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PROVISIONAL GUIDANCE FOR AIR QUALITY MANAGEMENT AT CLAY BRICK INSTALLATIONS

1. Introduction

The Department of Environmental Affairs and Tourism (DEAT) has embarked on a project aimed at reviewing and amending prioritised Registration Certificates issued in terms of section 10 of the APPA and to develop initial capacity within government in respect of Atmospheric Emission Licenses as contemplated in the new Air Quality Act. The main aim of the so-called APPA Registration Certificate Review Project is:

The review and amendment of the Registration Certificates for prioritised air polluters in such a way as to ensure the building of initial air quality management capacity in provinces and affected local authorities as well as ensuring measurable air quality improvements during, and immediately following, the period of transition between APPA and AQA

A total of 9 industry sectors were selected on various criteria to be reviewed as part of this project of which the Clay Brick Sector is one. In the review and amendment of existing APPA registration certificates, a single, comprehensive 'registration certificate' will be compiled for selected enterprises operating at a specific site.

In addition, 'Clamp kilns for brick production' is a listed activity (Listed Activity no. 5.2) under the National Environmental Management: Air Quality Act No 39 of 2004 with draft national minimum emission limits. Listed Activity 5.2 (under the Mineral Processing Industry category) has identified sulphur dioxide (SO_2) and particulates (in the form of dust fallout) to be controlled.

- For dust fallout the requirement is a minimum of 8 dust fallout buckets placed on the facility boundary in the eight principal wind directions based on the method prescribed in SANS 1929:2004. Dust fallout must be measured monthly and the three month running average must not exceed the limit value for adjacent land use according to SANS 1929:2004 (see section following).

- Ambient concentrations of sulphur dioxide (SO_2) must be measured monthly using passive diffusive samplers for a twelve month running average not to exceed limit value for adjacent land use according to SANS 1929:2004.

2. SANS Air Quality Guidelines

Air quality guidelines and standards and other evaluation criteria are fundamental to effective air quality management, providing the link between the potential source of atmospheric emissions and the user of that air at the downstream receptor site. The ambient air quality guideline values and standards indicate safe daily exposure levels for the majority of the population, including the very young and the elderly, throughout an individual's lifetime. Air quality guidelines and standards are normally given for specific averaging periods. These averaging periods refer to the time-span over which the air concentration of the pollutant was monitored at a location. Generally, five averaging periods are applicable, namely an instantaneous peak, 1-hour average, 24-hour average, 1-month average, and annual average.

The South African Bureau of Standards (SABS) was engaged to assist DEAT in the facilitation of the development of ambient air quality standards. A technical committee was established to oversee the development of standards. Three working groups were established by this committee for the drafting of ambient air quality standards for (i) sulphur dioxide, particulates, oxides of nitrogen and ozone, (ii) lead and (iii) volatile organic compounds, specifically benzene. Two documents were produced during the process, viz.:

- SANS 69 - South African National Standard - Framework for setting & implementing national ambient air quality standards

- SANS 1929 - South African National Standard - Ambient Air Quality - Limits for common pollutants

The latter document includes air quality limits for particulate matter less than 10 µm in aerodynamic diameter (PM10), dustfall, sulphur dioxide, nitrogen dioxide, ozone, carbon monoxide, lead and benzene. The SANS documents were approved by the technical committee for gazetting for public comment and were finalized and published in November 2004.

The SANS methodology in setting ambient air quality standards adopted the tiered approach. It was recommended that the following thresholds be established for specific pollutants-averaging periods:

– *Limit values* are to be based on scientific knowledge, with the aim of avoiding, preventing or reducing harmful effects on human health and the environment as a whole. Limit values are to be attained within a given period and are not to be exceeded once attained.

– *Information and investigation thresholds* are intended to highlight pollutant concentrations at which the public need be informed that the most sensitive individuals may be impacted and/or at which investigations into reasons for the elevated levels need to be initiated.

– *Alert thresholds* refer to levels beyond which there is a risk to human health from brief exposure. The exceedance of such thresholds necessitates immediate steps.

The limit values and associated averaging periods are primarily based on human health effect data given for specific averaging periods. In the selection of suitable limit values to be used as the basis for local guidelines, reference was made to the lowest observed adverse effect level (LOAEL) rather than exclusively to the standards adopted by other countries. The reason being that other country-specific considerations that may not be applicable in SA, may have been taken into account in the standard setting process. It was however noted that the standards more recently promulgated (e.g. limit values of the EC, UK and certain of the Australian standards) closely coincide with LOAELs.

2.2 SANS Dust fallout Guidelines

A perceived weakness to these current dust-fall guidelines is that they are purely descriptive without giving any guidance for action or remediation. On the basis of the cumulative South African experience of dustfall measurements, Standards South Africa have published two important new standards in terms of air quality underlying limits for dustfall rates

In terms of dust deposition standards, a four-band scale evaluation is used (Table 1) as well as target, action and alert thresholds (Table 2). Results pertaining to dustfall monitors that are located within the boundaries of the mine as defined by the legal, fenced boundaries of the enterprise cannot be evaluated against the criteria as set out by Table1 in general environmental reports. On-site monitors can thus be evaluated for industrial control purposes and occupational health guidelines or standards.

An enterprise may submit a request to the authorities to operate within band 3 (action band – as outlined in Table 1) 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 disposal) and provided that an appropriate control technology is applied for this 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 1.

Exceptions pertaining to these standards include the following:

- Dustfall that exceeds the specified rates but that can be shown to be the result as 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 localised to a particular operation.
- Natural seasonal variations, for example the naturally windy months each year, will not be considered extreme events for this definition.

Deposition rates must be expressed in units if $mg/m^2/day$ over a 30 day averaging period.

Table 1: Four-band scale evaluation criteria for dust deposition (After SANS 1929: 2004).

Band Number	Band Description Level	Dustfall rate (D) (mg/m^2/day, 30 day average)	Comment
1	Residential	D < 600	Permissible for residential and light commercial.
2	Industrial	600 < D <1200	Permissible for heavy commercial and industrial.
3	Action	1200 < D <2400	Requires investigation and remediation if two sequential months lie in this band, or more than three occur in a year.
4	Alert	2440 < D	Immediate action and remediation required following the first incidence of dustfall rate being exceeded. Incident report to be submitted to the relevant authority.

Table 2: Target, action and alert thresholds for dust deposition (After SANS 1929: 2004).

Level	Dustfall rate (D) (mg/m^2/day, 30 day average)	Averaging Period	Comment
Target	300	Annual	
Action Residential	600	30 days	Three within any year, no two sequential months.
Action Industrial	1200	30 days	Three within any year, not sequential months.
Alert Threshold	2400	30 days	None. First incidence of dustfall rate being exceeded requires remediation and compulsory report to the authorities.

2.3 SANS SO_2 Ambient Air Quality Guidelines

Sulphur dioxide is damaging to the human respiratory function. Exposure to sulphur dioxide concentrations above certain threshold levels increases the prevalence of chronic respiratory disease and the risk of acute respiratory illness. Due to it being highly soluble, sulphur dioxide is more likely to be adsorbed in the upper airways rather than penetrate to the pulmonary region.

Ambient air quality guidelines from the SANS 1929:2004 are given in Table 3. The guidelines are expressed in µg/m³ with the volume standardized at a temperature of 25°C and a pressure of 101.3 kPa.

The requirement for SO_2 measurements from Listed Activity 5.2 are 12 monthly average using passive diffusive samplers providing monthly average results. Thus, the annual average guideline concentration of 50 µg/m³ will be the indicator.

Table 3: Ambient air quality guidelines and standards for sulphur dioxide for various countries and organisations

Authority	Maximum 1-hourly Average (µg/m³)	Maximum 24-hour Average (µg/m³)	Annual Average Concentration (µg/m³)
Proposed South African Standards (based on the SANS:1929,2004)	350(a)	125(b)	50(b)
Notes: (a) Proposed South African Standards as published in the Government Gazette of 9th June 2006 (b) SANS 1929 - South African National Standard - Ambient Air Quality - Limits for common pollutants. Also proposed South African Standards as published in the Government Gazette of 9th June 2006			

3. Ambient Monitoring Procedures

3.1 Dust Fallout Monitoring

Dust fallout monitoring is a crude and non-specific test method primarily focussed to study long-term trends and to obtain samples of settlable particulate matter for further chemical analysis. It is not suitable for determining dust fallout in small areas affected by specific sources. The advantage of dust fallout buckets is the simplicity of the method, the relative low costs associated with it and that it can be operated without large technically-skilled staff (ASTM D1739-98).

Two types of dustfall monitors exists, viz. (i) single dust bucket monitors; and (ii) four-bucket wind directional monitors.

The single dust bucket monitors are deployed following the American Society for Testing and Materials standard method for collection and analysis of dustfall (ASTM D1739-98). This method employs a simple device consisting of a cylindrical container (not less than 150 mm in diameter) half-filled with de-ionised water exposed for one calendar month (30 ±2 days). The water is treated with an inorganic biocide to prevent algal growth in the buckets. The most common reagent used for this is a 10% copper sulphate solution (approximately 3 ml per litre of water bucket).

The bucket stand should comprise a wind shield at the level of the the rim of the bucket to provide an aerodynamic shield (Figure 1). The bucket holder is connected to a 2 m galvanized steel pole, which is either directly attached to a fence post or can be attached to a galvanized steel base plate.. This allows for a variety of placement options for the fallout samplers. Exposed buckets, when returned to the laboratories, are rinsed with deionised water to remove residue from the sides of the bucket, and the bucket contents filtered through a coarse (>1 mm) filter to remove insects and other course organic detritus. The sample is then filtered through a pre-weighed paper filter to remove the insoluble fraction, or dust fallout. This residue and filter are dried, and gravimetrically analysed to determine the insoluble fraction (dust fallout).

Figure 1: Single dust bucket monitor

Figure 2: Four bucket wind directional bucket monitor

The four bucket wind directional bucket monitors also comprises cylindrical 5 L containers half-filled with de-ionised, treated water which are exposed for one calendar month (30 ±2 days). The monitor however comprises a cluster of four buckets, a rotating lid above the buckets and a wind vane (Figure 2). The lid is designed so as to close three of the buckets whilst allowing the fourth bucket to be open. The prevailing wind direction determines which of the buckets is open at any given time. E.g. the monitor could be installed so that northerly, southerly, easterly and westerly winds result in buckets 1, 2, 3 and 4 being open respectively. The aim of using this monitor is to link dust deposition to different airflow field and hence to sources located in the direction from which the wind is blowing. Wind directional bucket monitors are typically used to identify neighbouring source contributions to dust deposition at the monitoring location according to the relative quantity of dust collect in each of the buckets. The quantitative results are however not directly comparable to the results of the ASTM method

3.2 Sulphur Dioxide Monitoring

Passive diffusive monitoring is the proposed method for monitoring ambient SO_2 concentrations due to brick making facilities.

Passive sampling takes samples of gas or vapour pollutants from the atmosphere through a static air layer or permeation through a membrane. The rate of flow is controlled by physical processes such diffusion and does not involve the active movement of air though the sampler by means of a pump. Passive samplers thus measure concentrations of pollutants based on the rate of chemical reactions and molecular diffusion. Advantages of these samplers include the following:

- no electricity nor field calibration is required
- samples are easy to prepare, assemble and analyse
- low capital and operational cost (facilitating the installation of several samplers in non-secure areas to enhance the potential for data collection)
- no field maintenance is required
- constant sampling rate

Passive diffusive samplers typically have an analytical detection limit of 0.2 $\mu g/m^3$ for SO_2 and a precision of $\pm 5\%$. The samplers are typically exposed for a month, following which they are collected and sent to a laboratory for analysis.

4. Guidance on Mitigation Measures at Clay Brick Facilities

4.1 Main sources of emissions at Clay Brick Facilities

Main sources of particulate emissions at clay brick facilities are typically unpaved access roads and the combustion of coal during the firing process.

SO_2 primarily derive from the combustion of fuel.

4.2 Possible mitigation measures

4.2.1 Unpaved Access Roads

Vehicle entrained dust from unpaved road surfaces resulted in high impacts near the source and off-site during both construction and operational phase predictions.

Three types of measures may be taken to reduce emissions from unpaved roads: (a) measures aimed at reducing the extent of unpaved roads, e.g. paving, (b) traffic control measures aimed at reducing the entrainment of material by restricting traffic volumes and reducing vehicle speeds, and (c) measures aimed at binding the surface material or enhancing moisture retention, such as wet suppression and chemical stabilization (EPA, 1987; Cowhert *et al.*, 1988; APCD, 1995). It is standard practice at most facilities to utilise water trucks on the unpaved roads.

In addition, chemical suppressants can be added to water to increase the control efficiency and typically result in less water required. Roads can also be treated on a semi-permanent basis with chemicals resulting in a surface similar to that of a paved road.

4.2.2 Kiln Operations

Improving the combustion efficiency of existing kilns, and upgrading kilns to newer and more efficient process designs (Hamner, 2006). The table below lists several low-cost ways to reduce waste and pollution in brick making. Company environmental programs should demonstrate that these options have been considered thoroughly.

Table 4: Solutions to Increase Efficiency and Reduce Waste in Clay Brick Production (Hamner, 2006)

Stack fuel around bricks to facilitate preheating	Solid fuel is mixed with the bricks throughout the kiln, either as sawdust mixed into the brick mass or as fuel channels in different levels of the kiln. By doing this, a combustion zone can be generated in the kiln that gradually moves upwards, using the residual heat in the lower, already burnt bricks for preheating of combustion air. The residual heat in the flue gasses is used for drying and preheating of the higher levels of crude bricks.
Improve brick drying before firing	Extended drying time reduces fuel requirements. Even drying throughout brick stacks reduces defective firing of bricks.
Improve air flow control	Stopping all air leaks and controlling the kiln opening size allows better control of air flow speed and direction to improve combustion
Switch to propane or natural gas fuel	If available and competitively priced, these fuels have significantly less emissions and can increase production quality and speed.
New kiln design	Vertical shaft brick kilns allow increased production rates and significantly decreased emissions through improved combustion air flow efficiency. Several other kiln designs have also proven to be relatively low-cost and much more efficient than traditional ovens or kilns.

5. Conclusion

In summary there are two limits applicable to the Clay Brick Manufacturing plants to ensure compliance with future air quality legislation. These are summarized in Table

Table 5: Compliance requirements and implementation guidelines

Monitoring Strategy Criteria	Ambient SO_2 Monitoring	Dustfall Monitoring
Monitoring objectives	▪ Compliance with Listed Activities requirements for process 5.2 ▪ Facilitate the measurement of progress against environmental targets within the main impact zone of the operation ▪ Temporal trend analysis to determine whether improvements or deterioration of ambient air is occurring within the main impact zone of the operation ▪ Tracking of progress due to pollution control measure implementation ▪ Informing the public about the extent of ambient sulphur dioxide concentrations	▪ Compliance with Listed Activities requirements for process 5.2 ▪ Facilitate the measurement of progress against environmental targets within the main impact zone of the operation ▪ Temporal trend analysis to determine the potential for nuisance impacts within the main impact zone of the operation ▪ Tracking of progress due to pollution control measure implementation ▪ Informing the public of the extent of localised dust nuisance impacts occurring in the vicinity of the operations
Monitoring location(s)	▪ At the facility boundary ▪ At facility boundary near residential areas if in urban environment	▪ 8 Dust fallout buckets (single/ directional) at the facility boundary in the eight principal wind directions
Sampling techniques	Passive Diffusive SO_2 sampling – operates in accordance with the Licensing Authority Method	*Single Bucket Dust Fallout Monitors* Single bucket fallout monitors to be deployed following the American Society for Testing and Materials standard method for collection and analysis of dustfall (ASTM D1739). *Four-bucket Wind-Directional Monitors* The monitor comprises four buckets with a rotating lid comprising a gap to permit dust collection in one bucket.
Sampling frequency and duration	Continuous SO_2 monitoring – monthly data collection and analysis – data stored as monthly averages and periodically (annually) reported.	On-going, continuous monitoring to be implemented facilitating data collection over 1-month averaging period as a 3 month running average
Commitment to QA/QC protocol	Comprehensive QA/QC protocol implemented, including monthly servicing of sites and regular calibrations of instruments.	Comprehensive QA/QC protocol implemented
Interim environmental targets	Recommended: Maximum sulphur dioxide concentrations not to exceed 50 $\mu g/m^3$ for annual averaging periods (based on the SANS 1929:2004 limits)	Maximum total daily dustfall (calculated from total monthly dustfall) of not greater than 600 $mg/m^2/day$ for residential areas. Maximum annual average dustfall to be less than 1200 $mg/m^2/day$ on-site
Action to be taken if targets are not met	▪ Source contribution quantification ▪ Review of current control measures for significant sources (implementation of contingency measures where applicable)	▪ Source contribution quantification ▪ Review of current control measures for significant sources (implementation of contingency measures where applicable)
Progress reporting	At least twice annually to the necessary authorities and community forum	

6. References

APCD (1995): *Colorado State Implementation Plan for Particulate Matter (PM10) - Denver Metropolitan Nonattainment Area Element*, jointly prepared by Regional Air Quality Council and Colorado Department of Health, Air Pollution Control Division, signed into law on May 31 1995.

ASTM D1739-98 (2004): Standard test Method for Collections and Measurement of Dustfall (Settleable Particulate Matter). American Society for Testing and Materials.

Cowherd C, Muleski GE and Kinsey JS, (1988): Control of Open Fugitive Dust Sources, EPA-450/3-88-008, US Environmental Protection Agency, Research Triangle Park, North Carolina.

Hamner B, (2006): The Clay Brick Industry: Improvement of Resource Efficiency and Environmental performance http://www.cleanerproduction.com/Directory/sectors/subsectors/clay.html

SANS (2004): *South African National Standard, Ambient air quality — Limits for common Pollutants*, SANS 1929:2004 Edition 1, Published by Standards South Africa, Pretoria, 2004.