# Guidelines – Air Environment

Issued by: Inspection Department – Operations Section

## 1.0 Air Environment General Guidelines

Clean air is a basic requirement of human health and well-being. Air pollution, however, continues to pose a significant threat to health worldwide. According to a World Health Organization (WHO) assessment of the burden of disease due to air pollution, more than two million premature deaths each year can be attributed to the effects of urban outdoor air pollution and indoor air pollution (from the burning of solid fuels).

Air pollutants may be either emitted into the atmosphere (primary air pollutants) or formed within the atmosphere itself (secondary air pollutants) apart from the physical state of pollutants (such as gaseous or particulate matter), it is important to consider the geographical location and distribution of sources. The local, urban, regional and global scale of air pollution can be distinguished, depending primarily on the atmospheric lifetime of specific air components.

There are some general guidelines / features, which are common to most works. Such guidelines are outlined below:

a. As part of proper supervision, the owner shall make tests and inspections of the process at frequent intervals as required by the Authority.

b. The results of all tests shall be recorded by the Authority representatives.

c. Adequate facilities for sampling shall be provided on chimneys and ducts.

d. The reference test method for particulate emissions is by the procedure of British Standard 3405:1983 or similar All limit values including EGs are expressed as being at the gas reference conditions of 30°C and a pressure of 1 bar, without correction for water vapor content.

e. Emissions shall be monitored continuously wherever practicable.

f. Roads and operating areas shall be hard surfaced and kept clean.

g. A good standard of housekeeping is essential.

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h.  Staff at all levels shall receive proper control training and instructions in their duties, with special emphasis on start-up, shutdown and abnormal conditions.

i.  Chimney heights shall be determined by the Authority taking into account all the relevant information on throughput, type of material, quality of emission, fuel type and rate of usage, local circumstances, etc.

j.  Dry emissions shall normally be vented to air with an efflux velocity of 10 – 15 m/sec at full load.

k.  When waste gases are wet, or have been in contact with liquids, the maximum chimney velocity shall be 9 m/s to prevent the emission of liquid droplets physically stripped from the wet inside chimney surfaces by high velocity gases.

l.  The minimum height of any chimney shall not be less than 3 meters above the ridge of any tallest building to which it is attached or adjacent.

m.  There shall be suitable means for dealing with spillages, as agreed with Authority.

n.  The construction of any boiler, heater, oven, etc. shall comply with PCFC requirements (see relevant EG).

o.  For any spray painting operation, a proper painting booth should be constructed with a proper extraction / filtration system to the Authority's satisfaction; no open air spray painting will be allowed.

p.  Proper extraction / filtration system to be provided for the air borne emissions from the proposed machinery. The detailed drawings to be submitted to PCFC for approval.

2.0  Chimneys

When the best practicable control means for prevention of emission of noxious or offensive substances have been used, the second part is to render harmless and inoffensive such substances as may be discharged. This is achieved by dispersion from suitably tall chimneys, taking into account the composition, volume rate of emission and temperature of the waste gases. The final decisions on the heights and diameters of chimneys shall be taken by the Authority.

For purposes of deciding on chimney heights of industry in the Free Zone, industry is divided into two parts:

a.  Where chimneys are needed to disperse the products of combustion fuel; and

b.  Where chimneys are needed to disperse airborne emission from process operations.

In the case of (a), for relatively small plants where the heat output is below 30MW, the publication on "Chimney Heights" issued by the UK government and obtainable from HMSO is used for determining heights of chimneys. It is a well-tried document over many years and allows multiple sources to be sited in industrial areas without exceeding permitted ground level concentration. On a case-by-case basis air dispersion modelling would be required from the clients.

3.0     Air Dispersion Modelling

Models are widely used in science to make predictions and/or to solve problems, and are often used to identify the best solutions for the management of specific environmental problems. Models may be physical – a scaled-down representation of reality; or, mathematical – a description of the system using mathematical relationships and equations.

Contaminants discharged into the air are transported over long distances by large-scale air-flow and dispersed by small-scale air-flows or turbulence which mixes contaminants with clean air. The dispersion by the wind is a very complex process due to the presence of different-sized eddies in atmospheric flow. Even under ideal conditions in a laboratory, the dynamics of turbulence and turbulent diffusion are some of the most difficult in fluid mechanics to model. There is no complete theory that describes the relationship between ambient concentrations of air pollutants and the causative meteorological factors and processes.

An atmospheric dispersion model is a:

a.  Mathematical simulation of the physics and chemistry governing the transport dispersion and transformation of pollutants in the atmosphere; and

b.  Means of estimating downwind air pollution concentrations given information about the pollutant emissions and nature of the atmosphere.

Dispersion models can take many forms. The simplest are provided in the form of graphs, tables or formulae on paper. Today, dispersion models more commonly take the form of computer programs, with user-friendly interface and online help facilities.

Most modern air pollution models are computer programs that calculate the pollutant concentration downwind of a source using information on the:

a.  Contaminant emission rate;

b.  Characteristics of the emission sources;

c.  Local topography;

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d.  Meteorology of the area; and

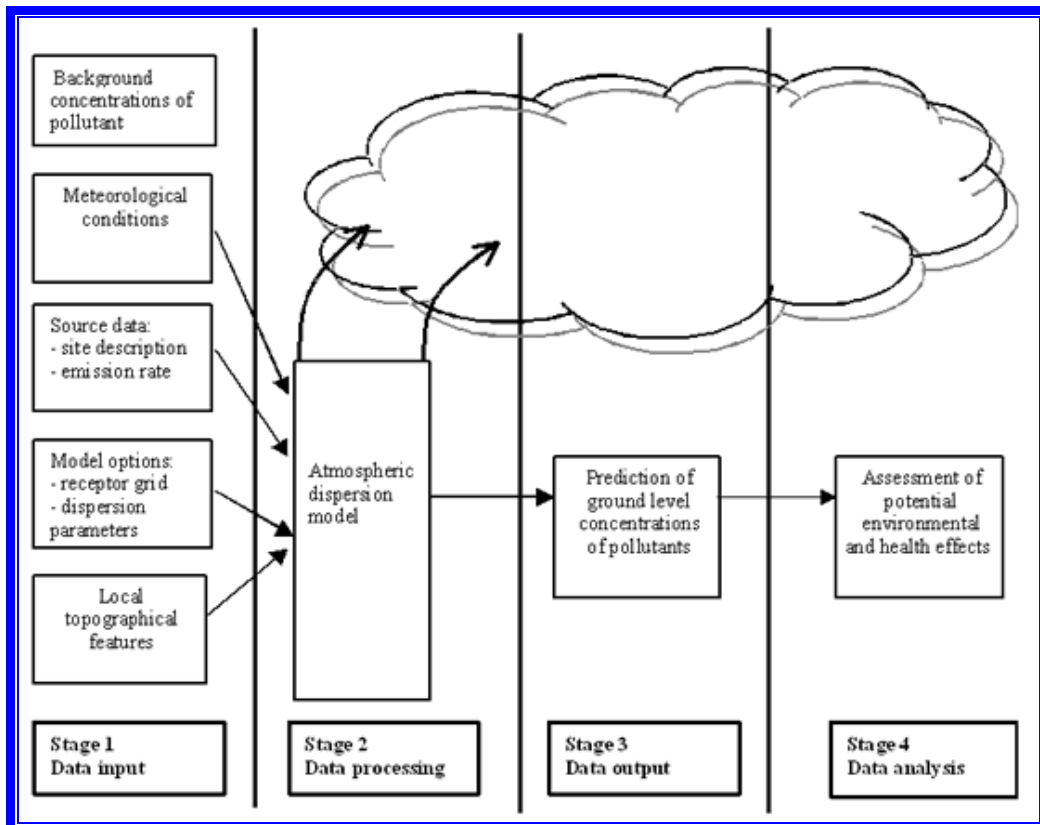e.  Ambient or background concentrations of pollutant.



**Figure 1.1 – Overview of the Air Pollution Modelling Procedure**

The process of air pollution modelling contains four stages (data input, dispersion calculations, deriving concentrations and analysis). The accuracy and uncertainty of each stage must be known and evaluated to ensure a reliable assessment of the significance of any potential adverse effects.

Models can be set up to estimate downwind concentrations of contaminants over varying averaging periods – ether short-term (three minutes) or long term (annual). The most common use of dispersion modelling is to assess the potential environmental and health effects of discharges to air from industrial or trade premises. Models are particularly valuable for assessing the impacts of discharges from new activities and to estimate likely changes as a result of process modifications.

Modelling results can also be used for:

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a. Assessing compliance of emissions with air quality guidelines, criteria and standards.

b. Planning new facilities;

c. Determining appropriate stack heights;

d. Managing existing emissions;

e. Designing ambient air monitoring networks;

f. Identifying the main contributors to existing air pollution problems;

g. Evaluating policy and mitigation strategies (e.g., the effect of emission standards);

h. Forecasting pollution episodes;

i. Assessing the risks of and planning for the management of rare events such as accidental hazardous substance releases;

j. Estimating the influence of geophysical factors on dispersion (e.g., terrain elevation, presence of water bodies and land use;

k. Running "numerical laboratories" for scientific research involving experiments that would otherwise be too costly in the real world (e.g., tracking accidental hazardous substance releases, including foot-and-mouth disease); and

l. Saving cost and time over monitoring – modelling costs are a fraction of monitoring costs and a simulation of annual or multi-year periods may only take a few weeks to assess.

Even the most sophisticated atmospheric dispersion model cannot predict the precise location, magnitude and timing of ground-level concentrations with 100% accuracy. However, most models used today (especially the US EPA approved models) have been through a thorough model evaluation process and the modelling results are reasonably accurate, provided an appropriate model and input data are used.

One of the key elements of an effective dispersion modelling study is to choose an appropriate tool to match the scale of impact and complexity of a particular discharge. When choosing the most appropriate model the principal issues to consider are:

a. The complexity of dispersion (e.g., terrain and meteorology effects); and

b. The potential scale and significance of potential effects, including the sensitivity of the receiving environment (e.g., human health versus amenity effects).
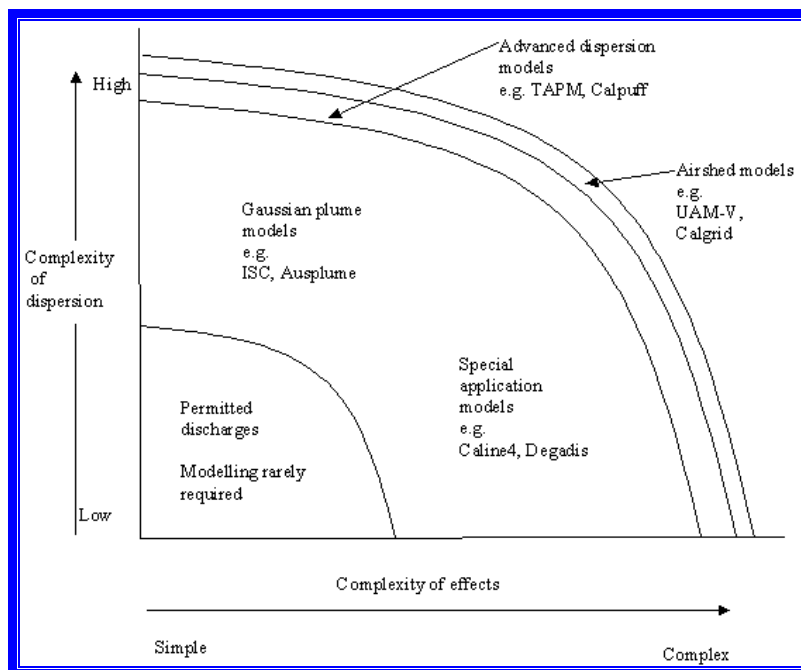
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**Figure 1.2 – Type of Model Typically Applied according to the Complexity of the Problem**

Plot the applicability of different models on a graph of complexity of dispersion (y-axis) against complexity of effects (x=-axis) Ausplume, and ISC models can deal with moderately complex dispersion but only limited complexity effects. TAPF and Calpuff can deal with both highly complex dispersions and highly complex effects.

### Air Dispersion Modelling Study

In order to estimate the impact to the ambient air quality of a proposed activity wherein there will be a source of emission of a pollutant, an air dispersion modelling study may be required by the Authority on case by case basis.

The results of the dispersion modelling study will be able to provide the Authority the information if the primarily proposed mitigating measure/s will be enough to at least lessen any impact to the ambient air of the proposed activity. For instance, if the results of the air dispersion modelling study showed that there are parameters of the ambient air quality that will be exceeding the standards, and then adjustment/s can be made to the proposed activity. The adjustment/s should be able to improve the quality of the ambient air and all parameters of the quality will be able to meet the standards required by the Authority.

Air dispersion modelling study should be designed to be able to answer the requirements of the Authority. The complete process as well as the tools and hypothesis used should be documented. Final report describing the whole process of the air dispersion modelling study

conducted, discussion on the results of the study, interpretation of the results and recommendations should be compiled submitted to the Authority.

4.0     General Industry Air Emission Guidelines

|  |  | Emission Limit |
|---|---|---|
| a. | Particulate Matter | |
| | (i)   Inert dust in ducts and chimneys from combustion sources | 250 mg / m$^3$ |
| | (ii)  Fugitive Dust – there shall be no significant visible emission except from combustion sources | |
| | (iii) There are many dusts and fumes which can have a harmful or nuisance effect on humans, animals, vegetation and materials of construction and for which special limits of emission are required. The following list if not exclusive and substances not on the list will be considered based on their merits. | |

Iron oxide fume from oxygen refining — 75 mg / m$^3$

\* Petroleum – solids from catalytic crackers — 100 mg / m$^3$

\* Petroleum – furnace carbon black — 5 mg / m$^3$

Phosphorus (as $P_2O_5$) — 5 mg / m$^3$

Tar fumes — 20 mg / m$^3$

Vinyl Chloride — 10 mg / m$^3$

\* Note: Desired range of Sulfur Recovery Units (SRUs) efficiency 98 – 99.9%

All volumes are referred to standard conditions of 30°C and 1 bar; electricity works burning fossil fuels are also referred to standard 12% emission of carbon dioxide in the waste gases.

(iv)  Routine methods of assessment may be used by agreement with the Authority, and continuous monitoring instruments shall be fitted wherever practicable.

(v)   Emissions in normal operation should be free from visible smoke and in any case should not exceed 250 mg/m$^3$

(vi)  Sand is prohibited for use as blasting media. Use of any abrasive blasting media containing more than 1% silica shall not be used in abrasive blasting operations in PCFC.

(vii) All abrasive blasters operating in PCFC shall use a recyclable non-metallurgical abrasive material.

Emission Limit

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b.  Gaseous Emissions

| | |
|---|---|
| Amines – total amine | 5 ppm v/v |
| – trimethylamine | 1 ppm v/v |
| Asphalt Fumes | 5 mg / m$^3$ |

The waste gases from industrial processes are often a mixture of acid gases, whilst it is not practicable to measure each component separately, it is convenient to measure the total acidity and to express it as sulfur trioxide (see below table) as a basis for comparison.

5.0     Source Emission Criteria – Air Pollutants

| Substance | Symbol | Sources | Maximum Allowable Emission Limits (mg / Nm$^3$) |
|---|---|---|---|
| Visible Emissions | | Combustion Sources | Ringlemann 1 or 20% opacity or 250 |
| | | Other Sources | None |
| Carbon Monoxide | CO | All sources | 500 |
| Nitrogen Oxides (expressed as Nitrogen Dioxide) | NOx | Combustion Sources Material Producing Industries Other Sources | See Table 1.3 1500 200 |
| Sulfur Dioxide | SO$_2$ | Combustion Sources Material Producing Industries Other Sources | 500 2000 1000 |
| Sulfur Trioxide including Sulfuric Acid Mist (expressed as Sulfur Trioxide) | SO$_3$ | Material Producing Industries Other Sources | 150 50 |
| Total Suspended Particles | TSP | Combustion Sources Cement Industry Other Sources | 250 50 150 |
| Ammonia and Ammonium Compounds (expressed as ammonia) | NH$_3$ | Material Producing Industries Other Sources | 50 10 |
| Benzene | C$_6$H$_6$ | All sources | 5 |
| Iron | Fe | Iron and Steel Foundries | 100 |
| Zinc and its Compounds (expressed as Zinc) | Zn | Electroplating / Galvanizing Industries | 10 |
| Lead and its Compounds (expressed as Lead) | Pb | All sources | 5 |
| Antimony and its Compounds | Sb | Material Producing Industries | 5 |

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| | | | |
|---|---|---|---|
| (expressed as Antimony) | | Other Sources | 1 |
| Arsenic and its Compounds (expressed as Arsenic) | As | All sources | 1 |
| Cadmium and its Compounds (expressed as Cadmium) | Cd | All sources | 1 |
| Mercury and its Compounds (expressed as Mercury) | Hg | All sources | 0.5 |
| Nickel and its Compounds (expressed as Nickel) | Ni | All sources | 1 |
| Copper and its Compounds (expressed as Copper) | Cu | All sources | 5 |
| Hydrogen Sulfide | $H_2S$ | All sources | 5 |
| Chloride | Cl- | Chlorine Works<br>Other Sources | 200<br>10 |
| Hydrogen Chloride | HCl | Chlorine works<br>Other Sources | 200<br>20 |
| Hydrogen Fluoride | HF | All sources | 2 |
| Silicon Fluoride | SiF4 | All sources | 10 |
| Fluoride and its Compounds including HF and SiF4 (expressed as Fluoride) | F- | Aluminum Smelters<br>Other Sources | 20<br>50 |
| Formaldehyde | CH2O | Material Producing Industries<br>Other Sources | 20<br>2 |
| Carbon | C | Odes Production<br>Waste Incineration | 250<br>50 |
| Total Volatile Organic Compounds [expressed as total organic carbon (TOC)] | VOC | All sources | 20 |
| Dioxins and Furans | | All sources | 1 (ng TEQ / m3) |

6.0    Ambient Air Quality Standards

| Substance | Symbol | Maximum Allowable Limits (μg / m³) | Average Time |
|---|---|---|---|
| Sulfur Dioxide | $SO_2$ | 350 | 1 hour |
| | | 150 | 24 hour |
| | | 50 | 1 year |
| Carbon Monoxide | CO | 23 (mg) | 1 hour |
| | | 10 (mg) | 8 hour |

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| | | | |
|---|---|---|---|
| Nitrogen Dioxide | $NO_2$ | 290 | 1 hour |
| | | 110 | 24 hour |
| Ozone | $O_3$ | 160 | 1 hour |
| | | 120 | 8 hour |
| Total Suspended Particles | TSP | 230 | 24 hour |
| | | 90 | 1 year |
| Particulate Matter | $PM_{10}$ | 300 | 1 hour |
| | | 150 | 24 hour |
| Lead | Pb | 1 | 3 months |
| Benzene | $C_6H_6$ | 50 | 1 hour |
| Fluoride | HF | 3 | 24 hour |
| | | 0.5 | 3 months |