ICS

ISBN 0-626-

SANS 1929:200x

Edition 1

SOUTH AFRICAN NATIONAL STANDARD

Ambient air quality — Limits for common pollutants

Published by Standards South Africa
1 dr lategan road groenkloof ✉ private bag x191 pretoria 0001
tel: 012 428 7911 fax: 012 344 1568 international code + 27 12
www.stansa.co.za

standards
SouthAfrica
(a division of SABS)

Table of changes

Change No.	Date	Scope

Foreword

This South African standard was approved by National Committee STANSA TC 5140.43, *Air quality*, in accordance with procedures of Standards South Africa, in compliance with annex 3 of the WTO/TBT agreement.

Introduction

SANS 69*, Framework for setting and implementing national ambient air quality standards* makes provision for the establishment of air quality objectives for the protection of human health and the environment as a whole. Such air quality objectives include limit values, alert thresholds and target values. Margins of tolerance, time frames for achieving compliance with limit values and permissible frequencies of exceeding limit values are required to be determined to enable the implementation of limit values for the purpose of air quality management and planning. These values are to be based on assessments which establish the ambient concentrations of prioritised pollutants, and evaluate the technical feasibility, economic viability and social and political acceptability of implementing measures to reduce and maintain air quality within limit values.

The numerical values for limit values, alert thresholds and target values are required to be based on the findings of work carried out by international scientific groups active in the field, taking into account the wealth of local knowledge and relevant local conditions.

The limit values presented in SANS 1929 are intended to inform air quality management. These limit values are not enforceable until such time as time frames for achieving compliance have been determined.

Although the framework makes provision for establishing air quality objectives for the protection of human health and the environment, it stipulates that limit values initially be set to protect human health. The setting of such limit values represents the first step in a process to manage air quality and initiate a process to ultimately achieve acceptable air quality nationally. The limit values presented in this standard can not therefore be viewed in isolation, but should be seen as one part of an air quality management programme.

It is envisaged that during future reviews this standard will be revised to include margins of tolerance, compliance time frames and permissible frequencies that limits may be exceeded, ~~exceedance~~ once the required assessments have been completed. The limit values will also be revised in future to address other components of the environment such as vegetation and ecosystems.

Ambient air quality – Limits for common pollutants

1 Scope

This standard gives the limits for common air pollutants to ensure that the negative effects of such pollutants on human health is prevented or reduced.

NOTE Limit values given in this standard are regarded as guidelines until such time as the margins of tolerance, compliance timeframes and permissible frequencies by which the limit values may be exceeded have been determined in accordance with SANS 69.

2 Normative references

The following documents contain provisions which, through reference in this text, constitute provisions of this standard. All documents are subject to revision and, since any reference to a document is deemed to be a reference to the latest edition of that document, parties to agreements based on this document are encouraged to take steps to ensure the use of the most recent edition of the documents indicated below. Information on currently valid national and international documents can be obtained from Standards South Africa.

ASTM D1739 *Standard test method for the collection measurement of dustfall.*

EC Directive on a limit value for lead in the air Directive 82/884/EEC (Council Directive of 3 December 1982).

EN 12341, *Air Quality – Determination of the PM10 fraction of suspended particulate matter - Reference method and field test procedure to demonstrate reference equivalence of measurement methods* .

EPA Compendium Method 14A, *Determination of volatile organic compounds in ambient air using specially prepared canisters with subsequent analysis by gas chromatography.*

EPA Compendium Method 17, *Determination of volatile organic compounds in ambient air using active sampling onto sorbent tubes.*

ISO 4224, *Ambient air – Determination of carbon monoxide – Non-dispersive infrared spectrometry method.*

ISO 5725-1, *Accuracy (trueness and precision) of measurement methods and results Part 1: General principles and definitions.*

ISO 7996, *Ambient air – Determination of the mass concentrations of nitrogen oxides – chemiluminescence method.*

ISO 9855, *Ambient air - Determination of the particulate lead content of aerosols collected in filters – Atomic absorption spectroscopy method.*

~~ISO/FDIS 10498, *Ambient air - determination of Sulfur dioxide - ultraviolet fluorescence method.* It seems the FDIS of this project was withdrawn – could not see if it was maybe published in between?~~
United States Office of the Federal Register. *Code of federal regulations*. Vol. 5. Regulation 40: Protection of the environment. Chapter 1: Environmental Protection Agency. Part 53: Ambient air monitoring reference and equivalent methods. Section 53.32: Test procedures for methods for SO_2, CO, O_3, and NO_2. Washington: U.S. Government Printing Office, 1999.

Royal Meteorological Society Policy Statement '*Atmospheric Dispersion Modelling: Guidelines on the Justification and Use of Models, and the Communication and Reporting of Results'.* Published in collaboration with the Department of the Environment, 1995.

SANS 13964/ ISO 13964, *Air quality – Determination of ozone in ambient air – Ultraviolet photometric method.*

SANS 69, *Framework for setting and implementing national ambient air quality standards.*

US-EPA '*Guidelines on Air Quality Models (Revised)*', EPA-450/2-78-027R, PB86-245248.

US-EPA *'Revision to the Guideline of Air Quality Models: Adoption of a Preferred Long Range Transport Model and Other Revisions; Final Rule'*, 40 CFR Part 51, 15 April 2003.

3 Definitions and abbreviations

For the purposes of this standard, the definitions in SANS 69 and the following definitions and abbreviations apply:

3.1 Definitions

3.1.1
assessment threshold

3.1.1.1
lower assessment threshold
level below which modelling or objective-estimation techniques alone may be used to assess ambient-air quality (see 5.1)

3.1.1.2
upper assessment threshold
level above which monitoring is mandatory and below which a combination of measurements and modelling techniques may be used to assess ambient-air quality (see 5.1)

3.1.2
averaging period
period over which an average value is determined

3.1.3
natural events
geothermal activities, bush fires, high-winds ~~events~~ or the atmospheric resuspension or transport of natural particles from dry regions

3.1.4
PM10
particulate matter which passes through a size-selective inlet with a 50 % efficiency cut-off at 10 µm aerodynamic diameter

3.1.5
zone
area designated by the national authority in which limit values for a specific pollutant are exceeded owing to the concentrations of that pollutant in ambient air due to natural sources

3.2 Abbreviations

3.2.1 EC – European Commission

3.2.2 CFR Code of Federal Regulations

3.2.3 NAAQS – National Ambient Air Quality Standards

4 Limits for common pollutants

4.1 Sulfur dioxide (SO_2)

4.1.1 General

NOTE For the purposes of this standard “sulfur” is deemed to be equivalent to “sulphur”.

Measures shall be taken to ensure that concentrations of SO_2 in ambient air, as assessed in accordance with the process outlined in clause 5, be managed with the aim of achieving the limit values laid down in 4.1.2 within the time frames as determined in accordance with SANS 69.

It is recognized that although national limit values laid down in 4.1.2 primarily aim at the protection of human health, these limit values may be revised in future to address other components of the environment such as vegetation and ecosystems.

4.1.2 Limit values for sulfur dioxide

Limit values are expressed in µg/m³ (see table 1). The volume of SO_2 shall be standardized at a temperature of 25 °C and a pressure of 101,3 kPa. Permissible frequencies for exceeding limit values, margins of tolerance and dates by which values are to be complied with, can only be determined after preliminary assessment has been undertaken in accordance with SANS 69.

An hourly limit value will be determined following the completion of the preliminary assessment undertaken in accordance with SANS 69. This value will be set at a level appropriate to ensure that compliance with this level is likely to ensure a 99.9 % compliance with the limit value indicated for 10 min average exposures. Once the hourly limit value is set, ongoing SO_2 monitoring suited to the collation of 10 min running average concentrations will only be required for areas in which the 1-hourly average revised limit value is exceeded.

Table 1 – Limit values, margins of tolerance and dates for compliance with limit values for sulfur dioxide

1	2	3	4	5
Exposure period	**Averaging period**	**Limit value**	**Margin of tolerance**	**Date by which limit value is to be complied with**
10 min limit value for the protection of human health	10-minute running average	500 µg/m³ (191 ppb) (permissible frequency for exceeding limit values to be determined)	[a]	[a]
Hourly limit value for the protection of human health	1 h	[b]	[a]	[a]
Daily limit value for the protection of human health	24 h	125 µg/m³ (48 ppb) (permissible frequency for exceeding limit values to be determined)	[a]	[a]
Annual limit value for the protection of human health	Calendar year	50 µg/m³ (19 ppb)	[a]	[a]

[a] to be determined in accordance with SANS 69.
[b] In the absence of 10 minute average values, an hourly average value of 350 µg/m³ shall be used as a guideline for assessment purposes(see 4.1.2).

4.1.3 Alert thresholds for sulfur dioxide

To be determined in accordance with SANS 69.

4.1.4 Reference method

The reference method for the analysis of SO_2 is ultraviolet fluorescence method in accordance with CFR 53.32.

NOTE Any other method may be used which can be demonstrated to give equivalent results.

4.2 Nitrogen dioxide (NO_2)

4.2.1 General

Measures shall be taken to ensure that concentrations of nitrogen dioxide in ambient air, as assessed in accordance with the procedure outlined in clause 5, be managed with the aim of achieving the limit values laid down in 4.2.2 within the time frames as determined in accordance with SANS 69.

It is recognized that although national limit values laid down in 4.2.2 primarily aim at the protection of human health, these limit values may be revised in future to address other components of the environment such as vegetation and ecosystems.

4.2.2 Limit values for nitrogen dioxide

Limit values are expressed in µg/m³ (see table 2). The volume shall be standardized at a temperature of 25 °C and a pressure of 101,3 kPa. Permissible frequencies for exceeding limit values, margins of tolerance and dates by which values are to be complied with, can only be determined after preliminary assessment has been undertaken in accordance with SANS 69.

Table 2 – Limit values, margins of tolerance and dates for compliance with limit values for nitrogen dioxide

1	2	3	4	5
Exposure periods	**Averaging period**	**Limit value**	**Margin of tolerance**	**Date by which limit value is to be complied with**
Hourly limit value for the protection of human health	1 hour	200 µg/m³ (106 ppb) (permissible frequency for exceeding limit values to be determined)	[a]	[a]
Annual limit value for the protection of human health	Calendar year	40 µg/m³ (21 ppb)	[a]	[a]

[a] to be determined in accordance with SANS 69.

4.2.3 Alert thresholds for nitrogen dioxide

To be determined in accordance with SANS 69.

4.2.4 Reference method

The reference method for the analysis of nitrogen dioxide is ISO 7996.

NOTE Any other method may be used which can be demonstrated to give equivalent results.

4.3 Carbon monoxide (CO)

4.3.1 General

Measures shall be taken to ensure that concentrations of COin ambient air, as assessed in accordance with the procedure outlined in clause 5, be managed with the aim of achieving the limit values laid down in 4.3.2 within the time frames as determined in accordance with SANS 69.

4.3.2 Limit values for carbon monoxide

Limit values are expressed in mg/m³ (see table 3). The volume shall be standardized at a temperature of 25 °C and a pressure of 101,3 kPa. Permissible frequencies for exceeding limit values, margins of tolerance and dates by which values are to be complied with, can only be determined after preliminary assessments have been undertaken in accordance with SANS 69.

The maximum daily 8-hour mean concentration will be selected by examining 8-hour running averages, calculated from hourly data and updated each hour. Each 8-hour average so calculated will be assigned to the day on which it ends, i.e. the first calculation period for any one day will be the period from 17h00 on the previous day to 01h00 on that day; the last calculation period for any one day will be the period from 16h00 to 24h00 on that day.

Table 3 – Limit values, margins of tolerance and dates for compliance with limit values for carbon monoxide

1	2	3	4	5
Exposure periods	**Averaging period**	**Limit value**	**Margin of tolerance**	**Date by which limit value is to be complied with**
Hourly limit value for the protection of human health	1 hour	30 mg/m³ (26 ppm) (permissible frequency for exceeding values to be determined)	[a]	[a]
8-hourly *running* average for the protection of human health	8-hourly running average calculated on 1-hourly averages	10 mg/m³ (8.7 ppm)	[a]	[a]
[a] to be determined in accordance with SANS 69.				

4.3.3 Alert thresholds for carbon monoxide

To be determined in accordance with SANS 69.

4.3.4 Reference method

The reference method for analysis of CO is ISO 4224 .

NOTE Any other method may be used which can be demonstrated to give equivalent results.

4.4 Particulate matter (PM10)

4.4.1 General

4.4.1.1 With regard to the setting of limit values for particulate matter, the following is recognized:

a) Different types of particles can have different harmful effects on human health.

b) There is evidence that risks to human health associated with exposure to man-made PM10 are higher than risks associated with exposure to naturally occurring particles in ambient air.

c) Insofar as they relate to PM10, action plans and other reduction strategies should aim to reduce concentrations of fine particles as part of the total reduction in concentrations of particulate matter.

4.4.1.2 Measures shall be taken to ensure that concentrations of particulate matter less than 10 µm in aerodynamic diameter (PM10) in ambient air, as assessed in accordance with the procedure outlined in clause 5, be managed with the aim of achieving the limit values laid down in 4.4.2 by the dates to be specified in accordance with SANS 69.

4.4.1.3 Target values in respect of PM10 concentrations in ambient air are those set out in 4.4.3. Such target values shall apply in accordance with SANS 69.

4.4.2 Limit values for particulate matter

Limit values are expressed in µg/m³ and are given for PM10 (see table 4). Permissible frequencies for exceeding limit values, margins of tolerance and dates by which values are to be complied with, can only be determined after preliminary assessments have been undertaken in accordance with SANS 69.

Table 4 – Limit values, margins of tolerance and dates for compliance with limit values for PM10

1	2	3	4	5
Exposure periods	**Averaging period**	**Limit value**	**Margin of tolerance**	**Date by which limit value is to be complied with**
Daily limit value for the protection of human health	24 hours	75 µg/m³ (permissible frequency for exceeding limit values to be determined)	[a]	[a]
Annual limit value for the protection of human health	Calendar year	40 µg/m³	[a]	[a]
[a] to be determined in accordance with SANS 69.				

4.4.3 Target values for particulate matter

Target values are expressed in µg/m³ and are given for PM10 (see table 5). Permissible frequencies for exceeding limit values, margins of tolerance and dates by which values are to be complied with, can only be determined after preliminary assessments have been undertaken in accordance with SANS 69.

Table 5 – Target values, permissible frequencies for exceeding limit values and dates by which target values are to be complied with for PM10

1	2	3	4
Exposure periods	**Averaging period**	**Target value**	**Target date by which value is to be met**
Daily limit value for the	24 hours	50 µg/m³	[a]

protection of human health		(permissible frequency for exceeding limit values to be determined)	
Annual limit value for the protection of human health	Calendar year	30 µg/m^3	[a]

[a] to be determined in accordance with SANS 69.

4.4.4 Alert thresholds for particulate matter

To be determined in accordance with SANS 69.

4.4.5 Reference method

The reference method for the determination of the PM10 fraction of suspended particulate matter is EN 12341.

NOTE Any other method may be used which can be demonstrated to give equivalent results.

4.5 Ozone (O_3)

4.5.1 General

Measures shall be taken to ensure that concentrations of ozone in ambient air, as assessed in accordance with the procedure outlined in clause 5, be managed with the aim of achieving the target values laid down in 4.5.2 within the time frames as determined in accordance with SANS 69.

It is recognized that although national target values laid down in 4.5.2 primarily aim at the protection of human health, these target values may be revised in future to address other components of the environment such as vegetation and ecosystems.

In order to take into account the specific formation mechanisms of ozone and the potential which exists for transboundary transportation of this pollutant, target values, rather than limit values, are set.

4.5.2 Target values for ozone

Target values are expressed in µg/m^3 (see table 6). The volume shall be standardized at a temperature of 25 °C and a pressure of 101,3 kPa. Permissible frequencies for exceeding limit values, margins of tolerance and dates by which values are to be complied with, can only be determined after preliminary assessments have been undertaken in accordance with SANS 69.

The maximum daily 8-hour mean concentration will be selected by examining 8-hour running averages, calculated from hourly data and updated each hour. Each 8-hour average so calculated will be assigned to the day on which it ends, i.e. the first calculation period for any one day will be the period from 17h00 on the previous day to 01h00 on that day; the last calculation period for any one day will be the period from 16h00 to 24h00 on that day.

Table 6 - Target values, margins of tolerance and dates by which limit values are to be complied with for ozone

1	2	3	4	5
Exposure periods	**Averaging period**	**Target value**	**Margin of tolerance**	**Date by which target value is to be complied with**
1. Hourly limit value for the protection of human health	1 hour	200 µg/m³ (102 ppb) (permissible frequency for exceeding limit values to be determined)	[a]	[a]
2. 8-hour limit value for the protection of human health	8-hourly running average calculated on 1-hourly averages(c)	120 µg/m³ (61 ppb)	[a]	[a]
[a] to be determined in accordance with SANS 69.				

4.5.3 Alert thresholds for ozone

To be determined in accordance with SANS 69.

4.5.4 Reference method

The reference method for the analysis of ozone is the UV photometric method as described in ISO 13964. The reference method for the calibration of ozone measuring instruments, is the reference UV photometer as described in ISO 13964.

NOTE Any other method may be used which can be demonstrated to give equivalent results.

4.6 Lead

4.6.1 General

Measures shall be taken to ensure that concentrations of lead in ambient air, as assessed in accordance with the procedure outlined in clause 5, be managed with the aim of achieving the limit values laid down in 4.6.2 within the time frames as determined in accordance with SANS 69.

The margins of tolerance and time frames within which compliance with limit values and target values need to be achieved are still to be defined after preliminary assessment has been undertaken in accordance with SANS 69.

4.6.2 Limit value for lead

Limit values for lead are expressed in µg/m³ (see table 7). The date by which the limit value is to be complied with, can only be determined after preliminary assessments have been undertaken in accordance with SANS 69.

Table 7 – Limit value and date by which the limit value is to be met for lead

1	2	3	4	5
Exposure period	**Averaging period**	**Limit value**	**Margin of tolerance**	**Date by which limit value is to be complied with**
Annual limit value for the protection of human health	Calendar year	0,5 µg/m³	[a]	[a]
[a] to be determined in accordance with SANS 69.				

4.6.3 Target value for lead

Target values are expressed in µg/m³ (see table 8). Target dates by which values are to be complied with, can only be determined after preliminary assessments have been undertaken in accordance with SANS 69.

Table 8 – Target value and date by which the target value is to be met for lead

1	2	3	4
Exposure period	**Averaging period**	**Target value**	**Target date by which value is to be complied with**
Annual limit value for the protection of human health	Calendar year	0,25 µg/m³	[a]
[a] to be determined in accordance with SANS 69.			

4.6.4 Reference methods

The reference method for the sampling of lead is described in the annex to Directive 82/884/EEC. This method shall be used until such time as the limit values are met. Thereafter the reference method will be that for PM10.

The reference method for the analysis of lead is ISO 9855.

NOTE Any other method may be used which can be demonstrated to give equivalent results.

4.7 Benzene (C_6H_6)

4.7.1 General

Measures shall be taken to ensure that concentrations of benzene in ambient air, as assessed in accordance with the procedure outlined in clause 5, be managed with the aim of achieving the limit value laid down in 4.7.2 within the time frames as determined in accordance with SANS 69.

Benzene is a human genotoxic carcinogen and there is no identifiable threshold below which there is no risk to human health. However, when limit value for benzene as given in this standard is difficult to achieve because of site-specific dispersion characteristics or relevant climatic conditions, and if the application of the measures would result in severe socio-economic problems, provincial and local authorities may ask for one time-limited extension under specific conditions.

4.7.2 Limit value for benzene

Limit values for benzene are expressed in µg/m³ (see table 9). The volume shall be standardized at a temperature of 25 °C and a pressure of 101,3 kPa. The date by which the limit value is to be met needs to be determined. This can only be determined after preliminary assessments have been undertaken in accordance with SANS 69.

Table 9 – Limit value and date by which the limit value is to be met for benzene

1	2	3	4	5
Exposure period	**Averaging period**	**Limit value**	**Margin of tolerance**	**Date by which limit value is to be complied with**
Annual limit value for the protection of human health	Calendar year	5 µg/m³ (1.6 ppb)	[a]	[a]
[a] to be determined in accordance with SANS 69.				

4.7.3 Reference methods

The reference methods for the sampling and analysis of benzene are either EPA compendium method 14 A or method 17.

NOTE Any other method may be used which can be demonstrated to give equivalent results.

4.8 Dust deposition

4.8.1 General

The four-band scale to be used in the evaluation of dust deposition is given in 4.8.2 and target, action and alert thresholds indicated in 4.8.3. Permissible margins of tolerance are outlined in 4.8.4 and exceptions noted in 4.8.5.

4.8.2 Evaluation criteria for dust deposition

Dust deposition rates shall be expressed in units of mg/m^{-2}/day^{-1} over a 30-day averaging period. Dust deposition shall be evaluated against a four-band scale as presented in table 10.

Table 10 - Four-band scale evaluation criteria for dust deposition

1	2	3	4
Band number	**Band description label**	**Dustfall rate (D) ($mg/m^{-2}/day^{-1}$, 30-day average)**	**Comment**
1	Residential	D < 600	Permissible for residential and light commercial
2	Industrial	600 < D < 1 200	Permissible for heavy commercial and industrial
3	Action	1 200 < D < 2 400	Requires investigation and remediation if two sequential months lie in this band, or more than three occur in a year.
4	Alert	2 400 < D	Immediate action and remediation required following the first incidence of dustfall rate being exceeded. Incident report to be submitted to relevant authority.

4.8.3 Target, action and alert thresholds

Target, action and alert thresholds for ambient dust deposition are given in table 11.

Table 11 - Target, action and alert thresholds for dust deposition

1	2	3	4
Level	**Dustfall rate (D) ($mg/m^{-2}/day^{-1}$, 30-day average)**	**Averaging period**	**Permitted frequency of exceeding dustfall rate**
Target	300	Annual	
Action residential	400	30 days	Three within any year, no two sequential months.
Action industrial	1 200	30 days	Three within any year, not sequential months.
Alert threshold	2 400	30 days	None. First incidence of dustfall rate being exceeded requires remediation and compulsory report to authorities.

4.8.4 Margin of tolerance

An enterprise may submit a request to the authorities to operate within band 3 (action band), as specified in table 10, for a limited period, provided that this is essential in terms of the practical operation of the enterprise (for example the final removal of a tailings deposit) and provided that an appropriate control technology is applied for the duration.

No margin of tolerance will be granted for operations that result in dustfall rates which fall within band 4 (alert band) as specified in table 10.

4.8.5 Exceptions

Dustfalls that exceed the specified rates but that can be shown to be the result of some extreme weather or geological event shall be discounted for the purpose of enforcement and control. Such event might typically result in excessive dustfall rates across an entire metropolitan region, and not be localized to a particular operation. Natural seasonal variations, for example, the naturally windy months each year, will not be considered extreme events for this definition.

4.8.6 Reference method

The reference method for dustfall is ASTM D1739.

NOTE Any other method may be used which can be demonstrated to give equivalent results.

5 Assessment of air pollutant concentrations

5.1 In order to determine applicable assessment methods for specific pollutants within each area, including zones and agglomerations, the concentrations of sulfur dioxide, nitrogen dioxide, particulate matter, ozone, lead, COand benzene shall be evaluated against the following thresholds:

(a) upper assessment threshold, i.e. the 99th percentile pollutant levels represent a pollutant value exceeding 70 % of a limit value (taking into account limit values for all periods which have been used to derive averages).

(b) lower assessment threshold, i.e. the 99th percentile pollutant levels are below 50 % of all limit values (taking into account limit values for all periods which have been used to derive averages).

5.2 Provision is made for three air pollutant concentration assessment methods to be used by areas, including zones and agglomerations, based on the classification pollutant concentrations relative to the upper and lower assessment thresholds. These methods are

a) mandatory monitoring, which may be supplemented by modelling techniques to provide an adequate level of information on ambient air quality. This method is required to be implemented in areas where the upper assessment threshold for a specific pollutant is exceeded.

b) a combination of measurement and modelling techniques shall be implemented in areas and for pollutants for which concentrations are between the upper and lower assessment thresholds, and

c) sole use of modelling or objective estimation techniques; this permissible in areas and for pollutants for which concentrations are below the lower assessment threshold.

5.3 The classification of areas and agglomerations to determine applicable assessment methods shall be based on air pollutant concentrations recorded during the previous five years where sufficient data are available. Where fewer than five years' data are available, results from measurement campaigns of short duration during the period of the year and at locations likely to be typical of the highest pollution levels may be combined with information from emission inventories and modelling to provide the concentration data required. Classification should be reviewed earlier than every five years in the event of significant changes in activities relevant to ambient air pollutant concentrations.

5.4 Where pollutants have to be measured, the measurements shall be taken at fixed sites determined by appropriate assessment. The analyser can be permanent or movable, but in the case of movable analysers they shall monitor at each site for at least two weeks in every two month period. The measurements shall be taken either continuously or by random sampling; the number of measurements shall be sufficiently large to enable the levels observed to be determined.

5.5 The criteria for determining the location of sampling points for the measurement of SO_2, NO_2, particulate matter, ozone, lead, CO and benzene in ambient air shall be those listed in annex A. The minimum number of sampling points for fixed measurements of concentrations of each relevant pollutant shall be as laid down in annex B and they shall be installed in each zone or agglomeration within which measurement is required, if fixed measurement is the sole source of data on concentrations within it.

5.6 Measurements of nitrogen dioxide shall be made at a minimum of 50 % of the ozone sampling points required by B.2. Measurement of nitrogen dioxide shall be continuous, except at rural background stations, as defined in A.2, where other measurement methods may be used.

5.7 For zones and agglomerations within which information from fixed measurement stations is supplemented by information from other sources, such as emissions inventories, indicative measurement methods and air quality modelling, the number of fixed measuring stations to be installed and the spatial resolution of other techniques shall be sufficient for the concentrations of air pollutants to be established in accordance with A.1 and A.2 and C.1.

5.8 For zones and agglomerations within which information from sampling points for fixed measurement of ozone is supplemented by information from modelling or indicative measurement (or both), the total number of sampling points specified in B.2 may be reduced, provided that:

a) the number of sampling points in each zone or agglomeration amounts to at least one sampling point per two million inhabitants or one sampling point per 50 000 km^2, whichever produces the greater number of sampling points;

b) each zone or agglomeration contains at least one sampling point, and

c) nitrogen dioxide is measured at all remaining sampling points except at rural background stations.

5.9 For zones and agglomerations within which measurement is not required, modelling or objective estimation techniques may be used.

5.10 The reference methods for the sampling and analysis of SO_2, NO_2, PM10, ozone, lead, CO and benzene shall be as given in the relevant clauses of this standard.

5.11 Each provincial authority shall ensure that at least one measuring station to supply data on concentrations of the ozone precursor substances listed in Annex E is installed and operated within its province. Each province shall choose the number and siting of the station at which ozone precursor substances are to be measured, taking into account the objectives, methods and recommendations laid down in annex E.

5.12 The reference techniques for air quality modelling shall be as laid down in annex F.

5.13 Any amendments necessary to adapt this clause and annexes A to E to scientific and technical progress shall ensure that such adaptations do not have the effect of modifying the limit values or alert thresholds either directly or indirectly.

6 Report and review

In order to facilitate the review of this standard the national authority will encourage research into the effects of the pollutants referred to herein, namely sulfur dioxide, nitrogen dioxide (and oxides of nitrogen), particulate matter, lead, carbon monoxide, ozone and benzene.

Amendments necessary for adaptation to scientific and technical progress may relate solely to criteria and techniques for the assessment of pollutant concentrations or detailed arrangements for forwarding information, and may not have the effect of modifying limit values or alert thresholds either directly or indirectly.

Annex A
(normative)

Location of sampling points for the measurement of atmospheric pollutants in ambient air

A.1 Macroscale siting of SO_2, NO_2, PM10, CO, benzene and lead sampling points

A.1.1 Sampling points directed at the protection of human health should be sited

a) to provide data on the areas within zones and agglomerations where the highest concentrations of pollutants occur to which the population is likely to be directly or indirectly exposed for a period which is significant in relation to the period used to derive averages in the case of limit value(s), and

b) to provide data on levels in other areas within the zones and agglomerations which are representative of the exposure of the general population.

A.1.2 Sampling points shall be sited to avoid measuring very small micro-environments in their immediate vicinity. As a guideline, a sampling point shall be sited to be representative of air quality in a surrounding area of not less than 200 m^2 at traffic-orientated sites and of several square kilometres at urban-background sites.

A.1.3 Sampling points should also, where possible, be representative of similar locations not in their immediate vicinity.

A.2 Macroscale siting of ozone sampling points

The macroscale siting criteria in table A.2 shall be used to assess the exposure of specific populations.

Table A.2 — Macroscale siting criteria for Ozone

1	2	3
Type of station	**Represented area**[a]	**Macroscale siting criteria**
Urban	A few square kilometres	– Away from the influence of local emissions such as traffic, petrol stations, etc.; – Vented locations where well mixed levels can be measured; – Locations such as residential and commercial areas of cities, parks (away from the trees), big streets or squares with very little or no traffic, open areas characteristic of educational, sports or recreation facilities.
Surburban	Some tens of square kilometres	– At a certain distance from areas of maximum emissions, downwind following the main wind direction/directions during conditions favourable to ozone formation; – Where populations located in the outer fringe of an agglomeration are exposed to high ozone levels; – Where appropriate, some suburban stations also upwind of the area of maximum emissions, in order to determine the regional background levels of ozone.
Rural	Sub-regional levels (a few square kilometres)	– Stations can be located in small settlements; – Representative of ozone away from the influence of immediate local emissions such as those from industrial installations and roads; – At open area sites, but not on higher mountain tops.
Rural background	Regional/national/continental levels (1 000 km^2 to 10 000 km^2)	– Station located in areas with lower population density, far removed from urban and industrial areas and away from local emissions; – Avoid locations which are subject to locally enhanced formation of near-ground inversion conditions, also summits of higher mountains; – Coastal sites with pronounced diurnal wind cycles of local character are not recommended.

[a] Sampling points should also, where possible, be representative of similar locations not in their immediate vicinity.

Include here?

A.? Macroscale siting of dustfall sampling points

The number and location of samplers shall be sufficient to monitor dust-fall at representative locations around the dust source, and will include monitors located at human residences and sensitive business, industrial or agricultural locations within a maximum distance of 2 km from source boundary. Micro-surroundings of the samplers shall where possible follow the ASTM 1739 prescriptions.

Dustfall monitors may also be located within the boundaries of the industrial plant as defined by the legal, fenced boundaries of the enterprise, for industrial control purposes. Even when included in general environmental reports, these site-internal monitors shall not be evaluated against the dust deposition evaluation criteria stipulated in 4.8.2.

A.3 Microscale siting of O_3, SO_2, NO_2, PM10, CO, benzene and lead sampling points

A.3.1 The following guidelines should be complied with as far as is practicable:

a) The flow around the inlet sampling probe shall be unrestricted, without any obstructions affecting the airflow in the vicinity of the sampler (normally some metres away from buildings, balconies, trees and other obstacles and at least 0,5 m from the nearest building in the case of sampling points representing air quality at the building line).

b) In general, the inlet sampling point shall be between 1,5 m (the breathing zone) and 4 m above the ground. Higher positions (up to 8 m) may be necessary in some circumstances. Higher siting may also be appropriate if the station is representative of a large area.

c) The inlet probe shall not be positioned in the immediate vicinity of sources in order to avoid direct intake of emissions unmixed with ambient air.

d) The sampler's exhaust outlet shall be positioned so that recirculation of exhaust air to the sample inlet is avoided.

e) Location of traffic-orientated samplers:

   1) for all pollutants, such sampling points shall be at least 25 m from the edge of major junctions and at least 4 m from the centre of the nearest traffic lane;
   2) for nitrogen dioxide and carbon monoxide, inlets shall be not more than 5 m from the kerb;
   3) for benzene, particulate matter and lead, inlets shall be sited so as to be representative of air quality near to the building line.

A.3.2 The following factors can also be taken into account:

a) interfering sources;
b) security;
c) access;
d) availability of electrical power and telephone communications;
e) visibility of the site in relation to its surroundings;
f) safety of the public and operators;
g) the desirability of co-locating sampling points for different pollutants;
h) planning requirements.

A.4 Documentation and review of site selection

The site selection procedures shall be fully documented at the classification stage by such means as compass-point photographs of the surrounding area and a detailed map. Sites shall be reviewed at regular intervals and documentation updated to ensure that selection criteria remain valid over time.

In the case of ozone, the site review process requires proper screening and interpretation of the monitoring data in the context of the meteorological and photochemical processes affecting the ozone concentrations measured at the respective site.

Annex B

(normative)

Criteria for determining the numbers of sampling points for fixed measurement of concentrations of atmospheric pollutants in ambient air

B.1 Minimum number of sampling points for fixed measurements to assess compliance with SO_2, NO_2, PM10, CO, benzene and lead limit values for the protection of human health and alert thresholds in zones and agglomerations where fixed measurement is the sole source of information (see table B.1).

B.1.1 Diffuse sources

Table B.1 — Minimum number of sampling points for fixed measurements to assess compliance with SO_2, NO_2, PM10, CO, benzene and lead limit values

1	2	3	4
Population of agglomeration or zone (thousand)	**If concentrations exceed the upper assessment threshold**[a]	**If maximum concentrations are between the upper and lower assessment thresholds**[b]	**For SO_2 and NO_2 in agglomerations where maximum concentrations are below the lower assessment threshold**[c]
0-250	1	1	not applicable
250-499	2	1	1
500-749	2	1	1
750-999	3	1	1
1 000-1 499	4	2	1
1 500-1 999	5	2	1
2 000-2 749	6	3	2
2 750-3 749	7	3	2
3 750-4 749	8	4	2
4 750-5 999	9	4	2
>6 000	10	5	3

[a] Areas in which the 99th percentile pollutant levels represent a value exceeding 70 % of a limit value (taking into account limit values for all periods used to derive averages).

[b] Areas in which the 99th percentile pollutant levels are between 50 % and 70 % of a limit value (taking into account limit values for all specified periods used to derive averages).

[c] Agglomerations where the 99th percentile pollutant levels are below 50 % of all limit values (taking into account limit values for all specified average periods)

In the case of areas polluted by NO_2, particulate matter, benzene and carbon monoxide, in which pollutant level exceeds the upper assessment threshold, at least one urban background station and one traffic-orientated station shall be included, provided this does not increase the number of sampling points.

B.1.2 Point sources

For the assessment of pollution in the vicinity of point sources, the number of sampling points for fixed measurements should be calculated taking into account emission densities, the likely distribution patterns of ambient air pollution and potential exposure of the population.

Sampling points for fixed measurements shall be sited to ensure that the samples taken will be representative of the exposure of the sampled population.

B.2 Minimum number of sampling points for fixed measurements to assess compliance with ozone limit values for the protection of human health and alert thresholds in zones and agglomerations where fixed measurement is the sole source of information (see table B.2).

Table B.2 — Minimum number of sampling points for fixed measurements to assess compliance with ozone limit values

1	2	3	4
Population of agglomeration or zone (thousand)	**Agglomerations (urban and suburban)[a]**	**Other zones (suburban and rural)[a]**	**Rural background**
0-250	-	1	1 station / 50 000 km^2 as an average density over all zones within the country[b]
250-499	1	2	
500-999	2	2	
1 000-1 499	3	3	
1 500-1 999	3	4	
2 000-2 749	4	5	
2 750-3 749	5	6	
> 3 750	1 additional station per 2 million inhabitants	1 additional station per 2 million inhabitants	

[a] At least 1 station in suburban areas, where the highest exposure of the population is likely to occur. In agglomerations, at least 50 % of the stations should be located in suburban areas.

[b] 1 station per 25 000 km^2 for complex terrain is recommended.

Annex C

(normative)

Data quality objectives and compilation of the results of air quality assessment

C.1 Definitions

C.1.1

data capture

ratio of the time for which the instrument produces valid data, to the time for which the statistical parameter or aggregate value is to be calculated

C.1.2

time coverage

percentage of the time considered for setting the threshold value during which the pollutant is measured

C.2 Data quality objectives

C.2.1 The following data quality objectives for allowed uncertainty of assessment methods, of minimum time coverage and of data capture of measurement are provided in table C.1 to guide quality assurance programmes.

Table C.1 — Data quality objectives per measuring station

1	2	3	4	5	6
Measurement	**SO_2 and NO_2,** %	**PM10 and Lead,** %	**Ozone** %	**Benzene** %	**CO** %
Fixed, continuous measurements[a]					
Uncertainty	15	25	15	25	15
Minimum data capture	90	90	90 (summer) 75 (winter)	90	90
Minimum time coverage				35[c] 90[d]	
Indicative measurements					
Uncertainty	25	50	30	30	25
Minimum data capture	90	90	90	90	90
Minimum time coverage	14[b]	14[b]	>10 (summer)	14[b]	14[b]
Modelling					
Uncertainty:					
Hourly averages	50-60		50 (daytime)		
8-hourly averages			50		50
Daily averages	50	not yet defined			
Annual averages	30	50		50	
Objective estimation					
Uncertainty	75	100	75	75	75

[a] Random measurements instead of continuous measurements may be applied for benzene if it can be demonstrated that the uncertainty, including the uncertainty due to random sampling, meets the quality objective of 25 %. Random sampling shall be evenly distributed over the year in order to avoid skewing of results.

[b] One day's measurement a week at random, evenly distributed over the year, or eight weeks evenly distributed over the year.

[c] Urban background and traffic sites (distributed over the year to be representative of various conditions for climate and traffic).

[d] Industrial sites.

C.2.2 The uncertainty (on a 95% confidence interval) of the measurement methods will be evaluated in accordance with the principles of ISO 5725-1, or equivalent. The percentages for uncertainty in the table are given for individual measurements, averaged over the period for considered by the limit values, for a 95 % confidence interval (bias plus two times the standard deviation). The accuracy for continuous measurements should be interpreted as being applicable in the region of the appropriate limit value.

C.2.3 The uncertainty for modelling and objective estimation is defined as the maximum deviation of the measured and calculated concentration levels, over the period for calculating the appropriate threshold, without taking into account the time of the events.

C.2.4 The requirements for minimum data capture and time coverage do not include losses of data due to the regular calibration or normal maintenance of the instrumentation.

C.2.5 By way of derogation, random measurements may be applied instead of continuous measurements for particulate matter and lead if it can be demonstrated that accuracy within the 95 % confidence interval with respect to continuous monitoring is within 10 %. Random sampling shall be spread evenly over the year.

C.3 Results of air quality assessment

The following information shall be compiled for zones or agglomerations within which sources other than measurement are employed to supplement information from measurements or as the sole means of air quality assessment:

a) a description of assessment activities carried out;

b) the specific methods used, with references to descriptions of the methods;

c) the sources of data and information;

d) a description of results, including accuracies and, in particular, the extent of any area or, if relevant, the length of road within the zone or agglomeration over which concentrations exceed limit value(s) or, as may be limit value(s) plus applicable margin(s) of tolerance and of any area within which concentrations exceed the upper assessment threshold or the lower assessment threshold as laid out in clause 5;

e) for limit values, the object of which is the protection of human health, the population potentially exposed to concentrations in excess of the limit value; and

f) where possible, maps should be compiled showing concentration distributions within each zone and agglomeration.

C.4 Standardization

For sulfur dioxide, nitrogen dioxide, benzene, COand ozone, the volumes shall be standardized at a temperature of 25 ºC and a pressure of 101,3 kPa.

Annex D
(informative)

Basis for setting an annual limit value for benzene

In proposing the limit value for benzene based on an annual average concentration for South Africa, there was a call to justify the adoption of the EU Guideline and in particular reference to the risk-based approach.

The reported acceptable risk level to be tolerated is in the range 1 in ten thousand to 1 in a million. The one in a million incremental cancer risk tends to have widespread use but its basis appears to be linked to arbitrary application by the US Food and Drug administration.

Taking the risk-based approach, it must be emphasised that risk determination must be justified using local data and the final risk profiles selected must be subjected to an overall risk management process subject to social, political and economic considerations. This approach has been justified in the WHO Air Quality Guidelines for Europe, 2000, Part I: General: Chapter 2: *Criteria used in establishing guideline values*.

The limit value proposed for South Africa is based on the EC document *Council Directive on Ambient Air Quality Assessment and Management:* Working group on benzene: Position Paper Sept 98. By referring specifically to paragraph 5.3 of this exhaustive position paper, the Working Group for organic volatile pollutants notes that, due to the phasing out of lead in South African fuel by 2006 and the probable low proportion of motor vehicles that will be fitted with catalytic converters by that time, it is possible that ambient concentrations of benzene may increase from present (2003) levels. The Working Group nevertheless concurs that exposure to benzene in ambient air should be as low as possible and that only an annual average limit value should be set.

In view of the uncertainties still associated with estimating the health risk due to benzene exposure, the Working Group for organic volatile pollutants concurs that the proposed limit of 5 $\mu g/m^3$ implements the precautionary approach until such time as further studies provide more certainty. The Working Group is of the opinion that full implementation of the standard cannot realistically be achieved in less than ten years.

Annex E
(informative)

Measurements of ozone precursor substances

E.1 Objectives

The main objectives of such measurements are to analyse any trend in ozone precursors, to check the efficiency of emission reduction strategies, to check the consistency of emission inventories and to help attribute emission sources to pollution concentration.

An additional aim is to support the understanding of ozone formation and precursor dispersion processes, as well as the application of photochemical models.

E.2 Substances

Measurement of ozone precursor substances should include at least nitrogen oxides, and appropriate volatile organic compounds (VOC). A list of volatile organic compounds recommended for measurement is given below.

Ethane
Ethylene
Acetylene
Propane
Propene
n-Butane
i-butane
1-Butene
trans-2-Butene
cis-2-Butene
1.3-Butadiene
n-Pentane
i-Pentane
1-Pentene
2-Pentene
Isoprene
n-Hexane
i-Hexane
n-Heptane
n-Octane
i-Octane
Benzene
Toluene
Ethyl benzene
m+p-Xylene
o-Xylene
1,2,4-Trimethylbenzene
1,2,3-Trimethylbenzene
1,2,5-Trimethylbenzene
Formaldehyde
Total non-methane hydrocarbons

E.4 Reference methods

The reference methods for the sampling and analysis of ozone precursor substances are either EPA compendium method 14 A or method 17.

NOTE Any other method may be used which can be demonstrated to give equivalent results.

E.5 Siting

Measurements should be taken in particular urban and suburban areas at any monitoring site considered appropriate with regard to the above monitoring objectives.

Annex F

(normative)

Guidance on Air Quality Models

F.1 General

Owing to limitations in the spatial and temporal coverage of air quality measurements, monitoring data normally are not sufficient as the sole basis for demonstrating compliance with air quality limits. Dispersion models compute ambient pollutant concentrations and deposition levels as a function of source configurations, emission strengths and meteorological characteristics, thus providing a useful tool to ascertain the spatial and temporal patterns in the ground level concentrations. Such models are widely used by environmental regulators in the US, UK, Europe, Australia and elsewhere to determine compliance with air quality limits.

This guidance is intended for use by regulators tasked with air quality assessment and compliance demonstration. It may also be used to inform modelling undertaken for the purpose of assessing compliance with air quality limits given emissions from either an existing or proposed source.

The guidance does not represent a comprehensive set of criteria covering all possible considerations related to dispersion model selection and applications. Instead it comprises a set of minimum requirements to promote the use of best practice in the application of atmospheric dispersion models for compliance assessment purposes.

F.2 Air quality model selection

F.2.1 Screening versus refined models

A hierarchy of models of increasing complexity exits, ranging from simple screening models which do not require site-specific meteorology to advanced, refined models able to account for pollutant dispersion within complex terrain environments and improved setting of source configuration parameter~~isations~~s.

In the assessment of individual source use may be made of a screening model in which worst-case meteorology is used. If the model indicates that emissions from the source will result in concentrations that are well below the required limits (say, <10%), including background levels of the pollutant, more detailed modelling should not normally be necessary. More advanced models only need to be used if it appears that the relevant air quality objective could be approached or exceeded taking into account source emissions and background concentrations. Such a tiered approach aims to progressively reduce uncertainty whilst minimising time and costs. Screening models should, however, be restricted to use for sources located in flat or undulating terrain.

Screening models are generally not able to simulate emissions from multiple sources. Such models are therefore not suitable for applications by authorities tasked with demonstrating compliance with air quality limits within their jurisdiction.

F.2.2 “Preferred” and “Approved” Models

Several air quality models have been approved for regulatory use for specific applications by various countries. The use of such models for appropriate demonstrations is recommended given that the models are likely to have been subject to evaluation studies and peer review; and the mathematics of the model, data requirements and programme operating characteristics are likely to be documented.

It should not be construed that the models preferred or approved for use elsewhere are to be used to the exclusion of all others or that they are the only models available for relating emissions to air quality.

F.2.3 Proprietary models

The use of proprietary software in regulatory analyses is recognized. Such software shall however have been evaluated and shown to be valid for the application for which it is being used.

The European initiative on "Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes" has resulted in a consensus developing on what should be considered in the evaluation of air quality models, namely quality assurance planning, documentation and scrutiny consistent with intended use. This ~~is given as including~~ scrutiny will include:

a) scientific peer review
b) supportive analyses (diagnostic evaluations, code verification, sensitivity and uncertainty analyses)
c) diagnostic and performance evaluations with data obtained in trial locations, and
d) statistical performance evaluations in the circumstances of the intended applications

It may be required that software and source codes be submitted for review to the responsible air quality regulatory authorities should the software be used for compliance demonstration. In such instances the ownership right of all proprietary software shall be recognised with such models, support software or documentation not being released to the public without prior approval from the software vendor.

F.2.4 Model selection criteria

The user of a model should be able to justify the choice of any particular model, and demonstrate its “fitness for purpose”. Model users shall be able to demonstrate that the model is suited to the following:

a) size of the modelling domain;
b) complexity of the terrain (includes potential for thermo-topographic and urban boundary layer effects);
c) nature of the sources; and
d) type of pollutant

Complex terrain refers to uneven terrain, coastal environments or urban areas where the potential exists for thermo-topographically induced air circulations or urban boundary layer effects. Models applied in such environments shall allow for spatial variations in wind, inversion break-up, comma correct? fumigation and atmospheric stagnation during calm wind periods.

Generally Guassian plume models should not be used beyond a distance of 50 km. For dispersion modelling purposes beyond a distance of 50 km it is recommended that use be made of a Lagrangian puff model (e.g. Gaussian puff) with provision being made for spatial variations in the meteorological field. This does not preclude the use of puff models for distances shorter than 50 km. For urban airshed modelling, use should be made of a model able to account for street- and urban-scale effects on meteorology, and the input of emissions for a range of diverse source types.

F.3 Treatment of specific pollutants

Ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), particulates (PM10 and PM2.5) and lead are often associated with emissions from numerous sources. Several of these pollutants are also closely related to each other in that they share common sources of emission and/or are subject to chemical transformations of similar precursors. It is therefore recommended that models be used which take into account the chemical coupling between relevant pollutants when feasible. For example, fine particles in the PM2.5 range are typically comprised primarily of secondary particles formed through transformations of sulfur oxides (SO_x), nitrogen oxides (NO_x) and VOCs. The simulation of PM2.5 concentrations based exclusively on particulate emissions and neglecting the secondary components of PM2.5 such as sulphates and nitrates, will therefore to result in an underestimation of actual PM2.5 concentrations.

The use of photochemical grid models is recommended for the prediction of ozone concentrations. Such models need to consider emissions of volatile organic compounds (VOC), nitrogen oxides (NO_x) and carbon monoxide (CO), as well as means for generating meteorological data governing transport and dispersion of ozone and its precursors.

F.4 Source data

F.4.1 General

Sources of pollutants can be classified as point, line, area and volume sources. Stacks and vents are typically categorized as point sources. The line sources most frequently considered are roadways along which there are well-defined movement of motor vehicles, but they may also be used to parameterise lines of roof vents or stacks. Area and volume sources are often collections of a multitude or? of minor sources with individually small emissions that are impractical to consider as a separate point or line source. Large area sources are typically treated as a grid of square areas with pollutant emissions distributed uniformly within each grid square.

F.4.2 Emission rates

Modelled emission rates shall be representative of the averaging period(s) for which air pollutant concentrations are being determined.

Temporal trends in emissions shall be accounted for, with both normal and upset emissions being modelled.

F.4.3 Surrounding source contributions

All sources that will have the potential to result in significant contributions to the ambient concentrations of the pollutant being modelled shall be included in the modelling analysis. Sources may be excluded from the modelling analysis if it can be demonstrated that the source does not significantly contribute to the concentrations in the modelling domain. This may be able to be addressed using a simple screening model.

F.4.4 Background concentrations

For proposed sources modelled concentrations shall be added to existing background concentrations in order to evaluate the cumulative impact relative to the air quality limits. Existing background concentrations may be ascertained based on monitoring or modelling approaches or a combination of such methods.

F.5 Receptor grids and related topics

F.5.1 Polar/Rectangular Receptor Grids Does this “slash”/ mean ‘and’ or ‘or’? Or something else?

The receptor grid shall be able to delimit the areas of highest possible impact. After hotspots have been located, remodelling of these areas should be undertaken with a receptor grid tight enough to ensure that the maximum point of impact has been identified (refined grid).

In general, the receptor network may be considered adequate if the difference of concentrations at neighbouring receptors is no larger than one-half the difference between the maximum modelled concentration and the air quality limit under consideration - stated numerically:

$$C_1 - C_2 \leq 0.5(C_l - C_m)$$

where

C_1 and C_2	are concentrations at receptors 1 and 2 (adjacent receptors)
C_l	is the air quality limit
C_m	is maximum concentration of receptors 1 and 2

In addition to using a network of evenly spaced receptors, discrete receptors shall be added at specific locations, for example at ambient air monitoring station locations and at locations where potentially high ambient air pollutant concentrations are expected to occur.

F.5.2 “Ambient air” boundary receptors

Receptor spacing along the ambient air boundary is required to assess the impact of a source at the closest region considered to be “ambient air”.

The United States EPA defines 'ambient air' in a January 21 1986 policy memorandum as follows: Ambient air is defined as "... that portion of the atmosphere, external to buildings, to which the general public has access. Exemption from ambient air is available only for the atmosphere over land owned or controlled by a source and/or to which public access is precluded by a fence or other physical barriers." Ambient air has been defined in SANS 69. Reference should at least be made to that definition, otherwise their may be some confusion.

7.5.3 Flag-pole heights

In the prediction of air pollutant concentrations for the purpose of health considerations, a receptor flag-pole height of 1.5 m shall be specified.

In comparing predicted with measured concentrations the flag-pole height shall reflect the height of the sampler's inlet manifold.

F.6 Terrain elevations

Simple terrain (terrain elevations below the level of pollutant release) and complex terrain (terrain elevations above the level of pollutant release) will need to be addressed in all modelling analyses if terrain within the vicinity of the subject source is expected to have an ~~effect~~ affect on pollutant dispersion.

Receptor elevations should be accurate to within ± 0.5 contour intervals, although this restriction may be relaxed to ±1 contour interval for areas where contour intervals appear very close together.

F.7 Meteorological data

F.7.1 Screening meteorological data

Screening models use a worst-case meteorological data set. Such data sets allow such models to simulate a full set of atmospheric conditions to calculate the highest possible concentration. Worst-case meteorological data shall only be used in a refined screening model for compliance analyses purposes and only if a representative actual meteorological data set is not available.

Only 1-hour concentrations can be calculated using the worst-case meteorological data set. For other averaging periods, impacts shall be calculated by applying appropriate time-scaled conversion factors.

F.7.3 Representative meteorological data

Actual meteorological data shall be used in a refined modelling analysis. At least one year of continuous on-site meteorological data should be used in the modelling analysis. If on-site data are not available for modelling, representative data collected from another meteorological site may be used. Such data shall, however, be shown to qualify in terms of quality assurance and site representativeness considerations.

To demonstrate data representativeness, an analysis shall be undertaken comparing the physiographic and meteorological parameters of the data site using the minimum requirements detailed below.

Minimum requirements to establish meteorological data representativeness are:

(1) physiographic analysis
The site to be modelled and the site for which meteorological data are available shall fall within the same generic category of terrain: for example
- flat terrain
- shoreline conditions
- complex terrain - three dimensional terrain, simple valley, complex valley, two dimensional terrain features

For representativeness of sites in complex terrain the following conditions shall be similar:
a) alignments of major terrain features in north-south orientation;
b) rations of height of valley walls to width of valley and terrain profiles;
c) height of ridge to length of ridge;
d) height of isolated hills to width of hills at the bases;
e) slope of terrain;
f) ratio of terrain heights to stack/plume heights; and
g) distance of proposed source from terrain features for example valley wall, hill.

(2) Meteorological analysis. The comparison shall contain:
a) comparison of regional meteorology to include typical synoptic weather patterns;

b) comparison of site meteorology to include similarity of wind flows, temperatures, inversion types and periods (etc.); and
c) comparison of the plume rise characteristics for each site.

In the case where the meteorological data is not determined to be representative, it may be necessary to collect site-specific meteorological data prior to undertaking the modelling analysis.

If more than one year of data are available, the model shall be run with all available years, up to a maximum of 5 years.

Estimation methods used in the calculation of meteorological parameters required by dispersion models, which are not routinely measured, shall be documented and their use justified.

F.8 Time averaging periods

Air pollutant concentrations shall be predicted for the same averaging period for which air quality limits are provided. Should such limits refer to running averages, rather than block averages, it shall be ensured that dispersion model outputs are used to calculate running averages.

Most dispersion models, including certain "approved" and "preferred" models, are only able to simulate pollutant concentrations for a one-hourly or longer averaging period. In order to use such models to demonstrate compliance with air quality limits for shorter averaging periods reference shall be made to reported concentration ratios between different averaging periods. Although this is a function of both source configuration and atmospheric turbulence, it can generally be shown that concentrations obtained over different averaging times are related as follows:

$$\frac{C_1}{C_2} = \left(\frac{T_2}{T_1}\right)^p$$

where

C_1 and C_2 are concentrations for averaging times T_1 and T_2, respectively;
T_1 and T_2 are any two averaging times;
p is a parameter ranging from 0.16 to 0.68, depending on the atmospheric stability. Most widely used values range between 0.16 and 0.25. Until locally derived values become available, it is recommended to use 0.2.

F.9 Building downwash

Airflow over and around buildings and other solid structures may restrict the dispersion of a pollutant source. When modelling release points where the release height is less than good engineering practice (GEP), the effects of building downwash will need to be addressed in the modelling analysis.

F.10 Quantification of model uncertainty

Any dispersion model will always have a degree of error due to unavoidable inaccuracies in the recorded meteorological data and the simplifications made in the model algorithms for atmospheric processes. In addition, atmospheric mixing has an inherent degree of randomness, owing to the turbulent flows that occur. It is for this reason that models are required to be validated and their degree of uncertainty specified. If a model is used for compliance demonstration the model uncertainty shall be quantified and communicated to the necessary decision-makers.

F.11 Comparison of predicted and measured concentrations for model validation

Dispersion model results should be compared where possible with available monitoring data. It shall be ensured that modelled and monitored concentrations are compared for the same averaging period. The generation of ~~frequency of exceedance curves~~ curves for the frequency that ~~for~~ modelled and monitored concentrations exceed the permissible values, provides a more effective basis for comparisons than does the simple comparison of maximum and mean period averages.

Any corrections made to the model during its validation shall be clearly documented and identified.

F.12 Information to be made available

The model user shall compile a written modelling protocol in instances where models are applied for compliance demonstration. This protocol should include:

a) location of sources;
b) emission rates, source type, source release parameters (point, volume, area or line source model input parameters);
c) discussion of surrounding terrain and the effects it will have on pollutant dispersion;
d) the modelling analysis methodology - including the model(s) to be used in the analysis, and an explanation of why the model(s) would be applicable; model limitations and margins of error should be made explicit;
e) technical options to be used with the model(s);
f) type of meteorological data used in the analysis, its origin, period it represents, and the manner in which the data were collected, processed and verified for quality assurance and site representativeness;
g) receptor grid type and spacing used in the analysis; and
h) air quality monitoring data and location of air quality monitoring location(s) used in the analysis for model result verification (if used).

Copies of model input and output files, including the meteorological data file, shall be retained and be made available to the regulatory authorities if requested. Local and provincial authorities undertaking modelling shall similarly retain records of their model inputs and outputs for possible scrutiny by national authorities.

Bibliography

Council Directive on Ambient Air Quality Assessment and Management: Working group on benzene: Position Paper Sept 98.

Fourie M., van Niekerk W. and Mouton G. (2003). *Technical Background Document for the Development of a National Ambient Air Quality Standard for Lead*, Report compiled on behalf of the Chemical and Allied Industry Association, Document number 005-2003, February 2003.

To be published on NACA's website

Scorgie Y., Annegarn H.J. and Burger L.W. (2003). *Review of International Air Quality Guidelines and Standards for the Purpose of Informing South African Air Quality Standards*, Report compiled on behalf of the Technical Committee on National Air Quality Standards - Working Group I, 5 March 2003. To be published on NACA's website

WHO Air Quality Guidelines for Europe, 2000, Part I: General: Chapter 2: *Criteria used in establishing guideline values*.