**Technical description of standard calculation method 1 (SRM1)**

RIVM Letter report 2014-0127

K. van Velze│J. Wesseling

Public summary

**Technical description of standard calculation method 1 (SRM-1)**

In 2007, the Dutch government determined that the effects of spatial planning on air quality are calculated using three standard calculation methods (SRM-1, -2 and -3). A clear description of the calculation rules of these standard calculation methods is of great importance for their correct use. RIVM has been asked by the Ministry of Infrastructure and the Environment to record the technical rules for calculating in an urban environment (SRM-1) in a report. The Ministry will refer to this report for the technical description of SRM-1.

The Dutch "Regulation on air quality assessment 2007" (Rbl 2007) provides practical information about the calculation method in addition to legal information. This concerns detailed information about the locations and the manner in which air quality must be determined using measurements and calculations. For the calculations with the standard calculation methods for air quality, the relevant formulas are given and the calculation steps are described.

The RIVM has added the latest developments to the calculation rules from the Rbl 2007 on all relevant points. This mainly concerns practical choices that have been necessary in recent years for the use of standard calculation methods. A separate report describes the calculation rules along (highways) roads (standard calculation methods 2).

Keywords: Standard calculation method, Air quality, (urban) roads.

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1. The calculation method and application

Good air quality in the living environment in the Netherlands is important for public health and for nature and ecosystems. Information about the condition of air quality, the occurrence of bottlenecks and the prevailing trends is obtained through measurements and model calculations. The Air Quality Assessment Regulation (Rbl, 2007) indicates which measurement and calculation methods have been found suitable and what requirements are set for this. The Rbl describes three standard calculation methods that can be used for the calculation of local air quality in the majority of situations with traffic or a device. The standard calculation method 1 (SRM1) described in this report is one of the calculation methods mentioned in Rbl.

SRM1 is intended for the calculation of concentrations of air pollutants near traffic roads within built-up areas, also referred to as "city roads" or streets. Characteristic of these roads is that buildings are present in the immediate vicinity, within a few tens of meters from the road. Air vertebrae around this development affect the air flow in the streets and thus the height of the concentrations of air pollution. This is in contrast to highways and other country roads where the air pollution emitted by traffic does not “hang” between existing obstacles, but is immediately removed by the wind. Standard calculation method 2 (SRM2) applies to this type of road.

Specifically, SRM1 distinguishes four categories of buildings within 60 meters of the road. A category with buildings on both sides of the road and more or less connected facades. The same situation but with relatively high facades, also known as "street canyon". A category with buildings on one side of the road, also with a more or less connected façade. In the latter category, the existing buildings are scattered in the area, for example a road with semi-detached or detached houses. Furthermore, SRM1 offers possibilities to take into account any trees that may be present, a wide central reservation or an exit from a tunnel tube. SRM1 is not suitable for complex situations with multiple road sections such as a traffic circle.

SRM1 is a description of the method on paper. An implementation of SRM1 has been available through Infomil for years (see http://car.infomil.nl/). In the course of 2014, a low-threshold implementation of SRM1 became available via the NSL calculation tool. This has the advantage that the calculation tool is linked to the Monitoring Tool database (http://www.nsl-monitoring.nl/ calculation/). The calculation tool is available for municipalities and provinces, but also for other stakeholders such as residents. It is also possible to view model results at http://www.atlasleef omgeving.nl/.

1. Origin and development

In 2007, the SRM1 was published in Appendix 1 of the Rbl. SRM1 is based on CAR II, the calculation model that has long been used by local authorities to calculate air quality.

The CAR model was developed by TNO (vd Hout et al., 1988) in the 1980s with the aim of being able to give an indication for a city road whether or not limit values ​​were exceeded. In consultation with the Ministry of VROM and RIVM, a PC version of the model has been developed (Eerens et al., 1993) that was made available to municipalities and provinces for the first time in the 1990s. Since then, annual updates have taken place of emission factors and background concentrations, data which are required for the use of the CAR model.

A new, more user-friendly calculation program, called CAR II, was published in 2002. An important substantive improvement was the application of background concentrations from GCN (Generic Concentrations in the Netherlands) with a higher spatial resolution than before. Subsequently, more substantive adjustments were made, of which the application of higher speed wind speeds in 2008 (Mooibroek et al., 2005) and the introduction of a calibration factor (Fk = 0.62) (Wesseling et al., 2007) the calculation results meant.

With the entry into force of Rbl (Rbl, 2007a), a few changes were made to SRM1 and a number of improvements were subsequently made (Rbl, 2007b, 2008, 2009, 2013). A brief description of these changes in SRM1 is included in Appendix 1.

Changes in scientific insights, social developments or legal embedding can be a reason for future adjustments to SRM1. In simple cases this may involve the adjustment of a model parameter, but the revision of one or more algorithms may also be necessary. If necessary, a (digital) update of this report will appear.

The description of SRM1 as presented in this report corresponds to the version that was in force in 2014, in accordance with the Rbl.

1. Technical description

Regulation of the Minister of Housing, Spatial Planning and the Environment of 8 November 2007, no. LMV 2007.109578, containing rules with regard to the assessment of air quality (Regulation on air quality assessment 2007)

This chapter contains the original text of appendix 1 from the “Regulation on air quality 2007” (Rbl 2007), obtained via http://wetten.overheid.nl, valid on 11-11-2013. There are various details of the calculation method described that were not specified in the Rbl 2007 but that are important for the outcome of the calculation method. In the monitoring tool belonging to the NSL, choices were made on these points in consultation with the Ministry of IenM. Some relations from the Rbl 2007 are formulated differently in the monitoring tool. This is mainly because the alternative formulation, although identical in results, is simpler and less prone to errors. Where relevant, text boxes reflect on the additions and alternative formulations.

**3.1 Terms**

Calculation distance: the distance between the calculation point and the road axis in meters; Calculation point: the point where the air quality is calculated; Road axis: line in the middle of the roadway.

**3.2 Range of application**

The method is intended for calculating the impact on air quality on a road. When applying this method, the situation under consideration meets the following conditions:

a. the road is in an urban environment;

b. the maximum calculation distance is the distance to the buildings, with a maximum of 30 or 60 meters relative to the road axis, depending on the street type;

c. there is hardly any difference in height between the road and the surroundings; d. there are no shielding structures along the road.

This method distinguishes between four types of roads. The road types are described on the basis of the buildings along the road:

1. more or less continuous buildings on both sides of the road at a distance of no more than 60 meters from the road axis, the distance between the road axis and facade being less than three times the height of the buildings, but greater than 1.5 times the height of the buildings;

2. more or less continuous buildings on both sides of the road at a distance of no more than 60 meters from the road, where the distance between road axis and facade is less than 1.5 times the height of the buildings;

3. on one side more or less contiguous buildings at a distance of a maximum of 60 meters from the road axis, whereby the distance between the road axis and facade is less than 3 times the height of the buildings;

4. all roads in an urban environment, other than road types 1, 2 and 3.

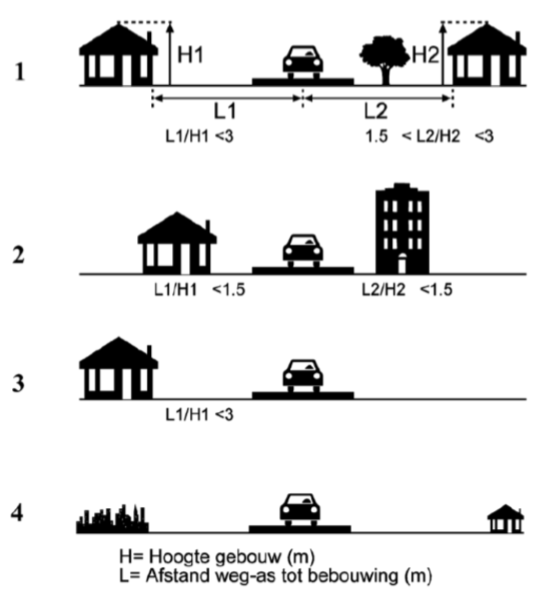


Figure 1: Road types standard calculation method 1

**3.3 Calculation method**

The calculation model makes it possible to perform calculations of:

1. the annual average concentrations of sulfur dioxide, nitrogen dioxide, nitrogen oxides, suspended particles (PM2.5 and PM10), lead, carbon monoxide, soot and benzene;

2. the number of times per year that the twenty-four-hour average concentration of suspended particles (PM10) is higher than the limit value of 50 μg / m3;

3. the 98 percentile of the eight-hour average concentration of carbon monoxide;

4. the number of times per year that the twenty-four-hour average concentration of sulfur dioxide is higher than the limit value of 125 μg / m3;

5. the number of times per year that the hourly average concentration of nitrogen dioxide is higher than the limit value of 200 μg / m3.

**a. annual average concentration**

The annual average concentration of sulfur dioxide, nitrogen oxides, suspended particles (PM2.5 and PM10), lead, carbon monoxide and benzene is calculated with the following equation:



With:

Cjm: annual average concentration [μg / m3];

Ca, jm: annual average large-scale concentration [μg / m3]: use is made of the data referred to in Article 66 of the Regulation;

Cb, jm: annual average traffic concentration contribution [μg / m3].

The annual average traffic concentration contribution for sulfur dioxide, nitrogen oxides, suspended particles (PM2.5 and PM10), lead, carbon monoxide and benzene is calculated with the following equation:



With:

Fk: calibration factor [-] with a value of 0.62;

E: emission number [μg / m / s]: see section 3.4;

θ: dilution factor [-]: see section 3.5;

Fb: tree factor [-];

Fregio: regional factor related to meteorology [-]: the data referred to in Article 66 of the Regulation are used for this. As of March 15, 2008, Fregio = 5 / wind speed (wind speed in meters per second) applies.

**Tree factor**

The tree factor is a measure of the presence of trees. Three tree factors are distinguished:

1: here and there trees or not at all;

1.25: one or more rows of trees with a mutual distance of less than 15 meters with openings between the crowns;

1.5: the crowns touch each other and span at least a third of the street width.

A tree factor higher than 1 may only be used if there are trees along a road section, on at least one side within 30 meters of the road axis, and with a mutual distance of less than 15 meters. This must be justified in the relevant decision.

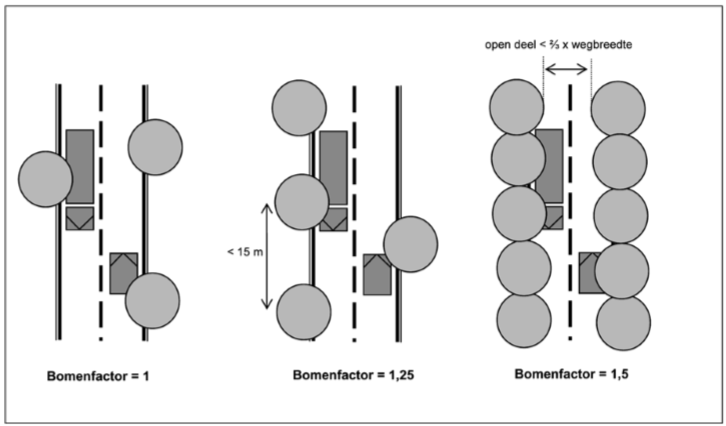


Figure 2: Schematic representation of trees in a street and associated tree factors in the calculation.

The annual average traffic traffic contribution for nitrogen dioxide depends on:

- the annual average traffic contribution to the concentration of nitrogen oxides (NOx);

- the chemical reactions in the atmosphere whereby a part of the NO is converted into NO2.

The annual average traffic traffic concentration contribution for nitrogen dioxide is determined on the basis of the following comparison:



With:

: annual average traffic concentration contribution to NO2 concentration [μg / m3];

: annual average traffic concentration contribution to NOx concentration [μg / m3];

: annual average large-scale ozone concentration [μg / m3]: use is made of the data referred to in Article 66 of the Regulation;

: weighted fraction of directly emitted NO2 [-]: see section 3.6;

B: parameter B that takes into account that a surrounding point is usually loaded on one-sided, over more than half a compass rose, by traffic;

K: parameter for the conversion from NO to NO2.

Parameters B and K are empirically determined and apply to all road types:

B: 0.6 [-];

K: 100 [μg / m3].

**b. number of exceedances limit value twenty-four-hour average concentration of suspended particles (PM10)**

The limit value for the twenty-four-hour average concentration of suspended particles (PM10) is 50 μg / m3. This limit value may be exceeded a maximum of 35 times per year.

The number of days that the twenty-four-hour average floating particle concentration (PM10) is higher than the limit value of 50 μg / m3 is calculated on the basis of the total annual average floating particle concentration (PM10). The comparison used depends on the height of the annual average concentration of suspended particles (PM10):

If Cjm[PM10]> 31.2 µg / m3:

,

If 16 <= Cjm[PM10] <= 31.2 µg / m3: ,

If 16 <= Cjm[PM10]:

,

With:

Cjm[PM10]: annual average concentration of suspended particles (PM10) [µg / m3];

ODpm10: the number of days that the twenty-four-hour average floating particle concentration (PM10) is higher than 50 μg / m3 [days / year].

**c. eight-hour average carbon monoxide concentration**

For carbon monoxide (CO), the result of the concentration calculation is the 98 percentile of eight-hour average values. The 98 percentile is calculated based on the annual average traffic concentration contribution with the following comparison:



With:

: 98 percentile of CO (eight-hour average) [μg / m3];

: conversion factor [-] of the annual average traffic concentration contribution to CO concentration to the 98 percentile (eight-hour average);

: annual average traffic concentration contribution to CO concentration [μg / m3];

: 98 percentile eight-hour average large-scale concentration of CO [μg / m3].

The data referred to in Article 66 of the Regulation is used for the 98-percentile eight-hour-average large-scale concentration.

The conversion factor from the annual average CO concentration to the 98 percentile (eight-hour average) depends on the road type:

Pco road type 1: 2.55;

Pco road type 2: 2.50;

Pco road type 3: 2.50;

Pco road type 4: 2.50.

**d. number of exceedances limit value twenty-four-hour average sulfur dioxide concentration**

The limit value for the twenty-four-hour average sulfur dioxide concentration is 125 μg / m3. This limit value may be exceeded a maximum of 3 times per year.

With the following comparison, based on the annual average sulfur dioxide concentration, a calculation can be made of the 4 highest twenty-four-hourly average sulfur dioxide concentrations:



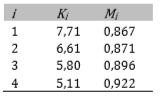
With:

: ie the highest twenty-four-hour average concentration of sulfur dioxide [μg / m3];

: annual average sulfur dioxide concentration [μg / m3];

Ki and Mi: conversion parameters [-] from the annual average concentration SO2 to the highest twenty-four-hour average concentration.

The Ki and Mi conversion parameters for SO2 are given as a function of i in the table below:



e. number of exceedances limit value hourly average concentration of nitrogen dioxide

The limit value for the hourly average concentration of nitrogen dioxide is 200 μg / m3. This limit value may be exceeded a maximum of 18 times per year.

Based on the annual average concentration of nitrogen dioxide, the following comparison can be used to calculate the 19 highest twenty-four-hourly average concentrations of nitrogen dioxide:



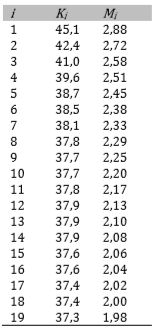
With:

 : ie highest hourly average concentration of nitrogen dioxide [μg / m3];

: annual average concentration of nitrogen dioxide [μg / m3];

Ki and Mi: conversion parameters [-] from the annual average concentration of NO2 to the highest hourly average concentration.

The Ki and Mi conversion parameters for NO2 are given as a function of i in the table below:



3.4 emission number

The traffic emissions are calculated for sulfur dioxide, nitrogen dioxide, nitrogen oxides, suspended particles (PM2.5 and PM10), lead and carbon monoxide from a weighted sum over the emissions of all relevant vehicle types. This can be done using the following equation:



With:

E: emission [μg / m / s];

N: the traffic intensity, being the number of vehicles per day;

fM: fraction of medium-duty motor vehicles [-];

fZ: fraction of heavy motor vehicles [-];

fb: fraction of buses [-];

EL: emission factor for a light motor vehicle [g / km];

EM: emission factor for a medium-weight motor vehicle [g / km];

EZ: emission factor for a heavy motor vehicle [g / km];

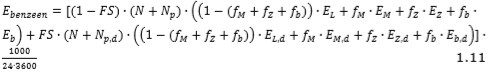
Eb: emission factor for buses [g / km];

FS: fraction of stagnant traffic, a number between 0 and 1 [-];

E \*, d: emission class of vehicle class \* for stagnant traffic [g / km] (\* = M, L, Z, b; speed class d).

The emission factors make use of the data referred to in Article 66 of the Regulation.

The traffic emissions are calculated for benzene with the following equation:



With:

Ebenzene: benzene emission [μg / m / s];

Np: correction factor (see equation 1.12); The other parameters as in comparison 1.10.

Parking movement correction factor for benzene The correction factor is determined on the basis of the following equation:



With:

PP: number of parking movements per 100 meters of street per day;

PMV: number of moving motor vehicles corresponding to the extra emissions resulting from 107 parking movements per 100 meters of street per 1 day.

The value for Pmv depends on the speed type:

outside road general: 3.500;

city traffic with less congestion: 1,700;

normal city traffic: 1,400; stagnant city traffic: 1,100.

*Effects of tunnel tube*

For a road section that connects directly to the exit of a tunnel tube, which is at least 100 meters long and in which there are two driving directions, the emissions up to a distance of 20 meters from the exit of a tunnel tube are calculated using the formula below:



With:

Etm: total emission per unit of length [µg / m / s] on the road section within a distance of 20 meters from the exit of a tunnel tube;

E: emissions per unit length from traffic on the road section itself [µg / m / s], as calculated with formula 1.10;

Et: emissions per unit length from the traffic in the tunnel tube (µg / m / s), as calculated with formula 1.10;

Lt: length of the tunnel tube [m];

# ut: number of exits from the tunnel tube [-].

For a road section that directly connects to the exit of a tunnel tube, that is at least 100 meters along and within which there is one direction of travel, the emissions up to a distance of 50 meters from the exit of a tunnel tube are calculated using the formula below:



Formulas 1.12a and 1.12b are based on a uniform distribution of the emissions in the tunnel over the adjacent road section.

When determining the emissions on road sections that connect to the entrance of a tunnel tube or connect to the exit of a tunnel tube that is shorter than 100 meters, the emissions from traffic in the tunnel tube are not taken into account.

**3.5 Dilution factor**

A variable in the equation for the calculation of an annual average concentration (equation 1.2) is the dilution factor. The dilution factor is calculated up to a distance of 30 meters from the axis of the road with the following equation (5 m ≤ S ≤ 30 m):



and only for street types 1 (wide street canyon) and 4 (generally urban, other than types 1, 2 and 3) for a distance of 30 to 60 meters from the axis of the road with the following equation (30 m <S ≤ 60 m):



With:

θ: dilution factor;

S: calculation distance;

a, b, c and α: parameters.

In the NSL calculation tool, calculation distances smaller than 3.5 meters are limited to 3.5 meters.

The parameters a, b, c and α depend on the road type:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Road type | | | |
|  | 1 | 2 | 3 | 4 |
| Description | Broad street cayon | Small street  cayon | one-sided buildings | General urban |
| old type CAR | 3a | 3b | 4 | 2 |
| a | 3.25\*10-4 | 4.88\*10-4 | 5.00\*10-4 | 3.1\*10-4 |
| b | -2.05\*10-2 | -3.08\*10-2 | -3.16\*10-2 | -1.82\*10-2 |
| c | 0.39 | 0.59 | 0.57 | 0.33 |
| α | 0.856 |  |  | 0.799 |

**3.6 Fraction directly emitted NO2**

Part of the NOx is emitted as NO2. The proportion of NO2 directly emitted by traffic is calculated as follows:



With:

fNO2: fraction of directly emitted NO2 [-];

ENO2: the amount of NO 2 emitted as determined in accordance with equation 1.10;

ENOx: the amount of NOx emitted as determined in accordance with equation 1.10.

**3.7 Cumulation of concentration contributions from different sources SO2, NOX, suspended particles (PM2.5 and PM10), CO and benzene**

In equation 1.1, the annual average concentration is calculated on the basis of the large-scale concentration data and the concentration contribution by road traffic in the relevant street. If, in addition to road traffic in the relevant street, other sources contribute to the concentrations of sulfur dioxide, nitrogen oxides, suspended particles (PM2.5 and PM10), carbon monoxide and benzene at the calculation point, it is possible to add this contribution to the concentration calculated with equation 1.1.

**Cumulation of NO2 concentration contributions from SRM1 roads and other sources**

With nitrogen dioxide, the contributions from several local sources cannot simply be added together2.

In order to cumulate the NO2 concentration contributions from multiple roads that fall within the scope of standard calculation method 1 (SRM1 roads) or from SRM1 roads and sources other than road traffic, the following steps must be taken:

1. calculate the annual average concentration contribution of NOx from each of the sources;

2. calculate the total annual average concentration contribution NOx;

3. calculate total annual average concentration contribution NO2.

The NOx concentration contribution of SRM1 roads is calculated with formula 1.2.

The NOx concentration contribution from sources other than road traffic in the relevant street is calculated on the basis of the specified NO2 contribution (s). The following equation is used for this:



At which:



With:

CNOx-bijdrage: annual average NOx concentration contribution source [µg / m3];

fNO2: (weighted) fraction of directly emitted NO2 [-]

CNO2-bijdrage: annual average NO2 concentration contribution [µg / m3];

Ca,jm[03]: background ozone concentration [µg / m3];

B, K: parameters, see equation 1.3.

The background concentration of ozone (,) is taken from the background concentration file and relates to the x and y coordinates of the corresponding street. With the specified NO2, the NOx contribution from the relevant sources 1, 2, etc. can be calculated. The NOx concentration contribution of the traffic in the street is calculated in the usual way. The following comparisons are used to calculate the total NO2 contribution:



With:

CNOx-totaal: the total NOx contribution from street and sources 1 and 2 [µg / m3];

CNOx-bron1: the NOx contribution from NO2 source 1 [µg / m3];

CNOx-bron2: the NOx contribution from NO2 source 2 [µg / m3].

The average weighted average for the total of the contributions must then be calculated for the individual NOx contributions:



With:

fNO2: weighted average fraction of directly emitted NO2 [-].

The total NO2 contribution is then:



With:

CNO2-bijdrage-totaal: the total NO2 contribution from street and sources 1 and 2 [µg / m3].

To add the NO2 contribution from more than two additional sources, an analogous method is followed, each additional contribution being combined with the other sources as described above. After the total annual average NO2 concentration has been calculated (in accordance with formula 1.1), the number of exceedances of the limit value for the hourly average concentration is calculated in the usual way on the basis of the newly calculated annual average NO2 concentration (CNO2-totaal).

**Cumulation NO2 concentration contributions from SRM1 and SRM2 roads**

If the NOx contribution calculated with SRM1 at an SRM1 location is greater than 0.049 µg / m3, the following steps must be followed to arrive at a cumulation of the NO2 concentration contributions of roads that fall within the scope of application of standard calculation method 1 (SRM1 roads) and the NO2 concentration contributions of roads that fall within the scope of standard calculation method 2 (SRM2 roads):

1. Determine NO concentration contributions from both the SRM1 and SRM2 roads.

If the NO concentration contribution is not available and the NOx concentration contribution and the fraction of directly emitted NO2 are available, then NO concentration contributions follow from the following comparisons:



With:

Cb,jm,SRM1[NO]: annual average traffic concentration contribution on SRM1 roads at NO concentration [µg / m3];

fNO2,SRM1: weighted fraction of directly emitted NO2 on SRM1 roads [-]: see section 3.6;

Cb,jm,SRM1[NOx]: annual average traffic concentration contribution on SRM1 roads at NOx concentration [µg / m3].



With:

Cb,jm,SRM2[NO]: annual average traffic concentration contribution on SRM2 roads at NO concentration [µg / m3];

fNO2,SRM2: weighted fraction of directly emitted NO2 on SRM2 roads [-]: see section 3.6;

Cb,jm,SRM2[NOx]: annual average traffic concentration contribution on SRM2 roads at NOx concentration [µg / m3].

2. Calculate the equivalent NO contribution for the SRM2 roads based on the following comparisons:



and



With:

Cb,jm,SRM2,eq[NO]: equivalent annual average traffic concentration contribution on SRM2 roads at NO concentration [µg / m3];

ϵ: interim calculation?;

K: 100 [µg / m3];

B: 0.6 [-].

3. Addition of the equivalent NO contribution for SRM2 roads to the NO concentration contribution of the SRM1 roads.



With：

Cb,jm,totaal[NO]: summed annual average traffic concentration contribution on SRM1 roads and SRM2 roads to NO concentration [µg / m3].

4. Calculate the NO2 concentration contribution based on the summed NO contribution based on the following equation:



With:

Ccb,jm[NO2]: annual average traffic traffic contribution to NO2 concentration [µg / m3];

Ca,jm[O3]: annual average large-scale ozone concentration [µg / m3]: use is made of the data referred to in Article 66 (a), (b), (g) and (h) of the Regulation.

5. Calculate the total cumulated NO2 concentration contribution based on the following equation:



With:

Cb,jm,totaal[NO2]: total cumulated annual average traffic contribution to NO2 concentration [µg / m3];

Cdb,jm,SRM1[NO2]: annual average contribution of directly emitted NO2 by traffic on SRM1 roads to NO2 concentration [µg / m3];

Cdb,jm,SRM2[NO2]: annual average contribution of directly emitted NO2 by traffic on SRM2 roads at NO2 concentration [µg / m3].

The annual average contribution of directly emitted NO2 from traffic on SRM1 and SRM2 roads to NO2 concentrations is calculated on the basis of the following comparisons:



With:

Cb,jm,SRM1[NOx]: annual average traffic contribution on SRM1 roads at NOx concentration [µg / m3];

And



With:

Cb,jm,SRM2[NOx]: annual average traffic contribution on SRM2 roads at NOx concentration [µg / m3].

**Cumulation contributions road traffic and devices on particulate matter floating particles (PM10)**

In determining the cumulation of the number of days with exceeding the limit values for the twenty-four-hour average PM10 concentration as a result of the contribution from road traffic and facilities, the following method is used:

1. The number of exceedance days at the calculation point as a result of the large-scale background concentration and the contribution of establishments is calculated using standard calculation method 3 (Article 75, first paragraph) or another method approved by the Minister (Articles 75 and 76).

2. The contribution of a road section to the number of exceedance days is derived from the annual average PM10 concentration contribution by traffic on this road section. This is based on the following comparison:



With:

ODVPM10: the number of days that the twenty-four-hour average PM10 concentration is higher than 50 µg / m3 as a result of traffic [days / year];

Cb,jm[PM10]: annual average concentration contribution PM10 by traffic [µg / m3], as calculated with equation 1.2.

3. The total number of exceedance days is calculated by adding the calculated number of exceedance days as a result of road traffic (see under 2) to the calculated number of exceedance days as a result of possible installations and the background concentrations (see under 1):



**3.8 Determine concentration contribution for traffic with separate lanes**

If there are two carriageways in a street, these carriageways must be regarded as two separate road sections if the distance between the two inner sides of the carriageways is at least 3 meters. If the distance between the two inner sides of the carriageways is less than 3 meters, both carriageways can be considered as one carriageway or two separate carriageways.

The following steps are followed in calculating the annual average concentration contribution from traffic in a street with two separate lanes:

1. For each section of road, the annual average traffic concentration contribution for sulfur dioxide, nitrogen oxides, suspended particles (PM10), lead, carbon monoxide and benzene is calculated at the calculation point with equation 1.2

- If the road type of the street is equal to road type 1, 2 or 4 (see figure 1 in section 3.2), this calculation is based on this road type for both road sections.

- If the road type in the street is equal to road type 3 (one-sided buildings; see figure 1 in section 3.2), then this calculation is based on road type 3 for the road section that is closest to the buildings. furthest from the buildings, road types 3 or 4 are assumed, depending on the distance between the axis of the road section and the facade, and the height of the buildings.

2. The total annual traffic concentration contribution for sulfur dioxide, nitrogen oxides, suspended particles (PM10), lead, carbon monoxide and benzene is determined by adding together the concentration contributions calculated per road section at the calculation point.

3. In the case of nitrogen dioxide, the contributions from both road sections cannot simply be added together. The annual average concentration contribution for nitrogen dioxide (NO2) is determined based on the total annual average concentration contribution for nitrogen oxides (NOx) and the share of NO2 in direct NOx emissions.

With the following comparison, the weighted average of the NO2 fraction in the total of the NOx contributions is calculated:



With:

fNO2(带上划线): weighted average of the NO2 fraction in the total of the NOx contributions by both road sections;

fNO2-wegdeel1: the fraction of directly emitted NO2 [-] in the NOx contribution by road section 1, as determined in equation 1.14;

fNO2-wegdeel2: the fraction of directly emitted NO2 [-] in the NOx contribution by road section 2, as determined in equation 1.14;

CNOx-wegdeel1: the NOx contribution by road section 1;

CNOx-wegdeel2: the NOx contribution by road section 2.

4. The total contribution of NO2 by the traffic on both road sections is calculated on the basis of equation 1.18.

1. Validation and uncertainties

**4.1 Validation in the period 1988 – 2010**

Since the introduction of the CAR model, the predecessor of SRM1, in the early 1990s, there has been a repeated comparison between model results and measurement results at the street stations in the National Air Quality Monitoring Network (LML). These street stations were then introduced in the LML with the aim of being able to test the CAR model. The locations for the traffic stations were selected in such a way that the widest possible range of input parameters for CAR was covered. The model results improved due to the experience gained in determining input data over the years. Modifications to the model also contributed to improving results. In a number of cases, these consisted of a recalculation of model parameters, possibly due to an increase in the available number of observations with the passage of years. A higher accuracy of input data, thanks to a higher spatial resolution, contributed to improvement. Results of model evaluations from those years are less important for the current version of the model because on the one hand a number of changes have been made to the model and on the other hand the level of the concentration levels and the composition of the air have changed.

**4.2 Validation after 2010**

At the request of the Ministry of Infrastructure and the Environment, RIVM compared more than 400 measurements of NO2 concentrations in 2010 and 2011 with concentrations calculated using standard calculation methods-1 and -2. The measured values ​​used are the observations at street stations in the LML and observations from various measurement campaigns in different municipalities that have been carried out using the passive sampling method. The concentrations of NOx, NO2, PM10 and CO were examined at the fixed measuring stations, while passive sampling only produced NO2 levels.

The study concluded that the uncertainty in a single calculation is considerable. On average, however, the calculated concentrations are close to the measured values. The agreement is so good that the differences are on average smaller than the uncertainties therein. For technical information about the comparison and detailed results, reference is made to the relevant report (Wesseling 2013).

1. Examples of use and application range

**5.1 Choice between calculation, wind tunnel simulation and measurement**

The legislation offers three options for determining air quality: (active) measurement on site, model simulation or wind tunnel measurement. The table below summarizes the advantages and disadvantages of these methods. A fourth method, passive sampling, has been included in the table that does not meet the statutory requirements, but gives a first indication of air quality at relatively low costs and which has been used increasingly frequently in recent years.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Acceptance | | Situations where application is possible | | | Required effort | | |
|  | Law | public | present day | future | unique combination of road and buildings | lead time | cost | physical space on location |
| Standard calculation method | √ | • | √ | √ | × | • | • | - |
| Wind tunnel simulation | √ | • | √ | √ | √ | •• | •• | - |
| Active measurement | √ | •• | √ | × | √/× | ••• | ••• | ••• |
| Passive measurement | × | •• | √ | × | √ | ••• | • | • |

Measurements that meet the set requirements generally give little cause for discussion but require a long duration of at least 1 year, cannot be used for future situations and the number of measurement locations is limited by the high management costs (order size: a few ten thousand euros) per year per measuring point). In addition, the housing of the measuring equipment must be able to fit in with the environment. An important point of discussion when using measurements is the question to what extent the results are representative of concentrations over time and in the environment.

Calculations with a calculation model, for example SRM1, can yield results for several calculation points in the short term, if desired for non-existent and / or future (scenario) situations.

Wind tunnel simulations can be used for situations that do not fit within the scope of SRM1 or SRM2. A protocol was published in 2013 for carrying out wind tunnel measurements for air quality studies.

**5.2 Choice between SRM1 and SRM2**

The most important factor that determines the choice between SRM1 and SRM2 is the presence of buildings and their influence on the distribution of traffic emissions. Furthermore, the choice depends on any height differences between the road and the environment, and the presence of shielding structures. The speed and handling of traffic on roads is also of great importance. For use in SRM1, various emission factors are available that fit in with urban traffic, driving at associated speeds and congestion. For SRM2, emission factors are available that are associated with traffic on (motor) motorways and that depend on the applicable speed regime (80-130 km / hour).



Figure 3: A typical SRM1 road with trees.

**5.3 Use of the web application "CAR"**

SRM1 is a description of the method on paper. An implementation of SRM1 has been available through Infomil for years (see http://car.infomil.nl/). CAR may disappear in the course of 2014 and a low-threshold implementation of SRM1 is expected to become available via the NSL calculation tool. This has the advantage that the calculation tool is linked to the Monitoring tool database.

**5.4 Use of the NSL Monitoring / Calculation tool**

The Ministry of Infrastructure and the Environment uses the monitoring tool (http://www.nsl-monitoring.nl) to monitor the progress of the National Air Quality Cooperation Platform. The monitoring tool includes an implementation of standard calculation methods 1 and 2. This implementation is known as the "calculation tool". The calculation tool is available on the website http://www.nsl-monitoring.nl/ calculating/ for municipalities and provinces, but also for other stakeholders such as residents.

**5.5 Required data for use**

The purpose of SRM1 is to calculate the air quality along a traffic road within built-up areas. At the location to be investigated, a calculation point is chosen near the traffic route that is representative of the exposure of the population, for example a point near the façade of houses or on the sidewalk. Prior to applying SRM1 to a location, information about the traffic on the road in question and about the environment must be collected, to be used as input data for the calculation model.

The data to be identified can be divided into location-specific data and generic data. The location-specific data characterizes the location with the help of a number of characteristics of traffic on the road and the immediate surroundings. The manuals of both CAR and the NSL calculation tool, both available inter alia on the Infomil website, provide extensive overviews of the location-specific data required.

In some cases, in addition to the local traffic road, one or more relevant sources of air pollution are present in the nearby area, such as a motorway or a facility. In that case there is a concentration of concentration contributions and the user must also add the concentration contribution (s) of the other sources to the input data for SRM1. For the calculation of these concentration contributions, use is made of SRM2 (highway) or SRM3 (facility). The generic data includes information at a higher scale level (resolution around 1 to 5 km2) that partly determines the air quality at the calculation point, such as wind speed and background concentrations. The generic data also includes the emission factors. Table 5.1 provides an overview of the generic data. For the average vehicle fleet in the Netherlands, the emission factors describe the emissions of air pollutants per car kilometer traveled, with a subdivision made in a few vehicle categories and see Table 5.2. The generic data is re-determined and published annually by the Ministry of Infrastructure and the Environment.

Table 5.1. Generic data for SRM1.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Given | Unit | Source | Frequency |  |
| Background concentration | µg/m3 | GCN | 1 time per year | RIVM |
| Meteorology (wind speed) | m/s |  | 1 time per year | KNMI |
| Emission factors | g/km |  | 1 time per year |  |
| Calibration factor | - |  | Incidental | RIVM |

Table 5.2. Classification of vehicle classes

|  |  |  |  |
| --- | --- | --- | --- |
|  | Category | Description according to decision | Everyday description |
| L | Light motor vehicles | Motor vehicles with 3 or more wheels, with the exception of vehicles of the medium and heavy categories | - all passenger cars  - most delivery vans  - trucks with 4 wheels |
| M | Medium-duty motor vehicles | Motor vehicles that are unsecured and fitted with 1 rear axle with 4 tires, with the exception of buses | - trucks with 2 axles and 4 rear wheels |
| Z | Heavy motor vehicles | Articulated motor vehicles and motor vehicles with a double rear axle, with the exception of buses | - trucks with 3 or more axles  - trucks with a trailer  - tractors with a trailer |
| b | Buses | Articulated and un articulated buses | - all buses for transporting more than ... people |

1. Terms and abbreviations

Short description of terms and abbreviations used in SRM1:

|  |  |
| --- | --- |
| Background Concentration | The large-scale concentration that should be taken into account if no local emission sources were present. |
| Tree factor | A number describing the effect of trees in the street on the spread of emitted air pollution. Tree factor = 1 means that there is no effect. |
| Concentration contribution | The contribution to the concentration of a specific local emission source. |
| Cumulation | Accumulation of concentration contributions from different emission sources. |
| Double counting | Double counting occurs as a road contribution that has already been processed in the background concentration, since it is also added separately. It is especially a problem for large sources such as highways. |
| Emission factor | The amount of air pollution (of a certain component) that is emitted on average by a vehicle (of a certain vehicle type) per kilometer traveled (expressed in [g / km]). |
| Emission number | The amount of air pollution emitted by a road, depending on traffic intensity, composition and speed characteristics, is emitted per meter of road length per unit of time (expressed in [µg / m / s]). |
| Fine dust | Particulate air pollution that penetrates deep into the lungs. (PM10 or PM2.5). |
| IenM | Ministry of Infrastructure and the Environment. |
| Organization | A company with one or more (point) sources. |
| Central reservation | The strip, not intended for traffic, as a separation between two traffic lanes. |
| Monitoring tool | To be able to carry out the monitoring of the NSL, the Ministry of Housing, Spatial Planning and the Environment developed the Monitoring Tool. It is a combination of SRM1, SRM2 and additional calculation rules. |
| NSL | National Air Quality Cooperation Program. |
| Exceeded days | The number of days on which the daily average PM10 concentration exceeds the legal limit of 50 µg / m / s. |
| Parking movement | Traffic movement aimed at parking motor vehicles. |
| Rbl 2007 | Regulation on air quality 2007 |
| Region factor | The effect of the prevailing wind in the region on the spread of emitted air pollution. |
| Calculation distance | The distance between the calculation point and the road axis in meters. |
| Calculation point | The point where the air quality is calculated. |
| Roadway | The continuous part of a road that is intended to be driven by vehicles. A roadway consists of two or more lanes. |
| Speed classification | The speed according to the classification used in SRM1. |
| SRM1 | Standard calculation method 1, calculation model for roads that are directly affected by wind or guide vertebrae around existing buildings. |
| SRM2 | Standard calculation method 2, calculation model for roads that are not directly affected by wind or slate whirls of any existing buildings. The influence of obstacles such as noise barriers is incorporated in SRM2. |
| Dilution factor | A number describing the effect of buildings in the street on the spread of emitted air pollution, in relation to a situation without buildings. |
| Vehicle type / class | Categorization of vehicles on the basis of weight, in addition, buses form a separate category. |
| Road axis | Line in the middle of the roadway. |
| Road section | The smallest functionally independent section of a road with the same, homogeneous properties and relationships and primarily intended for use by road traffic. |
| Road type | Characterization of the influence of buildings along a road on the spread of emitted air pollution. SRM1 distinguishes between 4 road types. |
| Sea salt | The contribution of sea salt in the PM10 concentrations and the associated exceedances. |
| 98-percentile | A measure that describes the occurrence of concentration peaks, expressed in the level that is not exceeded in 98% of the measured values at a location. |