Government of **Western Australia**
Department of **Water and Environmental Regulation**

Guideline

Air emissions

Activities regulated under the:
Environmental Protection Act 1986
Environmental Protection Regulations 1987

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Draft for external consultation

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1 Purpose

This *Guideline: air emissions* (the guideline) ensures that adequate information is provided to the Department of Water and Environmental Regulation (the department) for assessing applications with identified air emissions, as regulated under the *Environmental Protection Act 1986* (EP Act).

2 Scope

This guideline applies to all applications for a works approval or licence under Part V of the EP Act with an identified air emission component.

Fugitive dust and odour emissions are not discussed in this guideline. For guidance on these emission types, see *Guideline: odour emissions* and *Guideline: dust emissions* (under development).

This guideline informs applicants:

- what information they should include in an application involving air emissions
- how we apply our assessment criteria for air emissions
- how to use a tool to screen out air emissions as insignificant
- when they should provide a detailed analysis and air emission modelling.

The information in this guideline is general in nature. Please note that we conduct all our assessments on a case-by-case basis, considering the application's site-specific characteristics.

This guideline does not consider air emissions in relation to occupational health and safety, which is the responsibility of the Department of Mines, Industry Regulation and Safety.

The definitions and acronyms used in this document are listed in the *Glossary.*

3 Context

The department's guidelines describe how we interpret and apply the legislation and policies we administer. Our guidelines are not mandatory considerations; however, they support applicants to provide the information we need to make sure their applications are processed in a timely fashion.

An application that does not align with the guidelines may result in a protracted assessment timeframe. If not enough information is provided for us to complete our assessment, we may decline or refuse the application.

Applicants should read this guideline in conjunction with other relevant department policies, guidelines and procedures, which are available on our website. Department application forms also indicate what information is required for applications with an identified air emissions component.

If a proposal is located in an area where ambient standards and limits have been defined under an Environmental Protection Policy (EPP), the EPP will take precedence over this guideline.

4 Legislation

The EP Act provides for the prevention, control and abatement of pollution and environmental harm in Western Australia, in accordance with the (section 4A of the EP Act):

- precautionary principle
- polluter pays principle
- principles of intergenerational equity
- conservation of biological diversity and ecological integrity
- waste minimisation principle.

In accordance with the above-listed principles and section 51 of the EP Act, all reasonable and practicable measures should be taken to prevent or minimise emissions. Under section 51 of the EP Act, it is an offence for occupiers of prescribed premises not to take these measures.

Part V Division 1 of the EP Act has general provisions for the regulation of pollution and environmental harm. Section 49 states: *A person who causes pollution or allows pollution to be caused commits an offence.* Furthermore, any person who emits, or causes an unreasonable emission to be emitted, from any premises commits an offence.

Section 49 of the EP Act provides the obligation that any person is not to cause, or enable to be caused, pollution or unreasonable emissions.

Part V Division 3 of the EP Act provides the department with mechanisms for regulating air emissions, by way of conditions on works approvals and licences applied to prescribed premises. A prescribed premises is one on which an activity listed in Schedule 1 of the Environmental Protection Regulations 1987 is carried out at or above the specified production or design capacity.

5 Environmental objective

This guideline aligns with the *Environmental factor guideline – Air Quality* of Western Australia's Environmental Protection Authority (EPA).

The EPA's objective for air quality is:

> *To maintain air quality and minimise emissions so that environmental values are protected.*

'Environmental value' is defined in the EP Act as: 'a beneficial use, or an ecosystem health condition'. The EPA's air quality objective recognises the link between air quality and the environmental values supported by good air quality. The EPA factor guideline also includes the principle of waste minimisation in accordance with the objectives of the EP Act.

6 Air quality

6.1 Definition of air quality

The department has adopted the same definition for air quality as the EPA:

> *The chemical, physical, biological and aesthetic characteristics of air.*
>
> *'Air' refers to all the air above the ground up to and including the stratosphere.*

Emissions to air include waste exhaust gases, vapours, fumes, particles, dust, and liquid droplets, or any combination of these, emitted to air.

6.2 Sources of air emissions

Many different activities can produce air emissions. Some of the activities the department regulates that typically produce air emissions include:

- oil and gas production and refining
- waste to energy plants
- incineration of waste
- fuel combustion
- electric power generation
- chemical manufacturing and processing
- asphalt and bitumen manufacturing
- metal smelting and refining
- concrete batching and cement manufacturing
- storage of chemicals.

6.3 Impact of air emissions on receptors

It is well established that air emissions can have adverse impacts on human health. These health impacts can be both chronic and acute. Air emissions can also have impacts vegetation, landforms, soil and water quality, as well as amenity and social surroundings.

Factors that influence the impact of air emissions on sensitive receptors include:

- proximity of sensitive receptors to the emission source
- the sensitivity of the receptor
- the nature of the emission such as the:
  - inventory and nature of substances emitted
  - source type (point or diffuse)
  - timing of emissions (intermittent or continuous)
- meteorology and topography
- emissions from other sources that may contribute to cumulative ground-level concentrations within the area.

7 Factors considered in air emissions assessments

The department considers air emissions in relation to their potential impact on human health, amenity and the environment.

The basis of our assessment of air emissions (excluding odour and fugitive dust) involves the predicted ground-level concentrations of air pollutants (GLCs) compared with air quality criteria. We have adopted criteria which are referred to as 'ambient air quality guideline values' (AGVs). The AGVs are described in *Section 7.1* (below) and presented in *Appendix A – Ambient air quality guideline values*.

As part of this comparison, we consider the following factors when assessing air emissions:

- cumulative impacts of the emission
- present and known/approved future sensitive receptors
- the proposed technology
- any air quality issues or complaints we have received (for existing premises)
- the compliance history of existing premises.

7.1 Ambient air quality guideline values (AGVs)

The AGVs we have adopted are listed in *Appendix A – Ambient air quality guideline values*.

These AGVs are based on the approved health guidelines of Western Australia's Department of Health (DoH) and the New South Wales Environmental Protection Authority publication, *Approved methods for the modelling and assessment of air pollutants in New South Wales* (EPA 2016). AGVs are expressed at standard conditions of temperature and pressure (0˚C, 101.325 kPa) and at ambient conditions (25˚C, 101.325 kPa).

The AGVs include different pollutant categories which are assessed by the department; these are summarised in Table 1.

Table 1 Summary AGVs pollutant categories

Pollutant categories	**Category description**	**Assessment approach**
Criteria pollutants *(Table A 1 in Appendix A)*	These are the most widespread pollutants in urban areas that are used as general indicators of air quality.	AGVs are to be met at all existing and future offsite sensitive receptors in the modelling domain.
Principal toxic substances (*Table A 2* in *Appendix A*)	Hazardous air pollutants that are carcinogenic, mutagenic, teratogenic, highly toxic or highly persistent in the environment.	AGVs generally should be met at, or everywhere within the modelling domain (excluding industry premises).
Individual toxic substances *(Table A 3 in Appendix A)*	Other toxic pollutants that threaten the beneficial uses of the air environment.	AGVs generally should be met at, or everywhere within the modelling domain (excluding industry premises).

The department may make exceptions on a case-by-case basis (e.g. premises in remote or industrial areas) to allow an alternative approach.

In some circumstances we may use an AGV other than what is presented in *Appendix A – Ambient air quality guideline values*.

For pollutants not listed in *Appendix A – Ambient air quality guideline values,* applicants may follow the reference hierarchy in Table 2 to identify a suitable

alternative air quality criteria. If no suitable alternative can be identified, contact the department or DoH for further advice.

More stringent requirements may apply to airsheds where estimated air quality is close to exceeding AGVs. If the GLC exceeds the AGV, the application may be refused or the applicant may need to consider alternative technology, controls and/or other mitigation measures to reduce potential impacts to acceptable levels.

In cases where the potential health impacts of proposed air emissions are uncertain, a comprehensive assessment of risk to human health may be required. Contact the DoH for further advice and information.

Table 2. Reference hierarchy for AGVs

Hierarchical rank	Jurisdiction/organisation
1	Western Australian guidelines (e.g. DoH guidance) Australian national guidelines (e.g. National Environment Protection Measures, NHMRC guidelines) Other Australian state and territory guidelines
2	World Health Organization (WHO)
3	United Kingdom Department of Health
4	Netherlands National Institute of Public Health and the Environment (RIVM)
5	Health Canada
6	United States (e.g. Agency for Toxic Substances Disease Registry, Environmental Protection Agency)

8 Assessment overview

The department's assessment process allows insignificant emissions to be 'screened out' from further analysis and assessment. *Section 9: Screening analysis* details the steps for screening out air emissions.

If the screening analysis identifies an air emission as insignificant, we will consider the emission to be low risk and hence no further analysis or assessment will be needed.

If an emission is not screened out, a detailed analysis should be completed. This process is outlined in *Section 10: Detailed analysis*.

Section 11: Reporting provides guidance on our reporting requirements for the screening and detailed analysis.

See Figure 1 (below) for an overview of the assessment pathway.

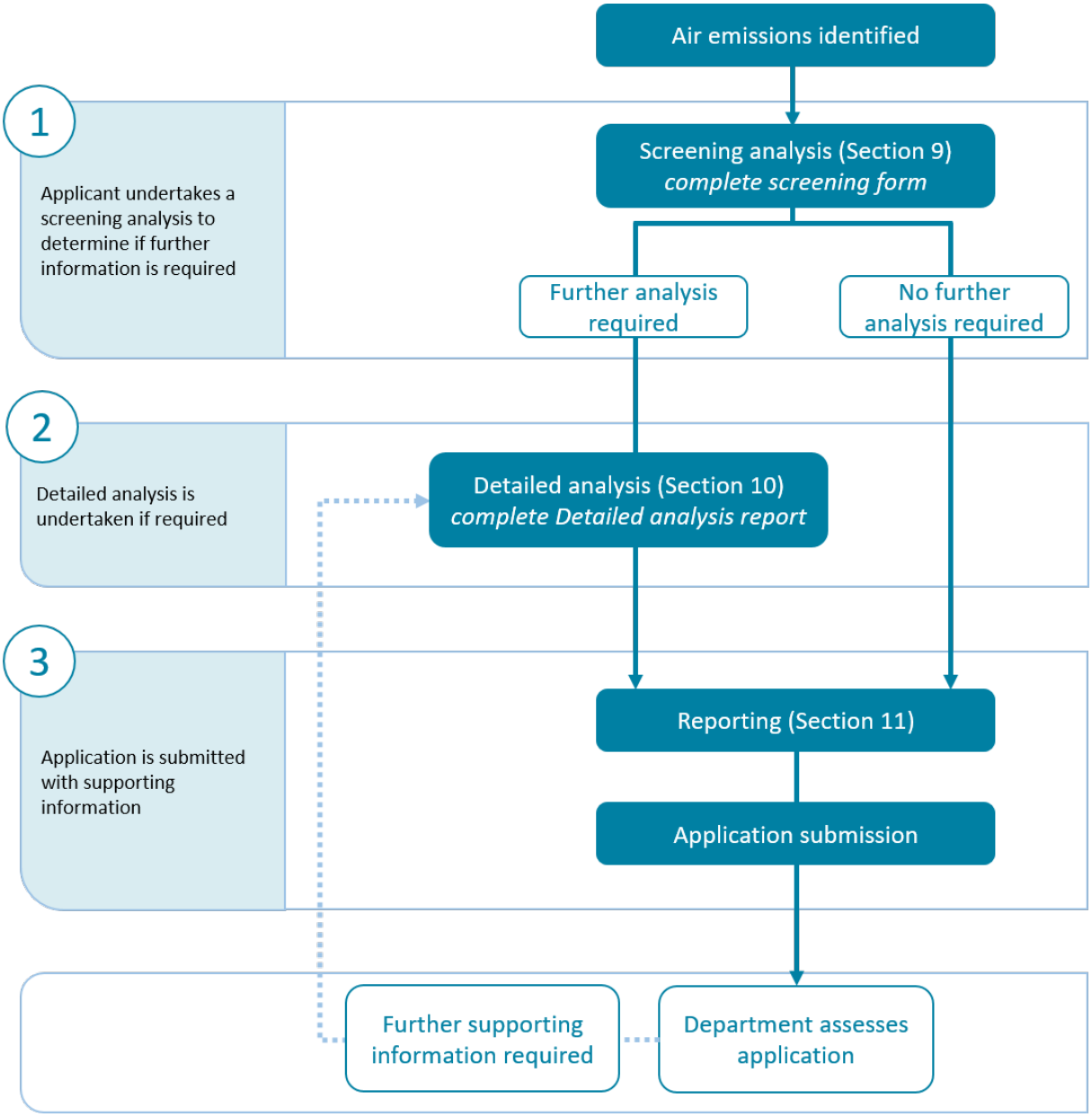

Figure 1. Overview of the assessment pathway

9 Screening analysis

The department has developed a screening analysis to help applicants identify insignificant air emissions.

The screening analysis:

- is a conservative analysis
- involves simple calculations to predict the screening concentration (SC) assuming worst-case conditions and not considering all factors affecting air dispersion (*Section 9.3*)
- compares the SC values with the AGV screening tolerances, which represent likely insignificant impacts (*Section 9.1*).

Applicants should conduct a screening analysis to determine if emissions are likely to be insignificant, or if further detailed analysis is required.

The screening calculation uses 'point source' emissions only (typically from a stack) and excludes plume rise, making it conservative (i.e. likely to provide estimates of concentrations higher than would actually occur). Despite this apparent limitation, it is possible to use the screening calculation procedure for other source types (such as volume and area sources), understanding that it will generally further over-estimate the ambient concentrations and make the screening decisions very conservative. This calculation only applies to 1-hour, 24-hour or annual AGVs.

Where the screening analysis indicates that air emissions are likely insignificant, we may still request additional information or a detailed analysis based on:

- our past experience regulating similar premises and circumstances
- special case factors including complex terrain, existing air quality impacts and potential cumulative effects
- known changes of receptor proximity in future
- the applicant providing insufficient information to substantiate the screening analysis.

Applicants should use our screening form to claim that an emission is insignificant and does not need further investigation and analysis (*Appendix B – Screening analysis form*). The screening form should be completed and submitted with their application.

When the screening indicates a likely insignificant impact, but special factors are present (e.g. complex terrain, cumulative effects), we may still require a detailed analysis for assessment purposes.

If an emission is not screened out, then the emission needs to be further analysed in accordance with *Section 10: Detailed analysis*.

9.1 AGV screening tolerances

An emission may be screened out as insignificant if screening concentrations (SCs) expressed as a percentage of the AGV are less than the tolerances discussed below and summarised in Table 3.

On a case-by-case basis, the department may accept a screening tolerance higher than those described below for isolated, remote or low-background emission situations where there is a low risk of the emission interacting with other sources.

1-hour averaging time

The SC can be considered insignificant if it is < 10% of the 1-hour AGV.

The 10% screening tolerance is a nominal value based on the assumption that short-term spatial and temporal variability reduces the likelihood of the source plume combining with plumes from other sources in the region.

24-hour averaging time

The SC can be considered insignificant if it is < 3% of the 24-hour AGV.

The 3% screening tolerance takes account of the increased likelihood of cumulative effects of sources over a 24-hour averaging period when compared with a 1-hour averaging time.

Annual averaging period

The SC can be considered insignificant if it is < 1% of the annual AGV.

Table 3. AGV tolerances for screening

Averaging time	**Screening concentration (SC)**
1 hour	< 10% of AGV
24 hours	< 3% of AGV
Annual	< 1% of AGV

9.2 Screening calculations

The calculation of SC involves three steps, including an adjustment step to take building effects into account. Figure 2 summarises these steps, with further detail provided below.

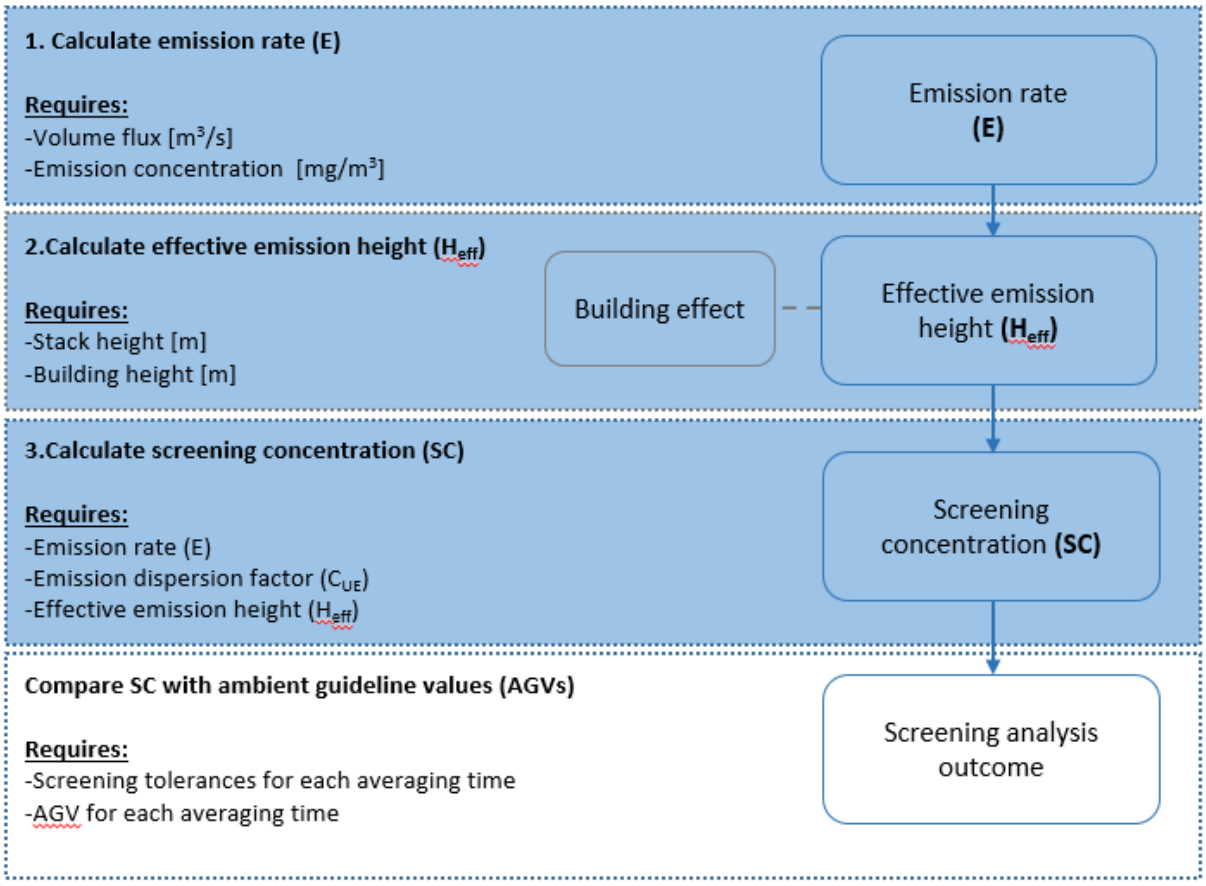

Figure 2: Overview of screening concentration (SC) calculation.

Example calculations with different building/stack heights, and examples of how to calculate and compare the SC to relevant AGVs are set out in *Appendix C – Example calculations for screening analysis*.

See *Exemptions and special cases* below for other considerations.

Step 1: Calculating emission rate (E)

A worst-case emission rate for each identified air emission is required. Examples of emission conditions may include:

- normal operating conditions (including intermittent batch production)
- start-up and shut-down conditions
- upset conditions.

It is the applicant's responsibility to provide reliable emission rate estimates and supporting evidence.

Equation 1. Emission rate (E)

$$E = \frac{C}{1000} \times Q$$

E: Emission rate of substance in grams per second (g/s)

C: Emission concentration in milligrams per cubic metre (mg/m^3) expressed on a dry basis at standard conditions[1]

Q: Volumetric flow rate of emission in cubic metres per second (m^3/s) expressed on a dry basis at standard conditions[1]

For the estimation of 1-hour and 24-hour average concentrations, the maximum emission rate needs to be estimated by the equation above.

For the estimation of annual average concentrations, the 99.9th percentile emission rate may be used if sequential hourly emissions data are available. Otherwise, the maximum emission rate is required.

The calculation of screening concentration assumes that the emission rate is constant for the averaging period being considered. Generally, if the emission is intermittent or variable, the maximum value is still used.

Step 2: Calculating effective emission height (H_{eff})

The effective emission height (H_{eff}) equals the stack height, unless the stack is near a building that is large enough to affect the plume. In this guideline, the H_{eff} calculation is a conservative approach that estimates the reduction of plume height. Enhancements to dispersion due to building wake effects are not considered.

The following parameters are used in the calculation:

H_{eff}: effective height of emission (m)

Hs: stack height (m) from ground level to stack tip

Hb: building height (m)

Wb: largest horizontal building width or length in any direction (m)

L: the smaller of Hb OR Wb (most buildings, other than tall narrow structures, have Hb < Wb)

The scenarios described below identify potential building effects, and provide guidance on adjusting H_{eff} to account for these effects. All buildings near a stack need to be considered and the highest building within a 5L distance should be identified and used in the calculation. As each building is considered, a new value of L may be identified. If this occurs then the revised 5L value should be checked to ensure that the largest value of L has been used.

[1] In the context of this guideline 'standard conditions' refer to standard temperature and pressure (0 ºC, 101.325 kPa)

The scenarios do not account for the effect of buildings of width smaller than height, or other complex building shapes. In these cases, a detailed analysis is required (see *Section 10*).

Scenario 1: No building effect (Hb < 40% of Hs, or distance to nearest building greater than 5L).

Equation 2 Effective emission height (H_{eff}) – no building effect

$$H_{eff} = Hs$$

Scenario 2: The stack is within 5L of a building with Hb > 40% of Hs

Equation 3 Effective emission height (H_{eff}) – building effect 1

$$H_{eff} = \frac{Hs}{3}\left(\frac{Hs}{Hb} + 0.5\right)$$

Note**:** The stack height (Hs) is measured from ground level.

Scenario 3: The stack is within 5L of a building and Hs < Hb

Equation 4. Effective emission height (H_{eff}) – building effect 2

$$H_{eff} = Min\ (Hs,\ 0.5 \times Hb)$$

Step 3: Calculating screening concentration

SC is calculated from the emission rate (E) and the emission dispersion factor (C_{UE}) using Equation 5.

Equation 5. Screening concentration (SC)

$$SC = C_{UE} \times E$$

SC: screening concentration in µg/m^3

E: emission rate of substance in g/s

C_{UE}: emission dispersion factor

The emission dispersion factor (C_{UE}) provides the maximum ground-level concentration in µg/m^3 resulting from a 1 g/s emission from a stack of varying height

at different averaging times (annual, 24 hour, 1 hour). It represents conservative worst-case dispersion conditions for a range of stack heights.

C_{UE} is a computed value from the air quality model ADMS 5, using 12 months of meteorological data collected in 2002–03 from our Caversham air quality monitoring station and the Bureau of Meteorology station at Perth Airport.

The C_{UE} for values of H_{eff} from 0 to 200 m can be selected from *Table 3*. For 1-hour averages the maximum and 99.9 percentile results are provided to enable comparison with the AGVs. For screening calculations, it is intended that the maximum 1-hour C_{UE} be used for all hourly criteria in *Table A 1* to *Table A 3*.

Table 4. Emission dispersion factor (C_{UE}) for different emission heights and averaging times

H_{eff} (m)	**C_{UE}**			
	Annual	24 hours	1 hour	
			Maximum	99.9 percentile
0	80	610	2210	2150
5	48	376	1400	1350
10	12	91	335	263
20	4.8	33	173	98
30	2.6	15	112	74
50	1	7	56	41
70	0.52	4.4	32	26
100	0.25	2.5	16.8	14.7
150	0.11	1.1	8.3	6.6
200	0.056	0.63	5.5	3.7

The SC value is expressed as a percentage of the applicable AGVs at ambient conditions (25˚C, 101.325 kPa). The SC is compared with the corresponding AGV (*Appendix A – Ambient air quality guideline values*) and assessed against the AGV tolerances for screening (see *Section 9.1*), which are percentages of AGVs that represent low risk for unreasonable impacts.

Exemptions and special cases

If a premises has more than one source of an air emission, applicants should not use the screening calculations described above for analysing such sources independently. It is acceptable to combine all sources of a single species into a hypothetical single emission point for a conservative approach. In this situation, the lowest H_{eff} should be used. Otherwise, applicants should conduct a detailed analysis (see *Section 10*), analysing multiple emissions from a premises using computer modelling that correctly accounts for the cumulative effects of independent sources.

There may be circumstances when screening calculations are inappropriate, such as:

- significant variation in ground level over the region of interest
- line sources
- sensitive receptors very close to the emissions source (the closest receptor considered in the simple calculation is greater than 200 m from the source)
- complex building structures
- complex meteorological factors.

In these circumstances, we will generally require a detailed analysis *(Section 10)*. We provide additional guidance on a case-by-case basis.

We may also grant exemptions from the requirement to undertake a screening analysis on a case-by-case basis (e.g. premises in remote or industrial areas) to allow an alternative approach to assessment.

9.3 Screening outcome

If the AGV screening tolerances are met, the air emissions are likely to be insignificant, and no further analysis is required. The application can then be submitted along with the completed screening analysis form (*Appendix B – Screening analysis form*). If an emission is not screened out, then applicants will need to further analyse the emission in accordance with *Section 10*.

10 Detailed analysis

When a screening analysis indicates the emission is potentially significant, applicants should conduct a detailed analysis to more accurately estimate impacts. A detailed analysis may also be required when the department disagrees with a screening analysis, or needs further information about the potential impact of an air emission.

If we request a detailed analysis, this does not imply a potential high impact. The outcome of a detailed analysis may actually show a low risk of air emission impact despite this not being identified in the screening analysis.

A detailed analysis requires additional technical information about the proposal and dispersion modelling to predict GLCs over the area impacted by the application. Including at sensitive receptors. In a detailed analysis, the modelled GLCs are compared against the relevant AGVs at 25˚C.

10.1 Modelling requirements

Our expectations in respect to air quality dispersion modelling and associated meteorological monitoring and/or modelling are outlined in the *Air quality modelling guidance notes* (DoE 2006) or its successor. Note that this publication is scheduled for review in the near future. For further information please contact us directly.

The proponent may choose to carry out 'worst case' dispersion modelling analyses for particular pollutants (via simplified, conservative calculations or models) to demonstrate to the department that air quality impacts are insignificant and therefore that more detailed modelling procedures are not warranted. The worst case analysis procedures should be adequately described, with reference to their source.

In addition to the modelling expectations outlined in the *Air quality modelling guidance notes* (DoE 2006), specific reporting requirements and other considerations depending on the emission type are presented below.

Criteria pollutants

- Cumulative emissions (pre-proposal and proposed) are reported as the maximum concentration.

Principal toxic and individual toxic substances

- Simulations using an averaging time of 1 hour are to be reported as the 99.9th percentile (9th highest value).
- Simulations using an averaging time longer than 1 hour are to be reported as the 100th percentile (highest value).
- For worst-case modelling, concentration should be reported as 100th percentile for simulations using an averaging time of 1 hour to ensure a conservative approach.

Note: The modelling analysis may be limited to emissions from the applicant's facility only, if the applicant shows (to the satisfaction of the department) that the background concentrations of the identified pollutants and other local sources of these pollutants are insignificant.

11 Reporting

After the applicant completes the analyses, the relevant reports should be submitted along with the application form and the information set out below.

The screening analysis reporting consists of:

- statement of the screening analysis outcome
- completed screening analysis form (*Appendix B – Screening analysis form*)
- supplementary documentation supporting the outcomes of the screening analysis, including details on special case factors.

If a detailed analysis is undertaken, a screening analysis report is not required.

The detailed analysis report includes the requirements outlined in the *Air quality modelling guidance notes* (DOE 2006). Applicants may need to conduct additional analyses if we request them.

Document implementation

This guideline comes into effect on the day it is published. Applications received after the publication of the guideline will be processed in accordance with the information contained within this guideline.

Related documents

Non-department documents	
Author	Title
NEPC	National Environment Protection (Ambient Air Quality) Measure
NSW EPA	Approved methods for the modelling and assessment of air pollutants in New South Wales
WA EPA	Environmental factor guideline – Air Quality (2016)
WA EPA	Framework for assessment procedures in EIA
WA EPA	Guidance for the assessment of environmental factors – separation distances between industrial and sensitive land uses
WA Parliament	Environmental Protection Act 1986 (EP Act)
WA Parliament	Environmental Protection Regulations 1987
WA State Government	Environmental Protection (Goldfields Residential Areas) (Sulfur Dioxide) Policy Order (No.2) 2003
WA State Government	Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999

Department documents
Title
Guideline: decision making
Guideline: industry regulation guide to licensing
Guideline: odour emissions
Guidance statement: risk assessment
Air quality modelling guidance notes
A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities

Custodian and review

The currency of this document will be continuously evaluated, and reviewed no later than three years from the date of issue or sooner as required.

Document details	
Lead group (custodian)	Better Regulatory Practice Branch; Air Quality Services Branch; and Industry Regulation Division
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12 Appendices

Appendix A – Ambient air quality guideline values

The department has adopted a set of AGVs as a tool to assess the level of risk associated with a proposed emission. These are presented in *Table A 1* to *Table A 3*. The AGVs are based on advice from Western Australia's DoH and the *Approved methods for the modelling and assessment of air pollutants in New South Wales* (EPA 2016).

The AGVs include: criteria pollutants, principal toxic substances and individual toxic substances (*Section 7.1*).

The AGVs have a range of averaging periods, depending on the health or environmental endpoint that the AGV was designed to protect. The following averaging periods are used in this guideline:

- annual: a continuous 365-day period
- 1 day or 24 hours: midnight to midnight
- 30 day
- 7 day
- 8 hour
- 4 hour
- 1 hour, based on clock hours.

AGVs are listed at ambient conditions (25ºC, 101.325 kPA) for comparison against screening calculations and dispersion modelling ambient concentration predictions. Some of these values are derived from figures quoted at standard temperature and pressure (STP) conditions. In these cases, the original STP values and their references are listed.

Table A 1: Ambient air quality guideline values for criteria pollutants.

Substance	**Averaging period**[l]	**Maximum (ambient) concentration**		
		ppm	**µg/m³ at 0˚C**	**µg/m³ at 25˚C**
Carbon monoxide (CO)	1 hour [d]	25		30 000
	8 hours [a,c]	9		10 000
Lead	Annual [a,c]		0.5	0.46

[l] For model or screening assessments use simple averaging. For comparison of ambient monitoring against health criteria use the following definitions – a 24-hour period is midnight to midnight, an annual average is 365 days, an 8-hour period is a rolling 8-hour average based on 1-hour averages, a 1-hour period is 1 clock hour.

Nitrogen dioxide (NO_2)	1 hour [a,c]	0.12	246	226
	Annual [a,c]	0.03	62	56
Particles (PM_{10})	24 hours [a,c]		50	46
	Annual [a]		25	23
Particles ($PM_{2.5}$)	1 day [a,c]		25	23
	Annual [a,c]		8	7
Particles (total suspended – TSP)	24 hours [b]		90[II]	82
Photochemical oxidants (as ozone)	1 hour [a,c]	0.1	214	196
	4 hours [a,c]	0.08	171	157
Sulfur dioxide (SO_2)	1 hour [a,c]	0.2	570	524
	24 hours [a,c]	0.08	228	210
	Annual [a,c]	0.02	60	52

[II] Temperature reference not defined in source reference, assume reference temperature of 0°C.

Table A 2: Ambient air quality guideline values for principal toxic substances

Substance[III]	**Averaging period**	**Maximum (ambient) concentration**		
		ppm	**µg/m³ at 0˚C**	**µg/m³ at 25˚C**
Acetaldehyde	24 hours [g]		2000[IV]	1830
	Annual [g]		50[IV]	46
Acrolein	1 hour [c]	0.00018		0.42
	24 hours [j]		0.08[IV]	0.074
Acrylonitrile[2B]	1 hour [c]	0.0037		8
	24 hours [j]		0.6[IV]	0.55
	Annual [j]		0.12[IV]	0.11
Alpha chlorinated toluenes and benzoyl chloride [2B] (assumes mixture)	24 hours [k]		0.3[IV]	0.27
	Annual [k]		0.03[IV]	0.027
Alumina	24 hours [g]		10[IV]	9.2
Ammonium nitrate	1 hour [g]		10[IV]	9.2
	Annual [g]		1[IV]	0.92
Antimony and its compounds [2B] (based on antimony trioxide)	1 hour [i]		0.9	0.82
	Annual [k]		0.03	0.027
Arsenic and its compounds [1C]	1 hour [c]			0.09
	24 hours [g]		0.03[IV]	0.027
	Annual [g]		0.003	0.0027
Asbestos [1]	In accordance with the filter membrane method [h]		0.01 limit fibres/ml[IV]	0.01 limit fibres/ml
Asphalt (bitumen / petroleum) fumes [2B]	1 hour [i]		9	9
Beryllium and its compounds [1]	1 hour [c]			0.004

[III] Annual reporting against the respective chronic (annual) value is required so that any exceedances of the chronic guideline can be evaluated and responded to in a timely fashion. This footnote applies to all (IARC) group 1 and 2 carcinogens.

[IV] Temperature reference not defined in source reference, assume reference temperature of 0°C.

Substance[III]	Averaging period	Maximum (ambient) concentration		
		ppm	µg/m³ at 0˚C	µg/m³ at 25˚C
Benzene[1]	Annual [e]		0.0002[IV]	0.00018
	1 hour [c]	0.009		29
	Annual [n]	0.003		9.6
Benzo(a)pyrene toxicity equivalent for polycyclic aromatic hydrocarbons [1]	Annual [n]			0.0003
Boron	1 hour [e]		300[IV]	275
1,3-butadiene[2B]	24 hours [k]		0.3[IV]	0.27
	Annual [k]		0.03[IV]	0.027
Carbon black [2B]	1 hour [i]		5	4.6
Chloroform (trichloromethane)	1 hour [o]		60[IV]	55
Chromium (III) compounds	1 hour [c]			9
	24 hours [g]		0.5[IV]	0.46
Chromium VI compounds [1C]	1 hour [c]			0.09
	Annual [g]		0.0002[IV]	0.00018
Cobalt [2B]	24 hours and annual [i]		0.1	0.092
Copper dusts	1 hour [c]			18
	24 hours [g]		1[IV]	0.92
Crotonaldehyde	24 hours [i]		1.5[IV]	1.4
	Annual [i]		0.9[IV]	0.82
1,2-dichloroethane (ethylene dichloride) [2B]	1 hour [c]	0.018		70
Di-nitro-toluene [2B] (based on 2,4 & 2,6 di-nitro-toluene)	24 hours [k]		0.3[IV]	0.27
	Annual [k]		0.03[IV]	0.027
Dioxins and furans [1C]	1 hour [c]			0.000002
Epichlorohydrin[2A]	24 hour [k]		0.3[IV]	0.27
	Annual [k]		0.03[IV]	0.027
Ethylbenzene	1 hour [c]	1.8		8000
	Annual [f]		300[IV]	270
Ethylene oxide [1C]	1 hour [k]		0.3[IV]	0.27

Substance[III]	**Averaging period**	**Maximum (ambient) concentration**		
		ppm	**µg/m³ at 0˚C**	**µg/m³ at 25˚C**
	Annual [k]		0.03[3]	0.027
Hydrogen fluoride	24 hours [f]			2.9/1.5
	7 days [f]			1.7[V]/0.8[VI]
	30 days [f]			0.84[V]/0.4[VI]
	90 days [f]			0.5[V]/0.25[VI]
Formaldehyde [1C]	1 hour [c]	0.018		20
Hydrogen cyanide	1 hour [c]	0.18		200
	24 hours [e]		10[IV]	9.2
	Annual [e]		0.8[IV]	0.73
Hydrogen sulphide[VII]	1 hour [p]		2800[IV]	2560
	24 hours [f]		150[IV]	137
	Annual [f]		2[IV]	1.8
Manganese and its compounds	24 hours [g]		0.15[IV]	0.14
Mercury (inorganic)	1 hour [f]		0.6[IV]	0.55
	Annual [f]		0.2[IV]	0.18
Molybdenum	24 hours [g]		12[IV]	11
Nickel and its compounds [2B]	1 hour [c]			0.18
	24 hours [l]			0.14
	Annual [l]			0.003
Pentachlorophenol [2B]	1 hour [c]			0.9
	24 hours [k]		0.3[IV]	0.27
	Annual [k]		0.03[IV]	0.027
Propylene oxide [2B]	1 hour [m]		0.3[IV]	0.27
Selenium	1 hour [i]		1[IV]	0.92[8]
Silica [1C](spodumene [VIII])	24 hours [g]		10[IV]	9.2

[V] General land use, which includes all areas other than specialised land use.

[VI] Specialised land use, which includes all areas with vegetation sensitive to fluoride, such as grape vines and stone fruits.

[VII] Health-based assessment criteria, noting that odour criteria may be applied for hydrogen sulphide in assessments. Please contact the department for more information: https://ww2.health.wa.gov.au/Articles/F_I/Hydrogen-sulfide-and-public-health.

[VIII] Use silica criteria for spodumene if ore contains significant silica content; otherwise, treat as particles.

Substance[III]	**Averaging period**	**Maximum (ambient) concentration**		
		ppm	**µg/m³ at 0˚C**	**µg/m³ at 25˚C**
	Annual [g]		3[IV]	2.7
Styrene	1 hour [i]		70[IV]	64
Toluene	24 hours [n]	1		3770
	Annual [n]	0.1		377
TDI (toluene-2,4-di-iso-cyanate; toluene-2,6-di-iso-cyanate) [2B]	1 hour [c]			0.04
	Annual [k]		0.03[IV]	0.027
Trichloroethylene [1]	24 hour [i]		98	90
	Annual [d]		2.3	2.1
Uranium (insoluble compounds)	Annual [f]		0.8[IV]	0.73
Uranium (soluble compounds)	Annual [f]		0.04[IV]	0.037
Vanadium	24 hours [g]		1[IV]	0.92
Vinyl chloride [1C]	24 hours [k]		0.3[IV]	0.27
	Annual [d]		1[IV]	0.92
Welding fume (total particulate) [2B]	1 hour [i]		9	8.2[8]
Wood dust (hardwoods & softwoods) [1C]	1 hour [k]		0.3[IV]	0.27
	Annual [k]		0.03[IV]	0.027
Xylenes (total of all isomers)	24 hours [n]	0.25		1080
	Annual [n]	0.2		870
Zinc	24 hours [e]		50	46

Table A 3: Air quality guideline values for individual toxic substances.

Substance	Averaging period	Maximum (ambient) concentration	
		ppm	µg/m^3 at 25˚C
Acetone	1 hour [c]		22 000
Acrylic acid	1 hour [c]	0.037	110
Ammonia[IX]	1 hour [c]		330
Aniline	1 hour [c]	0.037	140
Barium (soluble compound)	1 hour [c]		9
Biphenyl	1 hour [c]	0.0037	24
Bromochloromethane	1 hour [c]	3.7	19 000
Bromoform (tribromomethane)	1 hour [c]	0.009	90
Bromotrifluoromethane	1 hour [c]	18	112 000
Cadmium	1 hour [c]		0.018
Carbon tetrachloride (tetrachloromethane)	1 hour [c]	0.0018	12
Chlorine	1 hour [c]	0.018	50
Chlorine dioxide	1 hour [c]	0.0018	5.1
Chloromethane (methyl chloride)	1 hour [c]	0.9	1900
Copper fume and mists	1 hour [c]		3.7
Cotton dust (raw)	1 hour [c]		3.7
Cyanide (as CN)	1 hour [c]		90
Cyclohexane	1 hour [c]	5	190
Cyclohexanol	1 hour [c]	0.9	3.8
o-dichlorobenzene	1 hour [c]	0.9	5500
1,2-dichloroethylene	1 hour [c]	3.7	14 400
Dichlorvos	1 hour [c]	0.0018	18
Dinitrobenzene (all isomers)	1 hour [c]	0.003	18
Ethanolamine	1 hour [c]	0.05	140
Ethyl butyl ketone	1 hour [c]	0.9	4200
Ethyl chloride (chloroethane)	1 hour [c]	18	48 000

[IX] Please note that this is health-based assessment criteria, and odour criteria may be applied for ammonia in assessments. Please contact the department for more information.

Substance	Averaging period	Maximum (ambient) concentration	
		ppm	µg/m^3 at 25˚C
Ethylene glycol (vapour)	1 hour [c]		1000
n-hexane	1 hour [c]	0.9	3200
2-hexanone	1 hour [c]	0.46	1800
Hydrogen chloride	1 hour [c]	0.09	140
Iron oxide fume	1 hour [c]		90
Magnesium oxide fume	1 hour [c]		180
Maleic anhydride	1 hour [c]	0.0046	18
MDI (di-phenylmethane di-iso-cyanate)	1 hour [c]		0.04
Mercury (organic)	1 hour [c]		0.18
Methyl acrylate	1 hour [c]	0.18	660
Methyl bromide (bromomethane)	1 hour [c]	0.09	350
Methylene chloride (dichloromethane)	1 hour [c]	0.9	3190
Nitric acid	1 hour [c]	0.037	90
n-pentane	1 hour [c]	11	33 000
2-pentanone	1 hour [c]	3.7	12 800
Phosgene	1 hour [c]		7
Phthalic anhydride	1 hour [c]	0.018	100
Propylene glycol monomethyl ether	1 hour [c]	1.8	6600
Silver metal	1 hour [c]		1.8
Silver, soluble compounds (as Ag)	1 hour [c]		0.18
Sulphuric acid	1 hour [c]		18
1,1,1-trichloroethane (methyl chloroform)	1 hour [c]	2.3	12 500
1,1,2-trichloroethane	1 hour [c]	0.18	1000
Trichlorofluoromethane	1 hour [c]	18.3	103 000
Trimethylbenzene (mixed isomers)	1 hour [c]	0.46	2200
Vinyl toluene	1 hour [c]	0.9	4400

Substance	**Averaging period**	**Maximum (ambient) concentration**	
		ppm	**µg/m^3 at 25˚C**
Zinc chloride fumes	1 hour [c]		18
Zinc oxide fumes	1 hour [c]		90

Table A 4 Toxicity codes and references for standards or guidelines

Additional comments	
Toxicity codes	
[1] IARC Group 1 carcinogen (known human carcinogen)	
[2A] IARC Group 2A carcinogen (probable human carcinogen)	
[2B] IARC Group 2B carcinogen (possible human carcinogen)	
Source reference of standards or guidelines	
a NEPC (2016)	i DoH internal guideline
b EPA WA (1992,1999)	j OMoE (2012)
c EPA NSW (2016)	k Toxikos TTC (2010)
d WHO (2000)	l DoH/Duffus J (2009)
e Toxikos (2012)	m USEPA (2000)
f Toxikos (2011)	n NEPC (2011)
g Toxikos (2010)	o ATSDR (1997)
h DoH (2009a)	p DoH (2009b)

Appendix B – Screening analysis form

Applicants should provide sufficient information with their application to enable the department to substantiate the screening analysis.

The screening analysis form below should be completed and submitted with the application. If the department agrees with the findings, no further analysis is required.

Information to provide

Description of premises and operations

- Operations and activities to be undertaken at the premises
- Air emission sources and pollutants from each source
- Classification of each pollutant (see Appendix A – Ambient air quality guideline values)
- Expected air emissions during planned phases (e.g. routine, start-up, maintenance)
- History of the premises/location including any existing activities at the site and past approvals and studies

Location review

- Map with Map Grid Australia (MGA) coordinate references showing the following:
  - premises location, including information of location characteristics (e.g. industry park)
  - air emission sources
  - location of existing and known future sensitive receptors, including GPS coordinates
  - topographical contours (e.g. electronic copies of .kmz and shape files)
- Description of the nature of receptors

AGV comparison

Air emission and source	Emission rate (g/s)	Averaging time	SC ($\mu g/m^3$)	AGV (25˚C, $\mu g/m^3$)	SC (%) of AGV	AGV screening criteria met?	
						Yes	No
						☐	☐
						☐	☐
						☐	☐
						☐	☐
Add more rows as required						☐	☐

Appendix C – Example calculations for screening analysis

Examples for calculating and comparing the SC to the relevant AGVs for the screening analysis are shown below. For more details on the process, see *Section 9.2* – Screening calculations.

Calculating emission rate (E)

A power station discharges combustion gases to air from a single stack:

- Monitoring data indicates an emission concentration (C) of **nitrogen oxides (NO_x)** of 200 mg/Nm^3
- The volumetric emission flow rate (Q) is 19.3 Nm^3/s

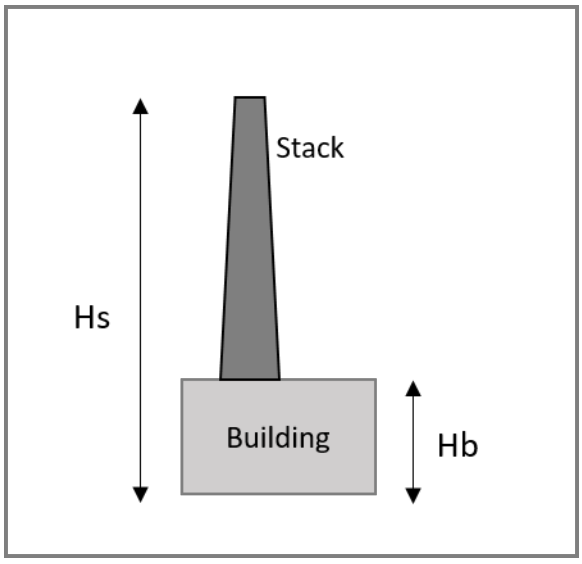
For this example, it is assumed that NO_x is present as 100% NO_2.

Using *Equation 1*:
E= (C/1000) x Q
E= (200/1000) x 19.3 = **3.86 g/s**

Calculating effective height of emission (H_{eff})

Scenario 1: There is no building effect because Hb < 40% of Hs

This section uses *Equation 2*.

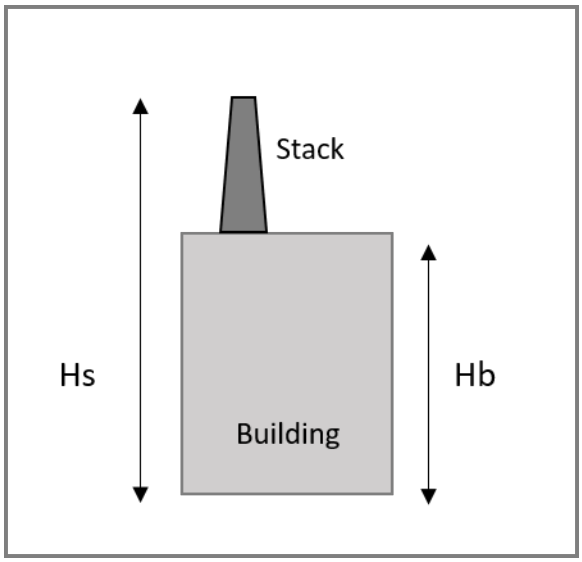


$$Hb = 10\ m$$
$$Hs = 30\ m$$

$$H_{eff} = Hs$$
$$H_{eff} = 30\ m$$

Scenario 2: The building is within 5L of the stack and Hb is > 40% of Hs

This section uses *Equation 3*.



$$Hb = 20\ m$$

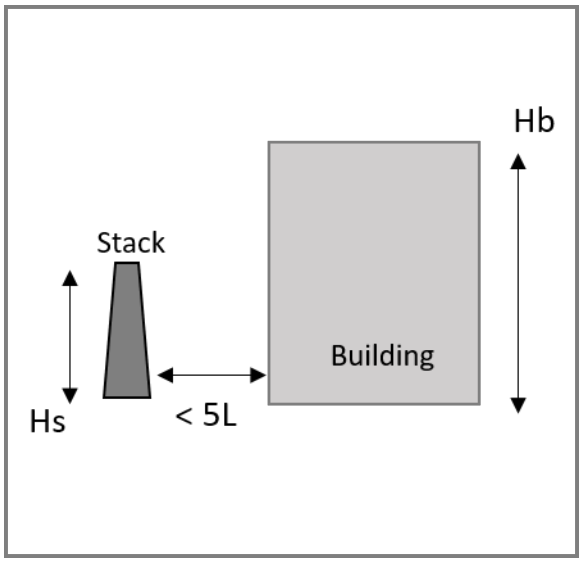
$$Hs = 24\ m$$

$$H_{eff} = \frac{Hs}{3}\left(\frac{Hs}{Hb} + 0.5\right)$$

$$H_{eff} = \frac{24}{3}\left(\frac{24}{20} + 0.5\right) = 13.6\ m$$

Scenario 3: The building is within 5L of the stack and Hs < Hb

This section uses *Equation 4*.



$$Hb = 15\ m$$

$$Hs = 10\ m$$

$$0.5\ Hb = 7.5\ m$$

$$0.5\ Hb < Hs$$

$$H_{eff} = Min(Hs, 0.5\ x\ Hb)$$

$$H_{eff} = 0.5\ x\ Hb = 7.5\ m$$

Calculating emission dispersion factor (C_{UE})

AGVs for NO_2 are 56 µg/m^3 (annual) and 226 µg/m^3 (1 hour) expressed at 25˚C and 101.325 kPa pressure as shown in *Appendix A – Ambient air quality guideline values*. A separate emission dispersion factor (C_{UE}) is required for these averaging periods.

Assuming an effective stack height (H_{eff}) of 30 m from Scenario 1, *Table 2* gives a C_{UE} of 2.6 for an annual averaging period and 112 for a 1-hour averaging period.

Calculating screening concentration (SC)

There are two AGVs for NO_2, resulting in two SCs.
This section uses *Equation 5* and *Table 3.*
A summary of the parameters used in this example are:

E= 3.86 g/s
C_{UE}= 2.6 µg/m^3 (annual averaging period)
C_{UE}= 112 µg/m^3 (1-hour averaging period)

SC= C_{UE} x E
SC= 2.6 x 3.86= **10.04 µg/m^3** (annual)
SC= 112 x 3.86= **432.3 µg/m^3** (1 hour)

Comparing the SC to the AGV

The above calculated annual and hourly SC for NO_2 is now compared to the AGV (*Appendix A – Ambient air quality guideline values*).

AGV comparison							
Air emission and source	Emission rate (g/s)	Averaging time	SC (µg/m^3)	AGV (25˚C, µg/m^3)	SC (%) of AGV	AGV screening criteria met?	
						Yes	No
NO_2	3.86	annual	10.04	56	17.9	☐	☒
NO_2	3.86	1 hour	432.3	226	191	☐	☒

For the annual SC result:

- The annual SC can be screened out if it is < 1% of the maximum annual AGV.
- The SC was 10.04 µg/m^3, which is 17.9% of the annual AGV (56 µg/m^3). This indicates a potentially significant air emission which cannot be screened out.

For the hourly SC result:

- The hourly SC can be screened out if it is < 10% of the maximum hourly AGV.
- The calculated SC was 432.3 µg/m^3, which is 191% of the hourly AGV (226 µg/m^3). This indicates an air emission which cannot be screened out.

Glossary

DWER	Department of Water and Environmental Regulation
Ambient air quality	The quality of air in the outdoor environment. This is typically measured away from direct sources of pollution and generally close to ground level (hence often referred to as ground-level concentrations).
AGV	Air (quality) guideline value
Building effect	The effect of structures/buildings etc. on pollutant plume dispersion.
Complex terrain	Topographic features that may influence the air emissions pathway (e.g. hills, valleys).
Concentration	Quantity of a pollutant in air expressed in unit of: • mass per unit volume (such as mg/m^3 or $\mu g/m^3$) and applies to gases, vapours and particulate matter (PM), but varies with the temperature of the gas stream and hence needs to be cited with the relevant temperature; or • volume per unit volume such as parts per million (ppm) or parts per billion (ppb) which only applies to gaseous pollutants and is independent of temperature
EPP	Environmental Protection Policy as defined in the EP Act; current examples include: • Environmental Protection (Kwinana) (Atmospheric Wastes) Policy Approval Order 1999 • Environmental Protection (Goldfields Residential Areas) (Sulfur Dioxide) Policy Order (No.2) 2003
GLC	Ground-level concentration in air of a contaminant to which a human being may be exposed.
NHMRC	National Health and Medical Research Council
Screening concentration (SC)	A simple and conservative calculation of ambient air concentration resulting from an emission, assuming worst-case conditions.
Screening tolerances	Recommended percentage of AGV used for screening analysis.

Insignificant	Air emissions screened out are considered insignificant and need no further analysis.
Instrument	A licence or works approval regulated under Part V of the EP Act.
Potentially significant	If air emissions are not screened out, they are potentially significant and require further analysis.
Standard conditions	Standard conditions in context of this guideline means temperature of 0ºC, and pressure 101.325 kPa.

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