group on the i[th] flight path during the day period on an average day,

— $N_{e,i,j}$ is the number of movements of the j[th] aircraft group on the i[th] flight path during the evening period on an average day,

— $N_{n,i,j}$ is the number of movements of the j[th] aircraft group on the i[th] flight path during the night period on an average day,

— T_n is the duration of the night period in seconds,

— $SEL_{i,j}$ is the sound exposure level from the j[th] aircraft group on the i[th] flight path.

The number of movements on an average day is calculated as the average of the number of movements over a year following:

$$N_{i,j} = \frac{Nyear,i,\ j}{365}$$

where the movements are separately counted for the periods day, evening and night and distinguished by the index d for the day period, e for the evening period and n for the night period.

The formula for L_{den} contains an additional +5 dB for the evening period (a factor of 3,16) to account for the number of movements in the evening period and an additional +10 dB for the night period (a factor of 10) to account for the number of movements during the night period.

2.4.4. Summary table of adaptations needed

The following table contains a presentation of the contents of ECAC Doc. 29 chapter by chapter showing similarities, differences and required additions needed to meet the requirements of Directive 2002/49/EC.

Section of the original text	Required adaptations
1. Introduction	Adapt to segmentation technique and common noise indicators as required by Annex II of Directive 2002/49/EC
2. Explanation of terms and symbols	Adapt to the use of noise indicators of Directive 2002/49/EC Noise unit must be A-weighted overall sound level Noise scale must be A-weighted equivalent sound level Replace 'noise index' by Directive 2002/49/EC noise indicators
3. Calculation of contours	'Period of some months' has to be changed to 'period of a year' to reflect the requirement of Directive 2002/49/EC for the 'average year' Correct (lateral attenuation $\Lambda(\beta,l)$ must be subtracted and not added) and adapt formula (1) in part 3.3 of ECAC doc. 29 following point 2.4.3 of these guidelines
4. Format of aircraft noise and performance information to be used	In part 4.1.3 of ECAC doc. 29, adapt cut-off levels to ensure compatibility with the lowest contour levels to be calculated according to Directive 2002/49/EC See point 3.3 of these guidelines for additional information on noise emission data (including a default recommendation providing information on flight profiles, engine thrust and flight speeds) for the purpose of strategic noise mapping
5. Grouping of aircraft types	Approach to aircraft grouping should be adapted to take into account current fleet on European airports. See point 3.3.2 of these guidelines for default NPD-data based on updated aircraft grouping. Section 5.4 of ECAC doc. 29 allows for completion of emission data where necessary
6. Calculation grid	Grid spacing need to be chosen by competent authorities to take into account particular situations when producing strategic noise maps
7. Basic calculation of the noise from individual aircraft movements	In point 7.3 of ECAC doc. 29, the duration correction/allowance may need to be adapted depending if the type of NPD-data used is based on $L_{A,max}$ (see part 2.4.3 of these guidelines). In particular, if the default data recommended in these guidelines is used, Δ_V must be replaced by Δ_A (see part 3.3.2 of these guidelines) In point 7.5 of ECAC doc. 29, segmentation technique should be followed (see part 2.4.2 of these guidelines) Point 7.6 of ECAC doc. 29 is irrelevant when segmentation technique is used

Section of the original text	Required adaptations
8. Noise during the take-off and landing ground roll	In part 8.2 of ECAC doc. 29, apply equation (16) for $90 < \Phi \leq 148{,}4°$ (to avoid discontinuity at 148,4°) and precise that $\Delta_L = 0$ for $\Phi \leq 90°$ Equation (18) of ECAC doc. 29 for the determination of the sound exposure level may need to be adapted to take into account duration correction/allowance if the type of NPD-data used is based on $L_{A,max}$ (see part 3.3.2 of these guidelines)
9. Summation of sound levels	Introduction of the common noise indicators of Directive 2002/49/EC. See part 2.4.3 of these guidelines
10. Modelling of lateral and vertical dispersion of flight paths	No adaptation needed
11. Computation of sound exposure level with correction for track geometry	Chapter irrelevant when segmentation technique is used
12. Overall guidance on the computation of the noise contours	This guidance chapter does not need to be modified, but should be read in the light of Directive 2002/49/EC requirements, in particular regarding noise indicators

2.5. *Industrial noise*

2.5.1. Description of the calculation method

The recommended interim computation method for industrial noise is ISO 9613-2: 'Acoustics — Abatement of sound propagation outdoors, Part 2: General method of calculation'. This method, referred to as 'ISO 9613-2' in these guidelines, specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict environmental noise levels around a variety of sources, including industrial sources.

2.5.2. Summary table of adaptations needed

Subject	Result of comparison — action
Noise indicator	The definitions of the base indicators are identical: A-weighted long-term average sound level determined over a long period of time of several months or a year taking into account variations in both emission and propagation. Assessment periods day, evening, night following Directive 2002/49/EC have to be introduced.
Propagation	
— atmospheric absorption	Data have to be chosen at national level in order to establish a table with air attenuation coefficient versus temperature and relative humidity typical for various European regions concerned, based on ISO 9613-1.

3. EMISSION DATA

3.1. *Road traffic noise — 'Guide du bruit 1980'*

3.1.1. Measurement procedure

XPS 31-133 refers to the 'Guide du Bruit 1980' as a default emission model for road traffic noise calculations. If a Member State who adopts this interim computation method wishes to update the emission factors, the measurement procedure described below is recommended. It should be noted that in 2002 the French authorities launched a project designed to review the emission values. Attention should be paid to these new values and the methods developed to obtain them, when published by the responsible authorities, so as to allow, if appropriate and considered necessary, for them to be used as input data for the calculation of road traffic noise.

The noise emission level of a vehicle is characterised by the maximum pass-by sound level L_{Amax} in dB measured at 7,5 m from the centreline of the trajectory of the vehicle. This sound level is determined separately for different vehicle types, speeds and traffic flows. While the slope of the road is identified, the road surface is not explicitly taken into account. To remain compatible with the original measurement conditions, measurements for the addition of vehicle acoustical characteristics should be made for vehicles driving on either of the following road surface types: cement concrete, very slim bituminous concrete 0/14, half-granulated bituminous concrete 0/14, superficial seal 6/10, superficial seal 10/14. A surface correction is then added according to the scheme presented in 3.1.4.

Measurements can be made either on single isolated vehicles of the traffic or on specific circuits under controlled conditions. The vehicle speed should be measured with a Doppler radar (accuracy of approximately 5 % at slow speeds). The traffic flow is determined either by subjective observation (accelerated, decelerated or fluid) or by measurement. The microphone is positioned 1,2 m above ground and 7,5 m horizontally from the centreline of the vehicle trajectory.

For use with XPS 31-133 and in accordance with the specifications of Guide du Bruit 1980, the sound power level L_w and noise emission E are calculated from the measured sound pressure level L_p and vehicle speed V by:

$$L_w = L_p + 25,5 \text{ and } E = (L_w - 10 \log V - 50)$$

3.1.2. Noise emission and traffic

3.1.2.1. *Noise Emission*

The term noise emission is defined as follows:

$$E = (L_w - 10 \log V - 50)$$

where V is the vehicle speed

The emission E is therefore a sound level which can be described in terms of dB(A) as the sound level L_{eq} on the reference isophone due to a single vehicle per hour in traffic conditions which are function of:

— vehicle type,

— speed (or velocity),

— traffic flow,

— longitudinal profile.

3.1.2.2. *Vehicle types*

Two vehicle categories for noise prediction are used:

— light vehicles (vehicles less than 3,5 tonne net load),

— heavy vehicles (vehicles greater or equal to 3,5 tonne net load).

3.1.2.3. *Speed*

For reasons of simplicity, the parameter vehicle speed is used in this method for the whole average speed range (from 20 to 120 km/h). In the case of lower speeds (lower than 60 or 70 km/h depending on the situation) however, the method is refined by means of the subsequently described traffic flow.

To determine a long-term sound level in Leq it is sufficient to know the average speed of a fleet of vehicles. This average speed of a fleet of vehicles can be defined as follows:

— the median speed V50, or the speed that is reached or exceeded by 50 % of all vehicles; or

— the median speed V50 plus half the standard deviation of speeds.

All average speeds determined with either of these methods that turn out to be below 20 km/h are set to 20 km/h.

If available data do not allow for the accurate estimation of the average speed, the following general rule can be followed: for each road segment, the maximum allowed speed on this segment is used. A new road segment must be defined whenever the allowed maximum speed changes. An additional correction is introduced for the lower speed range (lower than 60 to 70 km/h depending on the situation), under which conditions corrections for one of the four flow types must be applied. Finally, all speeds below 20 km/h are set to 20 km/h.

3.1.2.4. *Various types of traffic flows*

Traffic flow type is a complementary parameter to speed, which accommodates acceleration, deceleration, engine load, and pulsated or continuous traffic motion. Four categories are defined below:

Fluid continuous flow: Vehicles move with a nearly constant velocity on the road section of interest. It is 'fluid' in that the flow is stable in both space and time for periods of at least ten minutes. Variations during the course of a day may be observed but without abrupt or rhythmic variations. Furthermore, it is neither accelerated nor decelerated but of steady velocity. This flow type corresponds to the traffic on a motorway/autobahn link or an interurban road, on an urban expressway (outside rush hours), and on major roads in an urban environment.

Pulsed continuous flow: A flow with a significant proportion of vehicles in a transitory state (i.e. either accelerating or decelerating) that is stable neither in time (i.e. there exist abrupt variations of flow during small time periods) nor in space (i.e. at any given moment in time irregular concentrations of vehicles exist on the road section of interest). It remains however possible to define an average overall velocity for this type of flow which is stable and repetitive for a sufficiently long period of time. This flow type corresponds to that found on city-centre roads, on major roads close to saturation, on dispatching or connecting roads with numerous crossings, in car parks, at pedestrian crossings and at junctions to housings.

Pulsed accelerated flow: This is a pulsed flow and thus turbulent. However, a significant proportion of all vehicles is accelerating, which in turn means that the notion of speed has a meaning only in discrete points as it is not stable during displacement. This is typically the case for traffic either on expressways after a crossing, or at a motorway slip road, at a tollbooth, etc.

Pulsed decelerated flow: This is the opposite of the previous one, in which a significant proportion of vehicles is decelerating. It is generally found on the approach of major urban crossings, on motorway or expressway exits or on the approach to a tollbooth, etc.

3.1.2.5. *Three longitudinal profiles*

Three longitudinal profiles are defined below, in order to take into account the difference in sound emission as a function of the slope of the carriageway:

— a horizontal carriageway or a horizontal carriageway section whose gradient in direction of traffic flow is less than 2 %;

— an ascending carriageway is one where upward gradient in the direction of traffic flow is greater than 2 %;

— a descending carriageway is one where the downward gradient in the direction of traffic flow is more than 2 %.

In the case of a one-way road this definition is directly applicable. In the case of two-way traffic a separate calculation for each driving direction and subsequent accumulation of results is required to obtain a precise estimate.

3.1.3. Quantified noise emission values for various road traffic types

3.1.3.1. *Schematic representation*

Guide du bruit provides nomograms giving the value of the sound level Leq (1 hour), in dB(A), (also known as noise emission E, described in 3.1.2.1). The sound level is given separately for a single light vehicle (the sound emission is then 'E_{lv}') and a single heavy vehicle (the sound emission is then 'E_{hv}') per hour. For these separate vehicle types, E is a function of speed (see 3.1.2.3), traffic flow (see 3.1.2.4) and longitudinal profile (see 3.1.2.5). While the sound level shown in the nomograms does not include any corrections for road surface, these guidelines include a correction scheme (see 3.1.4).

The frequency-dependent basic sound power level L_{Awi}, in dB(A), of a compound point source i in a given octave band j is calculated from the individual sound emission levels for light and heavy vehicles obtained from nomogram 2 of Guide du Bruit 1980 (referred to as 'nomogram 2' in these guidelines) using the following equation:

$$L_{Awi} = L_{Aw/m} + 10\lg(l_i) + R(j) + \psi$$

where:

— $L_{Aw/m}$ is the global sound power level per metre length along the lane attributed to the specified source line, in dB(A), given by:

$$L_{Aw/m} = 10 \text{ Log } \left(10^{\left(E_{lv} + 10 \log Q_{lv}\right)/10} + 10^{\left(E_{hv} + 10 \log Q_{hv}\right)/10}\right) + 20$$

where:

— E_{lv} is the sound emission for light vehicles as defined in nomogram 2,

— E_{hv} is the sound emission for heavy vehicles as defined in nomogram 2,

— Q_{lv} is the volume of light traffic during the reference interval,

— Q_{hv} is the volume of heavy vehicles during the reference interval;

— Ψ is the road surface noise level correction defined in 3.1.4;

— l_i is the length of the section of the source line represented by a component point source i in meters;

— R(j) is the spectral value, in dB(A), for octave band j given in Table 2.

TABLE 2

Normalised A-weighted octave band traffic noise spectrum calculated from third octave spectrum of EN 1793-3

j	Octave band (in Hz)	Values of R(j) (in dB(A))
1	125	− 14,5
2	250	− 10,2
3	500	− 7,2
4	1000	− 3,9
5	2000	− 6,4
6	4000	− 11,4

3.1.4. Road surface correction

3.1.4.1. *Introduction*

Above a certain speed the overall noise emitted by a vehicle is dominated by the tyre-road contact noise. It depends on vehicle speed, type of road surface, (in particular porous and sound-deadening surfaces) and tyre type. Guide du bruit 1980 provides a standard noise emission for a standard road surface. The scheme described below is suggested to introduce road surface corrections. It is compatible with EN ISO 11819-1 provisions.

3.1.4.2. *Surface type definitions*

— Smooth asphalt (concrete or mastic): is the reference road surface defined in EN ISO 11819-1. It is a dense, smooth-textured, either asphalt concrete or stone-mastic asphalt surface with a maximum chipping size of 11 - 16 mm.

— Porous surface: is a surface with a void volume of at least 20 %. The surface has to be less than five years old (the age restriction accounts for the tendency of porous surfaces to become less absorptive over time as the voids fill up. If special maintenance is applied the age restriction may be lifted. However, after the initial five years term measurements must be made to determine the acoustics properties of the surface. The sound-reducing effect of this surface is a function of vehicle speed).

— Cement concrete and corrugated asphalt: includes both the cement concrete and coarse-texture asphalt.

— Smooth texture paving stones: paving stones with a distance smaller than 5 mm between the blocks.

— Rough texture paving stones: paving stones with a distance greater than or equal to 5 mm between the blocks.

— Others: is an open category into which each Member States may place corrections for other surfaces. To ensure harmonised use and results, data must be obtained in accordance with EN ISO 11819-1. The data obtained should be entered into Table 3. For all measurements, the passage speeds must be equal to the standard's reference speeds. The Statistical Pass-By Index (SPBI) equation will be used to evaluate the effect of the percentage of heavy vehicles. 10 %, 20 %, 30 % will be used respectively to calculate the SPBI for each of the three percentage ranges defined in Table 3 (0-15 %, 16-25 % and > 25 %).

TABLE 3

Standard road surface correction scheme

Speed	< 60 km/h			61-80 km/h			81-110 km/h		
% Heavy vehicles	0-15 %	16-25 %	> 25 %	0-15 %	16-25 %	> 25 %	0-15 %	16-25 %	> 25 %
Surface type									

3.1.4.3. *Recommended correction scheme*

TABLE 4

Proposed road surface correction scheme

Road surface categories	Noise level correction Ψ		
Porous surface	0-60 km/h	61-80 km/h	81-130 km/h
	- 1 dB	- 2 dB	- 3 dB
Smooth asphalt (concrete or mastic)	0 dB		
Cement concrete and corrugated asphalt	+ 2 dB		
Smooth texture paving stones	+ 3 dB		
Rough texture paving stones	+ 6 dB		

3.2. *Railway noise*

3.2.1. Introduction

The Dutch railway noise computation method RMR has its own emission model that is described in detail in Chapter 2 of the original Dutch text. This emission model can remain to be used in all Member States without modification.

With regard to emission data, these guidelines identify in 3.2.2 the Dutch emission database as the recommended default database. However, the measurement methods described in 3.2.2.2 will allow Member States to produce new emission data to compensate for the lack of emission data of non-Dutch rolling stock on non-Dutch rails in the default database.

3.2.2. The noise emission model

Prior to the calculation of the 'equivalent continuous sound pressure level' all vehicles that use a specified section of railway line and follow the appropriate service guidelines should be either placed in the 10 railway vehicles categories shown in 3.2.2.1 or, where appropriate, into additional categories after carrying out measurements according to 3.2.2.2.

3.2.2.1. *Existing train categories*

The existing categories that are provided in the Dutch emission database are primarily differentiated by propulsion system and wheel brake system as follows:

Category	Train description
1	Block braked passenger trains
2	Disc braked and block braked passenger trains
3	Disc braked passenger trains
4	Block braked freight trains
5	Block braked diesel trains
6	Diesel trains with disc brakes

Category	Train description
7	Disc braked urban subway and rapid tram trains
8	Disc braked InterCity and slow trains
9	Disc braked and block braked high speed trains
10	Provisionally reserved for high speed trains of the ICE-3 (M) (HST East) type

3.2.2.2. *Measurement method*

The noise emission characteristics of a railway vehicle or of a track can be determined by measurement. The measurement procedures are described in:

— 'Reken- en Meetvoorschrift "Railverkeerslawaai 2002, Ministerie Volkshuisvesting, Ruimtelijke Ordening" en Milieubeheer, 28 maart 2002'.

Three procedures are given to determine the characteristics of new train categories or non-Dutch rolling stock on non-Dutch tracks (procedures A and B) and of non-Dutch tracks (procedure C):

— Procedure A is a simplified method, which provides a way of determining if a railway vehicle can be allocated to an existing category (as referred to in 3.2.2.1). This method can also be used for new (yet to be constructed) vehicles on which it is impossible to carry out noise measurements. This allocation is done mainly on the basis of the type of propulsion system (diesel, electric, hydraulic) and the braking system (disc or block).

— Procedure B describes methods of obtaining emission data for rail vehicles that do not necessarily fit into an existing train category. A so-called 'free category' is introduced to which any vehicle type can be assigned, if its noise emission is determined according to this procedure. The data obtained in this manner take into account the separation of vehicle, the track sound radiation and the wheel and track roughness. Also the different sources of noise — traction noise, rolling noise and aerodynamic noise — are taken into account along with the heights of the different sources.

— Procedure C allows for the determination of the acoustical characteristics of track construction (sleepers, ballast bed, etc). The noise calculation method is based on the fact that the track characteristics, in octave bands, are independent of the type of vehicle or of the speed of the vehicle. To verify this, it is necessary to perform measurements at one location at two additional speeds (difference > 20, respectively 30 %). The differences in the calculated track characteristics should be below 3dB in each of the octave bands. If the correction is dependent on speed, additional research has to be carried out that may lead to speed-dependent characteristics.

3.2.2.3. *Emission model*

If calculations are carried out following SRM I, emission values in dB(A) are determined as follows:

$$E = 10lg\left(\sum_{c=1} y10_{E_{nr,c}/10} + \sum_{c=1} y10_{E_{r,c}/10}\right)$$

where:

— $E_{nr,c}$ is the emission term per rail vehicle category for non-braking trains,

— $E_{r,c}$ emission term for braking trains,

— c is the train category,

— y is the total number of categories present.

The emission values per rail vehicle category are determined from:

$$E_{nr,c} = a_c + b_c \lg v_c + 10lgQ_c + C_{b,c}$$
$$E_{r,c} = a_{r,c} + b_{r,c} \lg v_c + 10lgQ_{r,c} + C_{b,c}$$

where the standard emission values a_c, b_c, $a_{r,c}$ & $b_{r,c}$ are provided in RMR.

If SRM II is used, then for each train category and for different sound source heights (up to 5 heights), emission values per octave band are determined. After the characterisation of the emission of different train categories, the emission of the specified section of railway line is calculated taking into account the passage of different train categories (and the fact that not all categories have sound sources at all heights) and the passage of trains under different conditions (braking or not braking). The emission factor in octave band i is calculated following:

$$L^h_{E,i} = 10 \text{ Log} \left(\sum_{c=1} n10^{E^h_{nb,i,c}/10} + \sum_{c=1} n10^{E^h_{br,i,c}/10} \right)$$

where n is the number of train categories using the railway line under consideration, $E^h_{nb,i,c}$ (resp. $E^h_{br,i,c}$) is the emission term for non-braking (resp. braking) units for train in each train category (c = 1 to n), in octave band i, and at assessment height h (h = 0m, 0,5 m, 2 m, 4 m and 5 m — dependent on the train category) calculated as follows:

$$E^h_{br,i,c} = a^h_{br,i,c} + b^h_{br,i,c} \log V_{br,c} + 10 \log Q_{br,c} + C_{bb,i\ m\ c}$$

$$E^h_{nb,i,c} = a^h_{i,c} + b^h_{i,c} \log V_c + 10 \log Q_c + C_{bb,i,m,c}$$

where:

— $a^h_{i,c}$ and $b^h_{i,c}$ (resp. $a^h_{br,i,c}$ and $b^h_{br,i,c}$): emission terms for train category c in non-braking (resp. braking) conditions, for octave band i, at height h.

— Q_c: mean number of non-braking units of the railway vehicle category concerned

— $Q_{br,c}$: mean number of braking units of the railway vehicle category concerned

— V_c: mean speed of passing non-braking railway vehicles

— $V_{br,c}$: mean speed of passing braking railway vehicles

— bb: type of track/condition of the railway tracks

— m: estimation of the occurrence of track disconnection

— $C_{bb,i,m}$: correction for to track discontinuities and rail roughness

3.3. *Aircraft noise*

3.3.1. Introduction

Further to a review of available databases, these guidelines provide in 3.3.2 a default recommendation for the computation of aircraft noise around airports using ECAC doc. 29 as modified following 2.4.

As underlined in the introduction to these guidelines, the use of the default recommended data is not compulsory, and Member States may use other data that they consider appropriate, provided they are suitable for use with ECAC doc. 29.

Furthermore, attention should be paid to ongoing initiatives relating to the establishment of an updated and internationally agreed database on civil aircraft noise. In particular, in the future, such a database may be provided jointly by Eurocontrol and the American Federal Aviation Authority.

3.3.2. Default recommendation

For the computation of aircraft noise, further to a review of readily available databases, it has been found that the following documents (see below) provide complete data covering noise power distance data and performance data for most types of civil aircraft including the new low noise aircraft generation:

— 'ÖAL-Richtlinie 24-1 Lärmschutzzonen in der Umgebung von Flughäfen Planungs- und Berechnungsgrundlagen. Österreichischer Arbeitsring für Lärmbekämpfung Wien 2001'

— 'Neue zivile Flugzeugklassen für die Anleitung zur Berechnung von Lärmschutzbereichen (Entwurf), Umweltbundesamt, Berlin 1999'

The data are based on a grouping of aircraft and contain $L_{A,max}$-levels. The following formula allows calculation of SEL-values using pass-by duration as an additional parameter.

SEL is calculated in dB from $L_{A,max}$ by

$$SEL = L_{A,max} + \Delta_A \;\&\; \Delta_A = 10 \cdot \lg \frac{T}{T_0}$$

with $T_0 = 1$ second and T in s expressed following:

$$T = \frac{A.d}{V + (d/B)}$$

where:

— A and B are constants which are different for take-off and approach and for different fixed-wing aircraft,

— d is the slant distance in m (see 2.4.2),

— V is the speed in m/s.

The sound levels are given for take-off thrust and for landing thrust. Thrust reduction after take-off is addressed via sound level reductions ΔL_ξ given at certain heights and speeds.

For each of the aircraft groups, default take-off-profiles are given with speed V and height H versus distance σ on the ground track from start-off-roll point and for greater distances with dH/dσ.

The sound level data and the performance data are normalised for temperature 15°C, humidity 70 % and pressure 1 013,25 HPa. They may be used for temperatures up to 30 °C and whenever the product of relative humidity and temperature is greater than 500.